SMART Spectro

Spectrophotometer

# OPERATOR'S MANUAL

v3.0 and higher • Printed 2.11

2000-01-MN

LaMotte

# CONTENTS

# GENERAL INFORMATION

## ■ PACKAGING & DELIVERY

Experienced packaging personnel at LaMotte Company assure adequate protection against normal hazards encountered in transportation of shipments. After the product leaves the manufacturer, all responsibility for its safe delivery is assured by the transportation company. Damage claims must be filed immediately with the transportation company to receive compensation for damaged goods.

Should it be necessary to return the instrument for repair or servicing, pack instrument carefully in suitable container with adequate packing material. A return authorization number must be obtained from LaMotte Company by calling 1-800-344-3100. Attach a letter with the authorization number to the shipping carton which describes the kind of trouble experienced. This valuable information will enable the service department to make the required repairs more efficiently.

## ■ GENERAL PRECAUTIONS

Before attempting to set up or operate this instrument it is important to read the instruction manual. Failure to do so could result in personal injury or damage to the equipment.

The SMART Spectro should not be stored or used in a wet or corrosive environment. Care should be taken to prevent water or reagent chemicals from wet spectrophotometer tubes from entering the SMART Spectro chamber.

NEVER PUT WET TUBES IN SPECTROPHOTOMETER.

## ■ SAFETY PRECAUTIONS

Read the labels on all LaMotte reagent containers prior to use. Some containers include precautionary notices and first aid information. Certain reagents are considered hazardous substances and are designated with a * in the instruction manual. Material Safety Data Sheets (MSDS) available at www.lamotte.com. Read the accompanying MSDS before using these reagents. Additional emergency information for all LaMotte reagents is available 24 hours a day from the Poison Control Center listed in the front of the phone book or by contacting the 24 hour emergency line for ChemTel 1-800-255-3924 (USA, Canada, Puerto Rico); locations outside the North American continent 813-248-0585. Be prepared to supply the name and four-digit LaMotte code number found on the container label or at the top of the MSDS or in the contents list for the test procedure. LaMotte reagents are registered with a computerized poison control information system available to all local poison control centers.

Keep equipment and reagent chemicals out of the reach of young children.

## ■ LIMITS OF LIABILITY

Under no circumstances shall LaMotte Company be liable for loss of life, property, profits, or other damages incurred through the use or misuse of their products.

## ■ WARRANTY

LaMotte Company warrants this instrument to be free of defects in parts and workmanship for 2 years from the date of shipment. If it should become necessary to return the instrument for service during or beyond the warranty period, contact our Technical Service Department at 1-800-344-3100 for a return authorization number or visit www.lamotte.com for troubleshooting help. The sender is responsible for shipping charges, freight, insurance and proper packaging to prevent damage in transit. This warranty does not apply to defects resulting from action of the user such as misuse, improper wiring, operation outside of specification, improper maintenance or repair, or unauthorized modification. LaMotte Company specifically disclaims any implied warranties or merchantability or fitness for a specific purpose and will not be liable for any direct, indirect, incidental or consequential damages. LaMotte Company's total liability is limited to repair or replacement of the product. The warranty set forth above is inclusive and no other warranty, whether written or oral, is expressed or implied.

## ■ SPECIFICATIONS

INSTRUMENT TYPE: Single beam spectrophotometer

| | |
|---|---|
| Readout | 5 line, 18 character per line LCD |
| Wavelengths | 350-1000 nm |
| Wavelength Accuracy | ± 2 nm |
| Wavelenth Resolution | 1 nm |
| Wavelength Bandwidth | 5 nm (max) |
| Photometric Range | 0-125%T, –0.1-2.5A |
| Photometric Accuracy | ± 0.005A |
| Photometric Stray Light | <0.5%T |
| Dispersive Device | 1200 Lines/mm ruled grating |
| Sample Chamber | Accepts 25 mm diameter flat-bottomed test tubes, 10 mm square cuvettes, 16 mm COD test tubes |
| Source Lamp | Quartz halogen |
| Modes | %/T, ABS, pre-programmed tests |
| Pre-Programmed Tests | YES, with automatic wavelength selection |
| Languages | English or Chinese |
| User Defined Tests | Up to 25 user tests can be input |
| RS232 Port | 8 pin mDIN |
| Power Requirements | Battery Operation (optional): Ni-Metal Hydride battery pack Line Operation: 110/220V, 50/60 Hz |
| Dimensions | 36 cm (wide) x 28 cm (deep) x 17 cm (tall) |
| Weight | 10.3 lbs, 4.65 kgs |

## ■ STATISTICAL AND TECHNICAL DEFINITIONS RELATED TO PRODUCT SPECIFICATIONS

Method Detection Limit (MDL): “The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.”[1] Note that, “As Dr. William Horwitz once stated, ‘In almost all cases when dealing with a limit of detection or limit of determination, the primary purpose of determining that limit is to stay away from it.’”[2]

1.CFR 40, part 136, appendix B

2.Statistics in Analytical Chemistry: Part 7 – A Review, D. Coleman and L Vanatta, American Laboratory, Sept 2003, P. 31.

**Precision:** Precision is the numerical agreement between two or more measurements.[3] The precision can be reported as a range for a measurement (difference between the min and max). It can also be reported as the standard deviation or the relative standard deviation. It is a measure of how close together the measurements are, not how close they are to the correct or true value. *The precision can be very good and the accuracy very bad. This is a useful measure of the performance of a test method.*

3.Skoog, D.A., West, D. M., Fundamental of Analytical Chemistry, 2nd ed., Holt Rinehart and Winston, Inc, 1969, p. 26.

**Accuracy:** Accuracy is the nearness of a measurement to the accepted or true value.4 The accuracy can be expressed as a range, about the true value, in which a measurement occurs (i.e. ±0.5 ppm). It can also be expressed as the % recovery of a know amount of analyte in a determination of the analyte (i.e. 103.5 %). This is a useful measure and what most customers are interested in when they want to know about the performance of a test method.

4.Skoog D.A., West D. M., Fundamental of Analytical Chemistry, 2nd ed., Holt Rinehart and Winston, Inc, 1969, p. 26.

**Resolution:** Resolution is the smallest discernible difference between any two measurements that can be made.5 For meters this is usually how many decimal places are displayed. (i.e. 0.01). For titrations and various comparators it is the smallest interval the device is calibrated or marked to (i.e. 1 drop = 10 ppm, 0.2 ppm for a DRT, or ±half a unit difference for an octaslide or color chart). Note that the resolution many change with concentration or range. In some cases the resolution may be less than the smallest interval, if it is possible to make a reading that falls between calibration marks. This is often done with various comparators. One caveat is, that resolution has very little relationship to accuracy or precision. The resolution will always be less than the accuracy or precision but it is not a statistical measure of how well a method of analysis works. The resolution can be very very good and the accuracy and precision can be very, very bad! This is not a useful measure of the performance of a test method.

5.Statistics in Analytical Chemistry: Part 7 – A Review, D. Coleman and L Vanatta, American Laboratory, Sept 2003, P. 34.

**Sensitivity:** Sensitivity is the resolution based on how this term is used in LaMotte catalogs. This term is not listed in any of the references. Sometimes it is used for detection limit. It is a confusing term and should be avoided.

**Repeatability:** Repeatability is the within-run precision.[6] A run is a single data set, from set up to clean up. Generally, one run occurs on one day. However, for meter calibrations, a single calibration is considered a single run or data set, even though it may take 2 or 3 days.

6.Jeffery G. H., Basset J., Mendham J., Denney R. C., Vogel's Textbook of Quantitative Chemical Analysis, 5th ed., Longman Scientific & Technical, 1989, p. 130.

Reproducibility: Reproducibility is the between-run precision.[7]

7.Jeffery G. H., Basset J., Mendham J., Denney R. C., Vogel's Textbook of Quantitative Chemical Analysis, 5th ed., Longman Scientific & Technical, 1989, p. 130.

## ■ CONTENTS AND ACCESSORIES

CONTENTS

| | |
|---|---|
| SMART Spectro Spectrophotometer | Battery Charger |
| Test Tubes, with Caps | Power Supply, 110/220V |
| Sample Cell Holder, Universal | SMART Spectro Quick Start Guide |
| Sample Cell Holder, 10 mm Square | SMART Spectro Manual |
| Power Cable | |

NOTE: The battery pack is not included and must be purchased separately. An empty slot is located in the original foam for the battery pack.

## ■ ACCESSORIES

| | |
|---|---|
| Battery Pack with Holder (rechargeable) | Code 2000-BP |
| Carrying Case | Code 2000-CS |
| SMARTLink 2 Software with Cable (compact disk) | Code 1912-CD |

## ■ EPA COMPLIANCE

The SMART Spectro is an EPA-Accepted instrument. EPA-Accepted means that the instrument meets the requirements for instrumentation as found in test procedures that are approved for the National Primary Drinking Water Regulations (NPDWR) or National Pollutant Discharge Elimination System (NPDES) compliance monitoring programs. EPA-Accepted instruments may be used with approved test procedures without additional approval.

## ■ CE COMPLIANCE

The SMART Spectrophotometer has been independently tested and has earned the European CE Mark of Compliance for electromagnetic compatibility and safety. To view the Declaration of Conformity go to www.lamotte.com.

# CHEMICAL TESTING

## ■ WATER SAMPLING FOR CHEMICAL ANALYSIS

### Taking Representative Samples

The underlying factor to be considered for any type of water sampling is whether or not the sample is truly representative of the source. To properly collect a representative sample:

- Sample as frequently as possible.
- Collect a large sample or at least enough to conduct whatever tests are necessary.
- Make a composite sample for the same sampling area.
- Handle the sample in such a way as to prevent deterioration or contamination before the analysis is performed.
- Perform analysis for dissolved gases such as dissolved oxygen, carbon dioxide, and hydrogen sulfide immediately at the site of sampling. These factors, as well as samples for pH testing, cannot be stored for later examination.
- Make a list of conditions or observations which may affect the sample. Other considerations for taking representative samples are dependent upon the source of the sample. Taking samples from surface waters involves different considerations than taking samples from impounded and sub-surface waters.

## ■ Sampling of Open Water Systems

Surface waters, such as those found in streams and rivers, are usually well mixed. The sample should be taken downstream from any tributary, industrial or sewage pollution source. For comparison purposes samples may be taken upstream and at the source of the pollution.

In ponds, lakes, and reservoirs with restricted flow, it is necessary to collect a number of samples in a cross section of the body of water, and where possible composite samples should be made to ensure representative samples.

To collect samples from surface waters, select a suitable plastic container with a tight fitting screw cap. Rinse the container several times with the sample to be tested, then immerse the container below the surface until it is filled to overflowing and replace the cap. If the sample is not to be tested immediately, pour a small part of the sample out and reseal. This will allow for any expansion. Any condition which might affect the sample should be listed.

Sub-surface sampling is required to obtain a vertical profile of streams, lakes, ponds, and reservoirs at specific depths. This type of sampling requires more sophisticated sampling equipment.

For dissolved oxygen studies, or for tests requiring small sample sizes, a Water

Sampler (LaMotte Code 1060) will serve as a sub-surface or in-depth sampler. This weighted device is lowered to the sampling depth and allowed to rest at this depth for a few minutes. The water percolates into the sample chamber displacing the air which bubbles to the surface. When the bubbles cease to rise, the device has flushed itself approximately five times and it may be raised to the surface for examination. The inner chamber of the sampling device is lifted out and portions of the water sample are carefully dispensed for subsequent chemical analysis.

A Snap-Plunger Water Sampler (LaMotte Code 1077) is another "in-depth" sampling device which is designed to collect large samples which can be used for a multitude of tests. Basically, this collection apparatus is a hollow cylinder with a spring loaded plunger attached to each end. The device is cocked above the surface of the water and lowered to the desired depth. A weighted messenger is sent down the calibrated line to trip the closing mechanism and the plungers seal the sample from mixing with intermediate layers as it is brought to the surface. A special drain outlet is provided to draw off samples for chemical analysis.

### Sampling of Closed System

To obtain representative samples from confined water systems, such as pipe lines, tanks, vats, filters, water softeners, evaporators and condensers, different considerations are required because of chemical changes which occur between the inlet and outlet water. One must have a basic understanding of the type of chemical changes which occur for the type of equipment used. Also, consideration should be given to the rate of passage and retaining time for the process water.

Temperature changes play an important part in deciding exactly what test should be performed. Process water should be allowed to come to room temperature, 20–25°C, before conducting any tests.

When drawing off samples from an outlet pipe such as a tap, allow sample to run for several minutes, rinsing the container several times before taking the final sample. Avoid splashing and introduction of any contaminating material.

## ■ FILTRATION

When testing natural waters that contain significant turbidity due to suspended solids and algae, filtration is an option. Reagent systems, whether EPA, Standard Methods, LaMotte or any others, will generally only determine dissolved constituents. Both EPA and Standard Methods suggest filtration through a 0.45 micron filter membrane, to remove turbidity, for the determination of dissolved constituents.** To test for total constituents, organically bound and suspended or colloidal materials, a rigorous high temperature acid digestion is necessary.

**LaMotte offers a filtering apparatus: syringe assembly (Code 1050) and membrane filters, 0.45 micron, (Code 1103).

## ■ AN INTRODUCTION TO COLORIMETRIC ANALYSIS & SPECTROSCOPY

Most test substances in water are colorless and undetectable to the human eye. To test for their presence we must find a way to “see” them. The LaMotte SMART Spectro can be used to measure any test substance that is itself colored or can be reacted to produce a color. In fact a simple definition of colorimetry is “the measurement of color” and a colorimetric method is “any technique used to evaluate an unknown color in reference to known colors”. In a colorimetric chemical test the intensity of the color from the reaction must be proportional to the concentration of the substance being tested. Some reactions have limitations or variances inherent to them that may give misleading results. Many such interferences are discussed with each particular test instruction. In the most basic colorimetric method the reacted test sample is visually compared to a known color standard. However, accurate and reproducible results are limited by the eyesight of the analyst, inconsistencies in the light sources, and the fading of color standards.

To avoid these sources of error, a colorimeter or spectrophotometer can be used to photoelectrically measure the amount of colored light absorbed by a colored sample in reference to a colorless sample (blank).

White light is made up of many different colors or wavelengths of light. A colored sample typically absorbs only one color or one band of wavelengths from the white light. Only a small difference would be measured between white light before it passes through a colored sample versus after it passes through a colored sample. The reason for this is that the one color absorbed by the sample is only a small portion of the total amount of light passing through the sample. However, if we could select only that one color or band of wavelengths of light to which the test sample is most sensitive, we would see a large difference between the light before it passes through the sample and after it passes through the sample.

The SMART Spectro uses a quartz halogen lamp as the source of white light. The white light passes through an entrance slit and is focused on a ruled grating consisting of 1200 lines/mm. The grating causes the light to be dispersed into various component wavelengths. The monochromator design allows the user to select which specific wavelength of interest will be passed through the exit slit and through the sample. The use of mirrors and additional filters prevents light of undesired wavelengths (overtones, stray light) from making it to the sample. A photodetector measures the amount of light which passes through the sample.

The difference in the amount of monochromatic light transmitted through a colorless sample (blank) and the amount of monochromatic light transmitted through a test sample is a measurement of the amount of monochromatic light absorbed by the sample. In most colorimetric tests the amount of monochromatic light absorbed is directly proportional to the concentration of the test factor producing the color and the path length through the sample. However, for a few tests the relationship is reversed and the amount of monochromatic light absorbed is inversely proportional to the concentration of the test factor.

The choice of the correct wavelength for testing is important. It is interesting to note that the wavelength that gives the most sensitivity (lower detection limit) for a test factor is the complementary color of the test sample. For example the Nitrate-Nitrogen test produces a pink color proportional to the nitrate concentration in the sample (the greater the nitrate concentration, the darker the pink color). A wavelength in the green region should be selected to analyze this sample since a pinkish-red solution absorbs mostly green light.

## ■ REAGENT BLANK

Some tests will provide greater accuracy if a reagent blank is determined to compensate for any color or turbidity resulting from the reagents themselves. A reagent blank is performed by running the test procedure on 10 mL of demineralized or deionized water. Use sample water to SCAN BLANK. Insert the reacted reagent blank in the colorimeter chamber and select SCAN SAMPLE. Note result of reagent blank. Perform the tests on the sample water as described. Subtract results of reagent blank from all subsequent test results.

NOTE: Some tests require a reagent blank to be used to SCAN BLANK.

## ■ SPECTROPHOTOMETER TUBES

Spectrophotometer tubes which have been scratched through excessive use should be discarded and replaced with new ones. Dirty tubes should be cleaned on both the inside and outside. Fingerprints on the exterior of the tubes can cause excessive light scattering and result in errors. Handle the tubes carefully, making sure the bottom half of the tube is not handled.

LaMotte Company makes every effort to provide high quality spectrophoto-

meter tubes. However, wall thicknesses and diameter of tubes may still vary slightly. This may lead to slight variations in results (e.g. if a tube is turned while in the sample chamber, the reading will likely change slightly). To eliminate this error put the tubes into the sample chamber with the same orientation every time.

The tubes that are included with the spectrophotometer have an index mark to facilitate this. If possible, use the same tube to SCAN BLANK and SCAN SAMPLE.

## ■ SELECTING AN APPROPRIATE WAVELENGTH

The most appropriate wavelength to use when creating a calibration curve is usually the one which gives the greatest change from the lowest reacted standard concentration to the highest reacted standard concentration. However, the absorbance of the highest reacted standard concentration should never be greater than 2.0 absorbance units. Scan the lowest and highest reacted standards at different wavelengths using the %T/ABS mode to find the wavelength which gives the greatest change in absorbance without exceeding 2.0 absorbance units. Use this wavelength to create a calibration curve.

Below is a list of suggested wavelength ranges for the color of the reacted samples. Use these as a starting point.

| Sample Color | Wavelength Range |
|---|---|
| Yellow | 350-450 |
| Yellow-Orange | 450-490 |
| Orange | 490-510 |
| Pink | 510-570 |
| Red | 570-600 |
| Green and Blue | 600-750 |

## ■ CALIBRATION CURVES

The SMART Spectro contains precalibrated tests for the LaMotte reagent systems. The first step in using a non-LaMotte reagent system with the SMART Spectro is to create a calibration curve for the reagent system. To create a calibration curve, prepare standard solutions of the test factor and use the reagent system to test the standard solutions with the SMART Spectro.

Plot the results (in ABS or %Transmittance) versus concentration to create a calibration curve. The calibration curve may then be used to identify the concentration of an unknown sample by testing the unknown, reading Absorbance or %T, and finding the corresponding concentration from the curve. The linear range of the reagent system can be determined and this information can be used to input a User Test into the SMART Spectro (see EDIT USER TESTS, page 35).

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PROCEDURE

1. Prepare 5 or 6 standard solutions of the factor being tested. The concentration of these standards should be evenly distributed throughout the range of the reagent system, and should include a 0 ppm standard (distilled water). For instance, the solutions could measure 0, 10%, 30%, 50%, 70%, and 90% of the system's maximum range.

2. Turn on the SMART Spectro. Select the appropriate %T/ABS wavelength from the %T/ABS mode. Be sure to select the appropriate wavelength for the color produced by the reagent system.

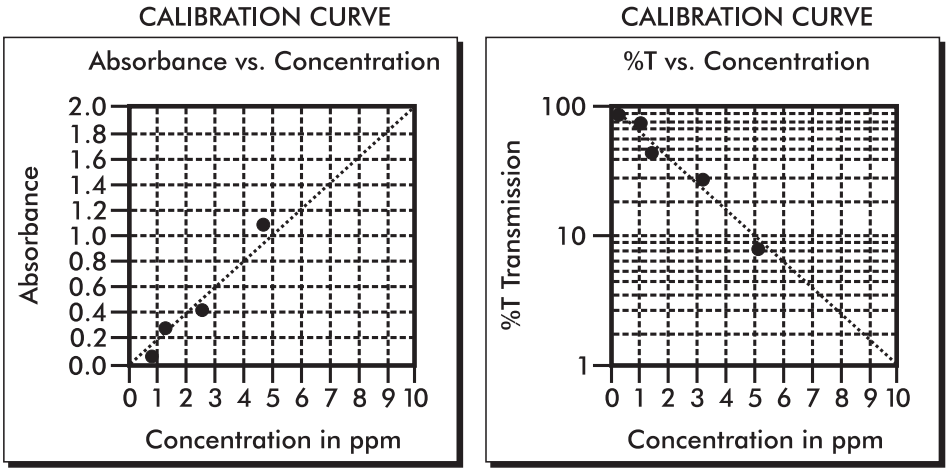
3. Use the unreacted 0 ppm standard to standardize the spectrophotometer by using it to scan blank.

4. Following the individual reagent system instructions, react each standard solution including 0 ppm. Record the reading and the standard solution concentration on a chart. Readings can be recorded as percent transmittance (%T) or absorbance (A).

5. Plot results on graph paper or computer using any available plotting program. If results are as %T versus concentration, semilog graph paper must be used. Plot the standard solution concentrations on the horizontal, linear axis, and the %T on the vertical, logarithmic axis. If results are as absorbance versus standard solution concentration, simple linear graph paper can be used. Plot the standard solution concentration on the horizontal axis, and the absorbance on the vertical axis.

6. After plotting the results, draw a line, or curve, of best fit through the plotted points. The best fit may not connect the points. There should be approximately an equal number of points above the curve as below the curve. Some reagent systems will produce a straight line, while others produce a curve. Many computer spreadsheet programs can produce the curve of best fit by regression analysis of the standard solution data.

*A sample of each type of graph appears below:*



## PREPARING DILUTE STANDARD SOLUTIONS

Standard solutions should be prepared to create a calibration curve. Standard solutions can be prepared by diluting a known concentrated standard by specified amounts. A chart or computer spreadsheet can be created to determine the proper dilutions. Use volumetric flasks and volumetric pipets for all dilutions.

1. In Column A – Record the maximum concentration of test as determined by the range and path length.
2. In Column B – Record the percent of the maximum concentration the standard solution will be.
3. In Column C – Calculate the final concentration of the diluted standard solutions by multiplying the maximum concentration (In Column A) by the % of maximum concentration divided by 100. (C = A x ).
4. In Column D – Record the final volume of the diluted sample (i.e. volume of volumetric flask).
5. In Column E – Record the concentration of the original standard.
6. In Column F – Calculate the milliliters of original standard required (C x D/E = F).

*A sample chart appears below:*

| A | B | C=A x B/100 | D | E | F=C x D/E |
|---|---|---|---|---|---|
| Maximum concentration of test | % of Maximum concentration | Final concentration of Diluted Standard | Volume of Standard | Concentration of Original Standard | mL of Original Standard Required |
| 10.0 ppm | 90 | 9.0 ppm | 100 mL | 1000 ppm | 0.90 mL |
| 10.0 ppm | 70 | 7.0 ppm | 100 mL | 1000 ppm | 0.70 mL |
| 10.0 ppm | 50 | 5.0 ppm | 100 mL | 1000 ppm | 0.50 mL |
| 10.0 ppm | 30 | 3.0 ppm | 100 mL | 1000 ppm | 0.30 mL |
| 10.0 ppm | 10 | 1.0 ppm | 100 mL | 1000 ppm | 0.10 mL |
| 10.0 ppm | 0 | 0 ppm | 100 mL | 1000 ppm | 0 mL |

## ■ STANDARD ADDITIONS

A common method to check the accuracy and precision of a test is by standard additions. In this method a sample is tested to determine the concentration of the test substance. A second sample is then “spiked” by the addition of a known quantity of the test substance. The second sample is then tested. The determined concentration of the spiked sample should equal the concentration of the first plus the amount added with the spike. The procedure can be repeated with larger and larger “spikes.” If the determined concentrations do not

equal the concentration of the sample plus that added with the “spike”, then an interference may exist.

For example, a 10.0 mL water sample was determined to contain 0.3 ppm iron. To a second 10.0 mL sample, 0.1 mL of 50 ppm iron standard was added. The concentration of iron due to the “spike” was (0.10 mL x 50 ppm)/10.0 mL = 0.50 ppm. The concentration of iron determined in the spiked sample should be 0.3 + 0.5 = 0.8 ppm iron.

(Note: any error due to the increased volume from the “spike” is negligible).

LaMotte offers a line of calibration standards which can be used to generate calibration curves and perform standard additions.

## ■ SAMPLE DILUTION TECHNIQUES & VOLUMETRIC MEASUREMENTS

If a test result using the SMART gives an OUT OF RANGE message then the sample concentration could be over range or under range. If it is over range, the sample must be diluted. Then the test should be repeated on the diluted sample to obtain a reading which is in the concentration range for the test. (Note: This is not true for colorimetric determination of pH.)

*Example:*

Measure 5 mL of the water sample into a graduated cylinder. Add demineralized water until the cylinder is filled to the 10 mL line. The sample has been diluted by one-half, and the dilution factor is therefore 2. Perform the test procedure, then multiply the resulting concentration by 2 to obtain the test result.

The following table gives quick reference guidelines on dilutions of various proportions. All dilutions are based on a 10 mL volume, so several dilutions will require small volumes of the water sample. Graduated pipets should be used for all dilutions.

| Size of Sample | Deionized Water to Bring Volume to 10 mL | Multiplication Factor |
|---|---|---|
| 10 mL | 0 mL | 1 |
| 5 mL | 5 mL | 2 |
| 2.5 mL | 7.5 mL | 4 |
| 1 mL | 9 mL | 10 |
| 0.5 mL | 0.5 mL | 20 |

If the above glassware is not available, dilutions can be made with the spectrophotometer tube. Fill the tube to the 10 mL line with the sample then transfer it to another container. Add 10 mL volumes of demineralized water to the container and mix. Transfer back 10 mL of the diluted sample to the tube and follow the test procedure. Continue diluting and testing until a reading,

which is in the concentration range for the test, is obtained. Be sure to multiply the concentration found by the dilution factor (the number of total 10 mL volumes used).

*Example:*

10 mL of sample is diluted with three 10 mL volumes of demineralized water; the dilution factor is four.

## ■ INTERFERENCES

LaMotte reagent systems are designed to minimize most common interferences. Each individual test instruction discusses interferences unique to that test. Be aware of possible interferences in the water being tested.

The reagent systems also contain buffers to adjust the water sample to the ideal pH for the reaction. It is possible that the buffer capacity of the water sample may exceed the buffer capacity of the reagent system and the ideal pH will not be obtained. If this is suspected, measure the pH of a reacted distilled water reagent blank using a pH meter. This is the ideal pH for the test. Measure the pH of a reacted water sample using the pH meter. If the pH is significantly different from the ideal value, the pH of the sample should be adjusted before testing.

Chlorine interferences can be removed with the use of glycine. Very high levels of chloramines may interfere if the test result is not read immediately. Oxidized manganese interferes but can be removed with arsenite. Bromine and iodine interferes but can be removed with a thioacetamide blank correction.

Interferences due to high concentration of the substance being tested, can be overcome by sample dilution (see page 16).

## ■ STRAY LIGHT INTERFERENCE

Normal indoor lighting causes no interference with the SMART. Always be sure the sample chamber lid is closed when scanning blanks or samples.

# OPERATION OF THE SMART SPECTRO

## ■ OVERVIEW

The SMART Spectro is a portable, microprocessor controlled, direct reading, single beam spectrophotometer. It has a 5 line, 18 character liquid crystal display for alphabetical and numerical messages. The operation is controlled with the keypad through menu driven software in response to selections shown on the display.

The test library consists of over 80 LaMotte tests and 25 “User Tests”. The spectrophotometer is also capable of running %T/Absorbance tests over the entire wavelength range of 350 - 1000 nm. The LaMotte tests are precalibrated for LaMotte reagent systems. The spectrophotometer displays the results of these tests directly in units of concentration. The 25 “User Tests” may be used to enter additional calibrations. All of these tests may be arranged in any of 3 sequences. These sequences can be modified a limitless number of times to meet changing testing needs.

The optics feature a quartz halogen bulb as a light source with a minimum life expectancy of 1000 hours. The incident white light is dispersed into its component wavelengths by a 1200 lines/mm ruled grating. The microprocessor controls the positioning of the grating, automatically positioning the grating to the correct wavelength for the test that has been selected. The monochromatic light is passed through the sample cell and is detected by a silicon photodiode.

The SMART Spectro is powered by an AC adapter that automatically recognizes the input voltage (110/220V) and converts it to the 12V needed to run the instrument. An optional battery pack is available for use where portability is important. To save power an automatic shut-off feature can be utilized (Energy Savings Mode).

A RS-232 serial port on the back of the spectrophotometer, and optional software, allows the spectrophotometer to be interfaced with a Winows-based personal computer for real time data acquisition and data storage. This port also allows an interface with a RS-232 serial printer.

Due to its portability, alternate power sources, and rugged construction, the SMART Spectro is ideal for lab and field use.

## ■ POWER SOURCE

To use the SMART Spectro with an AC power supply:

1. Plug the Power Supply into the AC Adapter socket on the back of the SMART Spectro.
2. Connect the Power Cable to the Power Supply and an electrical outlet.

To use the Battery Pack, see page 51.

## ■ COMPONENTS

Figure 1 shows a diagram of the SMART Spectro and the components.


Figure 1

# QUICK START

| | |
|---|---|
| 1. Press **ON**. The LaMotte logo screen will appear for about 2 seconds and the MAIN MENU will appear. | MAIN MENU 12:00:01<br>* CALIBRATE WL<br>PROGRAMMED TESTS<br>%T/ABS<br>PC LINK |
| 2. Press ▲ or ▼ to scroll to PROGRAMMED TESTS. | MAIN MENU 12:00:01<br>CALIBRATE WL<br>* PROGRAMMED TESTS<br>%T/ABS<br>PC LINK |
| 3. Press ***ENTER** to select **PROGRAMMED TESTS.** | PROGRAMMED TESTS<br>* SEQUENCE 1<br>SEQUENCE 2<br>SEQUENCE 3<br>ALL TESTS |
| 4. Press ▼ to scoll t**o ALL TESTS**. | PROGRAMMED TESTS<br>SEQUENCE 1<br>SEQUENCE 2<br>SEQUENCE 3<br>* ALL TESTS |
| 5. Press ***ENTER** to select **ALL TESTS.** | ALL TESTS<br>* 1 Alkalinity-UDV<br>2 Aluminum<br>3 Ammonia-N L F<br>4 Ammonia-N L S |

| | |
|---|---|
| 6. PresS ▲ or ▼ to scroll to the desired test. | ALL TESTS<br>1 Alkalinity-UDV<br>* 2 Aluminum<br>3 Ammonia-N L F<br>4 Ammonia-N L s |

| | |
|---|---|
| 7. Press ***ENTER** to select the test. | 2 Aluminum<br>* SCAN BLANK<br>SCAN SAMPLE<br>END 535 NM |

| | |
|---|---|
| 8. Insert the blank. Press ***ENTER** to scan the blank. | 2 Aluminum<br>SCAN BLANK<br>* SCAN SAMPLE<br>END 535 NM |

| | |
|---|---|
| 9. Insert the reacted sample. Press ***ENTER** to scan the sample. The result will be displayed. | 2 Aluminum<br>T = 16.5%T<br>A = 0.7834A<br>C = 1.28 PPM<br>PRINT PRESS ENTER |

After obtaining test results, scroll with ▲ or ▼ , and make another selection with ***ENTER**. Press **EXIT** to escape to previous menu.

# GENERAL OPERATING PROCEDURES

The operation of the SMART Spectro is controlled by a microprocessor. The microprocessor is programmed with menu driven software. A menu is a list of choices. This allows a selection of various tasks for the spectrophotometer to perform, such as, scan blank, scan sample, and edit test sequences. The keypad is used to make menu selections which are viewed in the display. There are eight selections accessible from the MAIN MENU - CALIBRATE WL, PROGRAMMED TESTS, %T/ABS, PC LINK, EDIT CLOCK, ENERGY MODE, STORE METHOD, and TEST MODE.

## ■ THE KEYPAD

The keypad has 6 buttons which are used to perform specific tasks.

| | |
|---|---|
| **ON** | This button is used to turn the spectrophotometer on. |
| ▲ | This button will cause the display to scroll up in a list of menu choices. It will move to the beginning of a list viewed in the display. It will auto scroll when held down. |
| ▼ | This button will cause the display to scroll down through a list of menu choices. It will move to the end of a list viewed in the display. It will auto scroll when held down. |
| * **ENTER** | This button is used to select the menu choice adjacent to the "*" in a menu viewed in the display. |
| **EXIT** | This button is an EXIT or ESCAPE button. When pressed, the display will EXIT from the current menu and go to the previous menu. |
| **OFF** | This button turns the spectrophotometer off. |

## ■ SAMPLE HOLDERS

The SMART Spectro Spectrophotometer is supplied with two removable sample cell holders. Each holder is secured in the chamber with a single screw. The square sample holder should be positioned so the arrow on the top is pointing toward the left. The square sample holder will hold 10 mm square cuvettes. The universal sample holder should be positioned with the V-channel toward the right side of the chamber. The universal sample holder will hold round tubes of varying diameters. When using the universal adapter, the tube should be placed between the white roller on the spring-loaded arm and the v-channel on the right-hand side of the adapter. Press the tube down on the white roller to retract the arm.

## ■ THE DISPLAY & THE MENUS

The display allows menu selections to be viewed and chosen. These choices instruct the spectrophotometer to perform specific tasks. The menus are viewed in the display using a general format which is followed from one menu to the next. Each menu is a list of choices or selections.

There are five lines in the display. The top line in each menu is a title or pertinent instruction. The top line does not change unless a new menu is selected. The second line is used in two ways. One way is to display additional information if the top line is insufficient. The second line is also used to display menu choices. The three additional lines are also used for menu choices.

## DISPLAY

| | |
|---|---|
| TESTING MENU | **Title or Instruction** |
| FIRST CHOICE | |
| SECOND CHOICE | **Menu Choice Window** |
| THIRD CHOICE | |
| AND ANOTHER | |
| AND SO ON | |
| END OF LIST | |

Think of the menu choices as a vertical list in the display which moves up or down each time an arrow button is pressed. This list or menu is viewed through a window, the menu choice window, in the display. Pushing the arrow buttons brings another portion of the menu into menu choice window. This is referred to as scrolling through the menu.

| | | | | | |
|---|---|---|---|---|---|
| TESTING MENU | ▼ | TESTING MENU | ▼ | TESTING MENU | |
| * FIRST CHOICE | | SECOND CHOICE | | ANOTHER | |
| SECOND CHOICE | | * ANOTHER | | AND ANOTHER | |
| ANOTHER | | AND ANOTHER | | * AND SO ON | |
| AND ANOTHER | | AND SO ON | | END OF LIST | |
| AND SO ON | | END OF LIST | | | |
| END OF LIST | | | | | |

An asterisk, "*", will start in the far left position of the top line in the menu choice window. As the menu is scrolled through, different choices appear next to the "*". The "*" in the display corresponds with the ***ENTER** button. Pushing the ***ENTER** button selects the menu choice which is adjacent to the "*" in the menu choice window.

As described previously, the **EXIT** button allows an exit or escape from the current menu and a return to the previous menu. This allows a rapid exit from an

inner menu to the **MAIN MENU** by repeatedly pushing the **EXIT** button. Pushing **OFF** at any time will turn the spectrophotometer off.

# CALIBRATION

## ■ CALIBRATE WAVELENGTH

The Calibrate Wavelength (CALIBRATE WL) mode is used to establish or re-establish the accuracy of the wavelength selection process. Normally, the Calibrate Wavelength procedure should be run after the SMART Spectro is turned ON and allowed to warm up for 15 minutes or if operating conditions (temperature, humidity, etc.) change significantly.

For field use, when operating with the battery, calibrate wavelength prior to going into the field using AC power. This will increase battery life in the field. Alternatively calibrate wavelength in the field immediately before testing. Turn Spectro on immediately before scanning blank. Calibrate wavelength just before scanning blank.

| | |
|---|---|
| 1. Press **ON**. The LaMotte logo screen will appear for about 2 seconds and the MAIN MENU will appear. | MAIN MENU 12:00:01<br>* CALIBRATE WL<br>PROGRAMMED TESTS<br>%T/ABS<br>PC LINK |

| | |
|---|---|
| 2. Press ▲ or ▼ to scroll to **CALIBRATE WL**. | MAIN MENU 12:00:01<br>* CALIBRATE WL<br>PROGRAMMED TESTS<br>%T/ABS<br>PC LINK |

| | |
|---|---|
| 3. Press ***ENTER** to select **CALIBRATE WL.** | MAIN MENU 12:00:01<br>* CALIBRATE WL<br>PROGRAMMED TESTS<br>%T/ABS<br>PC LINK |

The Calibrate Wavelength procedure takes about 1-2 minutes to be completed. During the calibration, the Spectro will display two numbers at the bottom of the screen. The first number is fixed. The second number will change and can have a range of values. The microprocessor will move the grating in search of the position that gives a very specific maximum light intensity. The microprocessor

will then move the grating a precise predetermined amount from this position. This precise movement will cause the grating to be positioned at 546 nm every time. Once calibrated the wavelength displayed during testing is accurate to ±2 nm. When the wavelength calibration is complete the display will go back to the Main Menu.

# PROGRAMMED TESTS

## ■ INTRODUCTION

The PROGRAMMED TESTS mode is used to run all LaMotte pre-programmed tests and USER TESTS. This is also where USER TESTS and SEQUENCES are set-up and edited.

| | |
|---|---|
| 1. Press **ON**. The LaMotte logo screen will appear for about 2 seconds and the MAIN MENU will appear. | MAIN MENU 12:00:01<br>* CALIBRATE WL<br>PROGRAMMED TESTS<br>%T/ABS<br>PC LINK |

| | |
|---|---|
| 2. Press ▲ or ▼ to scroll to **PROGRAMMED TESTS**. | MAIN MENU 12:00:01<br>CALIBRATE WL<br>* PROGRAMMED TESTS<br>%T/ABS<br>PC LINK |

| | |
|---|---|
| 3. Press ***ENTER** to select **PROGRAMMED TESTS**. In the **PROGRAMMED TESTS** menu there are three alterable sequences and one **ALL TESTS** fixed sequence as well as the **EDIT** function. | MAIN MENU 12:00:01<br>* CALIBRATE WL<br>PROGRAMMED TESTS<br>%T/ABS<br>PC LINK |

# SEQUENCES OF TESTS

**SEQUENCE 1**, **SEQUENCE 2**, and **SEQUENCE 3** are alterable sequences. They may be edited using the **EDIT** function mode. Any of the LaMotte pre-programmed tests or User Tests may be placed in these sequences in whatever testing order that is preferred. Some examples of typical sequences are given below.

| SEQUENCE 1 |
|---|
| * 60 Molybdenum LR |
| 79 Phosphate |
| 9 Bromine LR |
| 76 pH TB |
| 15 Chlorine |
| 86 Silica HI |
| 45 Hydrazine |
| 32 Copper DDC |
| 51 Iron Bipyr |
| END OF LIST |

| SEQUENCE 2 |
|---|
| * 1 Aluminum |
| 35 Cyanide |
| 41 Fluoride |
| 53 Iron Phen |
| 55 Manganese L |
| 64 Nitrate N LR |
| 26 COD Low |
| 77 Phenols |
| 78 Phosphate L |
| 90 Sulfide LR |
| END OF LIST |

| SEQUENCE 3 |
|---|
| * 3 Ammonia-N L F |
| 32 Copper DDC |
| 64 Nitrate-N LR |
| 67 Nitrite-N LR |
| 74 pH CPR |
| 78 Phosphate L |
| 85 Silica Lo |
| END OF LIST |

NOTE: Sequences always end with END OF LIST to indicate that there are no more tests in the sequence.

These alterable sequences allow a series of tests to be setup that are run frequently. The order of the individual tests in the sequence is determined by the user. After running a test, press **EXIT** to escape back to the Sequence menu. Move the ▼ down to the next test listed and press ***ENTER**. Continue this pattern until the entire sequence has been completed.

**ALL TESTS** is a fixed sequence containing the LaMotte pre-programmed tests and User Tests.

Modification of the alterable sequence is accomplished through the **EDIT** function. This function is explained in detail in the section titled **EDIT**.

It should be noted that if a %T/ABS test is to be included in a sequence, the %T/ABS test must first be setup as a User Test (but no actual calibration needs to be performed, only select a name and wavelength).

Pressing the **EXIT** button while in a sequence menu will escape back to the **PROGRAMMED TESTS** menu.

Pressing the **OFF** button at any time will turn the SMART Spectro off.

# GENERAL TESTING PROCEDURES

The following are some step by step examples of how to run tests from the **PROGRAMMED TESTS** menu. These test procedures are designed to be used with LaMotte SMART Spectro reagent systems.

## ■ TESTING WITH THE LaMOTTE PROGRAMMED TESTS

| | |
|---|---|
| 1. Press **ON**. The LaMotte logo screen will appear for about 2 seconds and the MAIN MENU will appear. | MAIN MENU 12:00:01<br>* CALIBRATE WL<br>PROGRAMMED TESTS<br>%T/ABS<br>PC LINK |
| 2. Press ▲ or ▼ to scroll to **PROGRAMMED TESTS**. | MAIN MENU 12:00:01<br>CALIBRATE WL<br>* PROGRAMMED TESTS<br>%T/ABS<br>PC LINK |
| 3. Press ***ENTER** to select **PROGRAMMED TESTS.** | PROGRAMMED TESTS<br>* SEQUENCE 1<br>SEQUENCE 2<br>SEQUENCE 3<br>ALL TESTS |
| 4. Press ▼ to scroll t**o ALL TESTS**. | PROGRAMMED TESTS<br>SEQUENCE 1<br>SEQUENCE 2<br>SEQUENCE 3<br>* ALL TESTS |

| | |
|---|---|
| 5. Press ***ENTER** to select **ALL TESTS.** | ALL TESTS<br>* 1 Alkalinity-UDV<br>2 Aluminum<br>3 Ammonia-N L F<br>4 Ammonia-N L S |

| | |
|---|---|
| 6. Press ▲ or ▼ to scroll to the desired test. | ALL TESTS<br>1 Alkalinity-UDV<br>* 2 Aluminum<br>3 Ammonia-N L F<br>4 Ammonia-N L S |

| | |
|---|---|
| 7. Press ***ENTER** to select the test. The SMART Spectro is ready to scan. The proper wavelength has been selected. | 2 Aluminum<br>* SCAN BLANK<br>SCAN SAMPLE<br>END 535 NM |

| | |
|---|---|
| 8. Insert the blank. Press ***ENTER** to scan the blank. The blank has been stored. | 2 Aluminum<br>SCAN BLANK<br>* SCAN SAMPLE<br>END 535 NM |

| | |
|---|---|
| 9. Insert the reacted sample. Press ***ENTER** to scan the sample. The result will be displayed. | 2 Aluminum<br>T = 16.5%T<br>A = 0.7834A<br>C = 1.28 PPM<br>PRINT PRESS ENTER |

| | |
|---|---|
| 10. Press ***ENTER** to print the result when connected to a printer or computer. To repeat the test, press **EXIT** to escape the test screen, then press ***ENTER** to scan the sample again. The last blank scanned is used to zero the spectrophotometer for repeat scans. A different blank can be used by pressing the button to scroll back to **SCAN BLANK** and then scanning another blank. | |

Press **EXIT** to escape back to the **PROGRAMMED TESTS** menu if no more samples are to be scanned for this test factor.

# SETUP & EDIT SEQUENCES & USER TESTS

The EDIT menu allows any of the three alterable test sequences (SEQUENCE 1, SEQUENCE 2, and SEQUENCE 3) and any of the 25 User Tests in the ALL TESTS fixed sequence to be edited. This feature allows a sequence or test which is used frequently to be set-up for easy access. The order of the sequence can be arranged to suit the needs of the user. Any combination, and any order of tests from ALL TESTS (including User Tests), may be placed into these sequences.

## EDIT A SEQUENCE

| | |
|---|---|
| 1. Go to the **PROGRAMMED TESTS** menu. Press ▲ or ▼ to scroll to **EDIT**. | PROGRAMMED TESTS<br>SEQUENCE 1<br>SEQUENCE 2<br>SEQUENCE 3<br>* EDIT |

| | |
|---|---|
| 2. Press ***ENTER** to select **EDIT.** | EDIT<br>* EDIT SEQUENCE 1<br>EDIT SEQUENCE 2<br>EDIT SEQUENCE 3<br>EDIT USER TESTS |

# ADDING OR DELETING TESTS

There are two ways to alter a sequence - **INSERT** and **DELETE**.

**INSERT** is used to add a new test to a sequence and to place the new test before an existing test in a sequence.

**DELETE** is used to remove an existing test from a sequence.

Below is a step by step example of how to **ADD** a test to **SEQUENCE 3** starting from the **EDIT** menu.

| | |
|---|---|
| 1. Press ▼ to scroll to the sequence to be edited. | EDIT<br>EDIT SEQUENCE 1<br>EDIT SEQUENCE 2<br>* EDIT SEQUENCE 3<br>EDIT USER TESTS |
| 2. Press ***ENTER** to select the sequence to be edited. | EDIT SEQUENCE 3<br>* END OF LIST |
| 3. Press ***ENTER** to select **END OF LIST.** | EDIT SEQUENCE 3<br>* INSERT<br>DELETE<br>END OF LIST |
| 4. Press ***ENTER** to select **INSERT** to insert a test into the sequence. | INSERT<br>* 1 Alkalinity-UDV<br>2 Aluminum<br>3 Ammonia-N L F<br>4 Ammonia-N L S |

| | |
|---|---|
| 5. Press ▲ **or** ▼ to scroll to the desired test**.** | INSERT<br>1 Alkalinity-UDV<br>* 2 Aluminum<br>3 Ammonia-N L F<br>4 Ammonia-N LF |

| | |
|---|---|
| 6. Press ***ENTER** to select the test and insert it before **END OF LIST**. The meter will return to the **EDIT SEQUENCE 3** menu. | EDIT SEQUENCE 3<br>* 2 Aluminum<br>END OF LIST |

| | |
|---|---|
| 7. Press ***ENTER** to select the first test in the sequence and allow a second test to be inserted above it on the list. | EDIT SEQUENCE 3<br>* INSERT<br>DELETE<br>2 Aluminum |

| | |
|---|---|
| 8. Press ***ENTER** to insert a test above the first test. | INSERT<br>* 1 Alkalinity-UDV<br>2 Aluminum<br>3 Ammonia-N L F<br>4 Ammonia-N LF |

| | |
|---|---|
| 9. Press ▲ **or** ▼ to scroll to the desired test**.** | INSERT<br>75 pH PR<br>76 pH TB<br>77 Phenol<br>* 78 Phosphate L |

| | |
|---|---|
| 10. Press ***ENTER** to add the second test to the list above the first test in the sequence. **SEQUENCE 3** has now been modified and will remain until it is deleted again. To run a test in **SEQUENCE 3** go to the **PROGRAMMED TESTS** menu. Press **EXIT** to exit the **EDIT SEQUENCE 3** menu and return to the **EDIT** menu. Press **EXIT** to exit the **EDIT** menu. The meter will save any changes and go to the **PROGRAMED TESTS** menu. | EDIT SEQUENCE 3<br>* 78 Phosphate L<br>2 Aluminum<br>END OF LIST |

Below is an example of how to **DELETE** a test from **SEQUENCE 3**, which was just created, starting from the **EDIT** menu.

| | |
|---|---|
| 1. Press ▼ to scroll to the sequence to be edited. | EDIT<br>EDIT SEQUENCE 1<br>EDIT SEQUENCE 2<br>* EDIT SEQUENCE 3<br>EDIT USER TESTS |

| | |
|---|---|
| 2. Press ***ENTER** to select the sequence to be edited. | EDIT SEQUENCE 3<br>* 78 Phosphate L<br>2 Aluminum<br>END OF TEST |

| | |
|---|---|
| 3. Press ▲ **or** ▼ to scroll to the test to be deleted**.** | EDIT SEQUENCES<br>78 Phosphate L<br>* 2 Aluminum<br>END OF LIST |

| | |
|---|---|
| 4. Press ***ENTER** to select the test to be deleted. | EDIT SEQUENCE 3<br>* INSERT<br>DELETE<br>2 Aluminum |

| | |
|---|---|
| 5. Press ▲ **or** ▼ to scroll to **DELETE.** | EDIT SEQUENCE 3<br>INSERT<br>* DELETE<br>2 Aluminum |

| | |
|---|---|
| 6. Press ***ENTER** to select **DELETE**. Sequence 3 has now been modified and will remain until it is edited again. To run a test in **SEQUENCE 3** go to the **PROGRAMMED TESTS** menu. Press **ENTER** to exit the **EDIT SEQUENCE 3** menu to the **EDIT** menu. Press **EXIT** to exit the **EDIT** menu. The meter will save any changes and go the **PROGRAMMED TESTS** menu. | EDIT SEQUENCE 3<br>* 78 Phosphate L<br>END OF LIST |

# EDIT USER TESTS

If a test other than the LaMotte programmed tests is performed regularly, a calibration for it may be entered in one of the 25 User Tests. These tests are originally named “User Test 1 - 25”. It will be possible to rename the test, select a wavelength, enter a new calibration and select the number of decimal places used to display the results. A User Test may be added for a reagent system for which no precalibrated test exists. A calibration of a LaMotte reagent system may also be entered. The calibration of a User Test can be changed at any time.

The User Tests have the ability to handle between 1 and 8 data points. The curve fitting options of linear least squares or linear least squares through zero are available. This requires that the test have a linear calibration, if accurate results are expected. The spectrophotometer will determine the Absorbance of the standards and calculate a response that will be stored to determine the concentration of future samples of unknown concentration. These standards should cover all the concentrations for the range of the test being performed and be scanned beginning with the lowest concentration and finishing with the highest concentration (for more information about this, see CALIBRATION CURVES, page 13). Prepare these solutions prior to entering a new calibration.

NOTE: A calibration procedure must be performed before using any of the User Tests. If a User Test is selected before a calibration has been entered the message not yet available press exit please will appear.

The User Tests can be placed in any of the alterable sequences using the EDIT mode.

| | |
|---|---|
| 1. Go to **PROGRAMMED TESTS** menu. Press ▼ to scroll to **EDIT**. | PROGRAMMED TESTS<br>SEQUENCE 2<br>SEQUENCE 3<br>ALL TESTS<br>* EDIT |

| | |
|---|---|
| 2. Press ***ENTER** to select **EDIT.** | EDIT<br>* EDIT SEQUENCE 1<br>EDIT SEQUENCE 2<br>EDIT SEQUENCE 3<br>EDIT USER TESTS |

| | |
|---|---|
| 3. Press ▼ to scroll to **EDIT USER TESTS**. | EDIT<br>EDIT SEQUENCE 1<br>EDIT SEQUENCE 2<br>EDIT SEQUENCE 3<br>* EDIT USER TESTS |

| | |
|---|---|
| 4. Press ***ENTER** to select **EDIT USER TESTS.** | EDIT<br>* 101 User Test 1<br>102 User Test 2<br>103 User Test 3<br>104 User Test 4 |

| | |
|---|---|
| 5. Press ▲ or ▼ to scroll to the user test to be edited. | EDIT<br>101 User Test 1<br>* 102 User Test 2<br>103 User Test 3<br>104 User Test 4 |

| | |
|---|---|
| 6. Press ***ENTER** to select the user test to be edited.<br>NOTE: The menu allows a test to be renamed, a wavelength to be selected, reacted standards to be scanned and the numerical format of the displayed test result to be selected. After editing any one of these menu choices the display will return to this menu. Any menu choice can be edited at any time by selecting it. The normal procedure would be to start with **NAME THE TEST**, then **SELECT WAVELENGTH**, then **NEW CALIBRATION**, and then **FORMAT RESULT**. | 102 User Test 2<br>* NAME THE TEST<br>SELECT WL<br>NEW CALIBRATION<br>FORMAT RESULT |

## ■ NAMING THE TEST

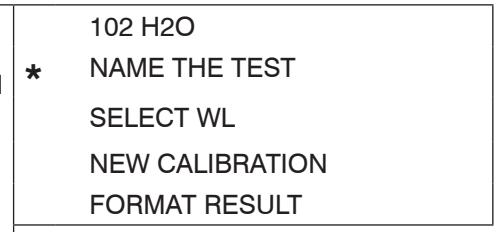
A NAME can be up to 14 characters long. The menu choices for each character are 26 letters A to Z, ten numerals 0 to 9, a space, a dash, a decimal point, and a ! as a terminator. Selecting the terminator indicates the end of the name and stores the name. The terminator, !, is the first menu choice since it is the one character that will always have to be selected. It is before the letter A. DO NOT CHOOSE THE ! UNTIL THE NAMING OF THE TEST HAS BEEN COMPLETED. The terminator should be selected following the end of the name. It must be the last character selected.

| | |
|---|---|
| 1. The user test to be edited has been selected. | 102 User Test 2<br>* NAME THE TEST<br>SELECT WL<br>NEW CALIBRATION<br>FORMAT RESULT |

| | |
|---|---|
| 2. Press ***ENTER** to select **NAME THE TEST.** Press ▼ to scroll to **CHANGE**. (Select **KEEP** to go back to the User Test menu.) | NAME THE TEST<br>* KEEP<br>CHANGE<br>END OF LIST |

| | |
|---|---|
| 3. Press ***ENTER** to select **CHANGE**. | NAME THE TEST<br>102<br>!ABCDEFGHIJKLMNOPQRS<br>TUVWXYZ0123456789-. |

4. Select the characters in the name one at a time, from left to right. In this example the new test name will be H2O. Press ▼ to scroll right to the first character. Selection of characters is controlled by moving the curser over the top of the letter to be chosen. Press ***ENTER** with the curser over the character to select it. The character will appear now in the line next to the test number. Continue in this fashion until entire name is entered. Press **EXIT** to delete/erase any incorrect entry and start over. Select **!** at the end of the name to save the name. The display will return to the **NAME THE TEST** menu. Select **KEEP** to save the name and return to the User Test menu. Note that the 102 is named H2O.



## ■ SELECTING THE WAVELENGTH

| | |
|---|---|
| 1. Scroll to **SELECT WL**. | 102 H2O<br>NAME THE TEST<br>* SELECT WL<br>NEW CALIBRATION<br>FORMAT RESULT |

| | |
|---|---|
| 2. Press ***ENTER** to select **SELECT WL.** | SELECT WL<br><br>546 NM<br><br>SET PRESS ENTER |

| | |
|---|---|
| 3. Press ▲ or ▼ to scroll to desired wavelength. | SELECT WL<br><br>560 NM<br><br>SET PRESS ENTER |

| | |
|---|---|
| 4. Press ***ENTER** to save the wavelength. The display will return to the **USER TEST** menu. | 102 H2O<br>* NAME THE TEST<br>SELECT WL<br>NEW CALIBRATION<br>FORMAT RESULT |

## ■ ENTERING A NEW CALIBRATION

| | |
|---|---|
| 1. Press ▼ to scroll to **NEW CALIBRATION**. | 102 H2O<br>NAME THE TEST<br>SELECT WL<br>* NEW CALIBRATION<br>FORMAT RESULT |
| 2. Press ***ENTER** to select **NEW CALIBRATION.** | INPUT DATA NUMBERS<br>DATA NUMBERS = 5<br>SET PRESS ENTER |
| 3. Press ▲ or ▼ to select the number of data points that will be used to create the calibration curve. The maximum number of data points is 8. | INPUT DATA NUMBERS<br>DATA NUMBERS = 6<br>SET PRESS ENTER |
| 4. Press ***ENTER** to save the selection. | NEW CALIBRATION<br>* ENTER STD.1<br>ENTER STD.2<br>ENTER STD.3<br>ENTER STD.4 |
| 5. Press ***ENTER** to select the first data point. | ENTER STD. 1<br>* SCAN BLANK<br>STD.1 =<br>!0123456789. |

| | | |
|---|---|---|
| 6. Place a blank in the sample chamber. Press ***ENTER** to SCAN BLANK. (STD. 1 is always a blank.) The display will indicate that the blank is being scanned. The display will indicate BLANKED. A cursor will appear on the character selection line. | * | ENTER STD. 1<br>SCAN BLANK<br>STD.1 =<br>! 0 1 2 3 4 5 6 7 8 9 . |

| | | |
|---|---|---|
| 7. Place the reacted standard of the lowest concentration in the chamber. Press ▲ or ▼ to enter the concentration of the standard by selecting the characters with the cursor. | * | ENTER STD. 1<br>SCAN BLANK<br>STD.1 =<br>! 0 1 2 3 4 5 6 7 8 9 |

| | | |
|---|---|---|
| 8. After the concentration has been entered, scroll to !. Press ***ENTER.** The standard will be scanned and the absorbance will be displayed. | * | ENTER STD. 1<br>BLANKED<br>STD.1 = 1.0<br>A=0.0016A |

| | | |
|---|---|---|
| 9. Press **EXIT** to return to the New Calibration menu. | * | NEW CALIBRATION<br>ENTER STD. 1<br>ENTER STD. 2<br>ENTER STD. 3<br>ENTER STD. 4 |

| | | |
|---|---|---|
| 10. Press **ENTER** and use the same procedure to scan the second data point. Repeat the procedure until the data from all of the standards has been entered into the calibration.<br>Note: Input the number of data points previously selected.<br>For example, when inputting 6 standards ignore the request for **ENTER STD. 7**. | * | NEW CALIBRATION<br>ENTER STD. 4<br>ENTER STD. 5<br>ENTER STD. 6<br>ENTER STD. 7 |

| | |
|---|---|
| 11. Press ▼ to scroll to **CALCULATE**. | NEW CALIBRATION<br>ENTER STD. 6<br>ENTER STD. 7<br>ENTER STD. 8<br>* CALCULATE |

| | |
|---|---|
| 12. Press ***ENTER** to select **CALCULATE**. | SELECT DEGREES<br>1 DEGREE THRU.0<br>1 DEGREE<br>2 DEGREE<br>* 3 DEGREE |

| | |
|---|---|
| 13. Press ***ENTER** to select the desired curve fit. | SELECT DEGREES<br>1 DEGREE THRU.0<br>* 1 DEGREE<br>2 DEGREE<br>3 DEGREE |

Note: **1 DEGREE THRU.0** calculates the best straight line fit through the data points and intersects with the origin at 0 ppm, 0 absorbance. This is a classical Beers Law calibration. If a one point calibration has been performed, the **1 DEGREE THRU.0** curve fit must be chosen. **1 DEGREE** calculates the best straight line fit but without forcing the line through the origin. The minimum number of standards needed for a calibration is one for **1 DEGREE THRU.0** and two for **1 DEGREE**.

**NOTE: 2 DEGREE and 3 DEGREE calculations are not available yet.**

| | |
|---|---|
| 14. Press ***ENTER** to select the desired curve fit type. The display will show the constraints for the best fit line. | KO=0.0000E +00<br>K1=0.3068E +0A<br>K2=0.0000E +00<br>K3=0.0000E+0A<br>Press EXIT return |

| | |
|---|---|
| 15. Press **EXIT** to return to the **SELECT DEGREES** menu. Press **EXIT** again to return to **INPUT DATA NUMBERS**. Press **EXIT** again to return to the **USER TEST** menu. | 102 H2O<br>* NAME THE TEST<br>SELECT WL<br>NEW CALIBRATION<br>FORMAT RESULT |

## ■ SELECTING THE NUMERICAL FORMAT OF THE RESULT

To input tests with very different ranges, the number of decimal places displayed for a result can be selected. A test which ranges from 20 to 1000 ppm should not be displayed with three decimal places. A test with a range from 0.010 to 0.500 needs three decimal places (the microprocessor will always calculate the concentration to many more significant figures than will be displayed). Menu choices of 0, 1, 2, or 3 decimal places will be given for the display.

| | |
|---|---|
| 1. Press ▼ to scroll to **FORMAT RESULTS.** | 102 H2O<br>NAME THE TEST<br>SELECT WL<br>NEW CALIBRATION<br>* FORMAT RESULT |

| | |
|---|---|
| 2. Press ***ENTER** to select **FORMAT RESULTS.** | DECIMAL PLACES?<br>0 PLACES<br>1 PLACE<br>2 PLACES<br>3 PLACES |

| | |
|---|---|
| 3. Press ▲ or ▼ to select the number of decimal places to be displayed. | DECIMAL PLACES?<br>0 PLACES<br>1 PLACE<br>* 2 PLACES<br>3 PLACES |

| | |
|---|---|
| 4. Press ***ENTER** to select the number format. | 102 H2O<br>* NAME THE TEST<br>SELECT WL<br>NEW CALIBRATION<br>FORMAT RESULT |

| | |
|---|---|
| 5. Press **EXIT** to return to EDIT USER TEST menu. Press EXIT again to escape to EDIT menu and again to return to the PROGRAMMED TEST menu.<br>Note: Test 102 was USER TEST 1 and now is H2O. It is still a USER TEST because its calibration can be changed but it has a different name. | 102 H2O<br>* NAME THE TEST<br>SELECT WL<br>NEW CALIBRATION<br>FORMAT RESULT |

## ■ MEASURING IN THE %T/ABS MODE

| | |
|---|---|
| 1. Press **ON**. The LaMotte logo screen will appear for about 2 seconds and the MAIN MENU will appear. | MAIN MENU 12:00:01<br>* CALIBRATE WL<br>PROGRAMMED TESTS<br>%T/ABS<br>PC LINK |

| | |
|---|---|
| 2. Press ▲ or ▼ to scroll to **%T**/**ABS**. | MAIN MENU 12:00:01<br>CALIBRATE WL<br>PROGRAMMED TESTS<br>* %T/ABS<br>PC LINK |

| | |
|---|---|
| 3. Press ***ENTER** to select **%T**/**ABS**. | %T/ABS 560NM<br>* SELECT WL<br>SCAN BLANK<br>SCAN SAMPLE<br>END OF LIST |

| | |
|---|---|
| 4. Press ***ENTER** to select SELECT WL | SELECT WL<br>WL=560 NM<br>* |

| | |
|---|---|
| 5. Press ▲ or ▼ to scroll to desired wavelength. | * SELECT WL<br>WL=600 NM |

| | |
|---|---|
| 6. Press ***ENTER** to select the wavelength. The meter is ready to scan. | %T/ABS 600 NM<br>SELECT WL<br>* SCAN BLANK<br>SCAN SAMPLE<br>END OF LIST |

| | |
|---|---|
| 7. Insert the blank into the chamber. Press ***ENTER** to scan the blank. Note: For most %T/ABS tests, a clear colorless water blank should be used. | %T/ABS 600 NM<br>SELECT WL<br>SCAN BLANK<br>* SCAN SAMPLE<br>END OF LIST |

| | |
|---|---|
| 8. Insert a reacted sample into the chamber. Press ***ENTER** to scan the sample. | %T/ABS 600 NM<br>T=90.7%T<br>A=0.0424A<br>PRINT PRESS ENTER |

At this point, it is possible to scan another sample, scan another blank, or select another wavelength. To print the results to a connected computer or serial printer, press ***ENTER** and return to previous menu. Press **EXIT** to escape to previous menu.

If no more samples are to be scanned, press **EXIT** to return to the **MAIN MENU** or press **OFF** to turn off the spectrophotometer.

# PC LINK

The SMART Spectro may be interfaced with any Windows-based program by using the LaMotte SMARTLink2 Program and Interface Cable (Code 1912-3) and compact disk (Code 1912-CD). The program stores customer information and test data in a database. It can be used to download data stored in the SMART Spectro data logger for each test site.

The spectrophotometer may also be interfaced with an RS-232 serial printer, using an interface cable (Code 1772) and setting the printer configuration to the Output below (see Computer Connection, below).

Choose PC LINK from the Main Menu. The user has the option to download the last 25 results or the entire data logging buffer (500 results). Downloading does not delete or empty the data logger.

## ■ OUTPUT

RS-232 compatible, asynchronous serial, 9600 baud, no parity, 8 data bits, 1 stop bit.

## ■ COMPUTER CONNECTION

RS-232 interface connection, 8 pin mini-DIN/9 pin F D-submin. (Code 1772)

# EDIT CLOCK

The clock information is used to time stamp the data points in the data logger.

| | |
|---|---|
| 1. Press **ON**. The LaMotte logo screen will appear for about 2 seconds and the MAIN MENU will appear. | MAIN MENU 12:00:01<br>* CALIBRATE WL<br>PROGRAMMED TESTS<br>%T/ABS<br>PC LINK |
| 2. Press ▲ or ▼ to scroll to **EDIT CLOCK**. | MAIN MENU 12:00:01<br>PROGRAMMED TESTS<br>%T/ABS<br>PC LINK<br>* EDIT CLOCK |
| 3. Press ***ENTER** to select **EDIT CLOCK**. The display will show seconds-minutes-hours-month-day-year.<br>Note: Hours are in a 24 hour format. | EDIT CLOCK<br>46-09-14-08-09-2010<br>SET SECONDS: 26<br>SET PRESS ENTER |
| 4. Press ▲ or ▼ to scroll to adjust the seconds to the correct time. | EDIT CLOCK<br>43-09-14-08-09-2010<br>SET SECONDS: 43<br>SET PRESS ENTER |
| 5. Press ***ENTER** to save the second setting. | EDIT CLOCK<br>43-09-14-08-09-2010<br>SET MINUTES: 09<br>SET PRESS ENTER |

| | |
|---|---|
| 6. Follow the procedure to set the minutes, hour, month, day, and year. Press **EXIT** to return to the **MAIN MENU**. | MAIN MENU 14:09:43<br>* CALIBRATE WL<br>PROGRAMMED TESTS<br>%T/ABS<br>PC LINK |

# ENERGY MODE

| | |
|---|---|
| 1. Press **ON**. The LaMotte logo screen will appear for about 2 seconds and the MAIN MENU will appear. | MAIN MENU 12:00:01<br>* CALIBRATE WL<br>PROGRAMMED TESTS<br>%T/ABS<br>PC LINK |

| | |
|---|---|
| 2. Press ▲ or ▼ to scroll to **ENERGY MODE**. | MAIN MENU 12:00:01<br>%T/ABS<br>PC LINK<br>EDIT CLOCK<br>* ENERGY MODE |

| | |
|---|---|
| 3. Press ***ENTER** to select **ENERGY MODE.** | ENERGY MODE<br>SAVE<br>* NORMAL<br>END OF LIST |

| | |
|---|---|
| 4. Press ▲ or ▼ to select the desired mode. In the NORMAL mode the meter will remain on until OFF is pressed. This is the default setting. In the energy saving SAVE mode, the meter will turn off 10 minutes after the last button press. The SAVE mode will conserve battery and lamp life. | ENERGY MODE<br>* SAVE<br>NORMAL<br>END OF LIST |

| | |
|---|---|
| 5. Press **EXIT** to return to the **MAIN MENU**. | MAIN MENU 12:00:01<br>* CALIBRATE WL<br>PROGRAMMED TESTS<br>%T/ABS<br>PC LINK |

# STORE METHOD

| | |
|---|---|
| 1. Press **ON**. The LaMotte logo screen will appear for about 2 seconds and the MAIN MENU will appear. | MAIN MENU 12:00:01<br>* CALIBRATE WL<br>PROGRAMMED TESTS<br>%T/ABS<br>PC LINK |

| | |
|---|---|
| 2. Press ▲ or ▼ to scroll to **STORE METHOD**. | MAIN MENU 12:00:01<br>PC LINK<br>EDIT CLOCK<br>ENERGY MODE<br>* STORE METHOD |

| | |
|---|---|
| 3. Press ***ENTER** to select **STORE METHOD.** | STORE METHOD<br>* AUTOMATIC<br>MANUAL<br>END OF LIST |

| | |
|---|---|
| 4. Press ▲ or ▼ to select the desired store method. In the **AUTO** method, all results will automatically be stored in the data logger. This is the default setting. In the **MANUAL** method, the user will be prompted after each test to decide whether to store the result. | STORE METHOD<br>* AUTOMATIC<br>MANUAL<br>END OF LIST |

| | |
|---|---|
| 5. Press ***ENTER** to select the store method and return to the **MAIN MENU**. | MAIN MENU 12:00:01<br>* CALIBRATE WL<br>PROGRAMMED TESTS<br>%T/ABS<br>PC LINK |

# TEST MODE

Select **TEST MODE** from the Main Menu. Test Mode allows the user to change the way that blanking and reading of results is carried out during the **%T**/**ABS** testing. It does not affect any of the Pre-programmed tests. **REGULAR** is the default test mode and should be used whenever the blank is clear or has less absorbance than the samples. This will be the case most of the time. In the rare instances where the blank will be darker or have more absorbance than the samples the Test Mode must be switched to **REVERSE** to avoid error messages and incorrect readings. Always reset the test mode to **REGULAR** at the end of each testing session.

The Test Mode should always be reset to REGULAR at the end of each testing session.

| | |
|---|---|
| 1. Press **ON**. The LaMotte logo screen will appear for about 2 seconds and the MAIN MENU will appear. | MAIN MENU 12:00:01<br>* CALIBRATE WL<br>PROGRAMMED TESTS<br>%T/ABS<br>PC LINK |

| | |
|---|---|
| 2. Press ▲ or ▼ to scroll to **TEST MODE**. | MAIN MENU 12:00:01<br>EDIT CLOCK<br>ENERGY MODE<br>STORE METHOD<br>* TEST MODE |

| | |
|---|---|
| 3. Press ***ENTER** to select **TEST MODE.** | TEST MODE<br>* REGULAR<br>REVERSE<br>END OF LIST |

| | |
|---|---|
| 4. Press ▲ or ▼ to select the desired test mode. | TEST MODE<br>* REGULAR<br>REVERSE<br>END OF LIST |

| | |
|---|---|
| 5. Press ***ENTER** to select the test mode and return to the **MAIN MENU**. | MAIN MENU 12:00:01<br>* CALIBRATE WL<br>PROGRAMMED TESTS<br>%T/ABS<br>PC LINK |

# BATTERY OPERATION

The SMART Spectro can be run using battery power. The battery pack consists of a rechargeable Ni-metal hydride battery pack. The battery pack is not included in the standard meter package and must be purchased as an accessory (Code 2000-BP). The battery charger/adapter used with the optional battery pack comes standard with each SMART Spectro.

## ■ CHARGING THE BATTERY PACK

1. Connect the Power Supply to the Battery Charger.
2. Connect the Battery Charger to the Battery Pack.
3. The battery pack will automatically charge. (For older battery packs with a switch, move the switch to the CHARGING position.) A full charge will require about 5 hours.

## ■ RUNNING THE SMART SPECTRO USING BATTERIES

Connect the Battery Pack to the SMART Spectro.

CAUTION: Do not connect the Power Supply directly to the Battery Pack. The connectors will not fit. Don't force them.

# MAINTENANCE

## ■ CLEANING

Clean with a damp, lint-free cloth.

DO NOT ALLOW WATER TO ENTER THE SPECTROPHOTOMETER CHAMBER OR ANY OTHER PARTS OF THE METER.

## ■ LIGHT BULB

The quartz halogen bulb in the SMART Spectro has an approximate life of 1000 hours. If a test is performed and there is no response and the unit is receiving adequate power, the light bulb may need to be re-secured or replaced. With the meter power ON check the rear lamp access panel to see if any light acan be observed through the vents. If the lamp is not ON it is either loose or burnt out. To determine if the lamp is loose, remove the vented panel on the back of the meter. Loosen both thumb screws, noting that the thumb screws do not remove from the unit completely; they are attached to the removable metal plate. Use a clean, folded paper towel to gently push the lamp and see if it lights up. If so, it was merely loose and can be firmly pushed into its socket. If the lamp doesn't light up, it should be replaced. Contact LaMotte Technical Service at 1-800-344-3100 ext 2, or eamil tech@lamotte.com for a Return Authorization number and service by LaMotte personnel. Or order LaMotte code# 27290-03 for a 10-watt replacement lamp and replacement instructions.

## ■ CLOCK BATTERY (RAM BATTERY)

The Smart Spectro date/clock function is powered by its own battery. This battery should be replaced about every 3 years. If the date or clock function stops or if you receive the message "Warning RAM Battery Low" you should replace the RAM battery as follows, or contact the LaMotte Technical Service Department by phone at 1-800-344-3100, fax 410-778-6394 or email tech@lamotte.com

Directions for opening the SMART Spectro meter housing

1. Before proceeding, unplug the Spectro AC power supply.
2. Turn the meter over and use a long neck (4" shaft) Phillips head screw driver to unscrew all 4 screws located in the recessed cavities. Note; do not remove the four screws that secure the rubber "feet" to the bottom of the Spectro.
3. Holding the top and bottom together, carefully turn the meter over again. The screws will fall out of the recessed cavity.
4. Carefully lift the top cover off. It is not necessary to disconnect any cables or wires.

CAUTION: Be careful. The electronic circuits are static sensitive. DO NOT

touch the electronic components. You do not need to touch the electronic components to replace the RAM battery.

If you will be touching the electronic components for any other reason, you must wear a grounding strap. If such a strap is not available then take every precaution possible to ground yourself before and during any contact with the electronic components by holding onto a grounded metal pipe or other grounded piece of metal. If this is not possible then at least touch a grounded piece of metal just prior to handling any components or touching the boards. Improper grounding can allow static buildup to short the components. LaMotte Company is not responsible for any such damages.

### Directions for Replacing the RAM Battery

1. The battery is a 3V coin battery on the top circuit board, about the size of a dime. It is a model CR1220 or BR1225. Replace the battery with the same model type.
2. Unplug the battery by popping it out of its holder. A small insulated, flat head screw driver may be used to help remove the old battery.
3. Plug in the new battery with positive side facing up.

### Assembly of the housing top and bottom

1. Reassemble the spectro housing. When putting the top and bottom back together be careful about the alignment of the metal panel on the back of the Spectro (lamp access panel). There are slots for this panel in both the top and bottom part of the housing.
2. Secure the top to the bottom using all 4 screws.

## ■ METER DISPOSAL

Waste Electrical and Electronic Equipment (WEEE)

Natural resources were used in the production of this equipment. This equipment may contain materials that are hazardous to health and the environment. To avoid harm to the environment and natural resources, the use of appropriate take-back systems is recommended. The crossed out wheeled bin symbol on the meter encourages you to use these systems when disposing of this equipment.

Take-back systems will allow the materials to be reused or recycled in a way that will not harm the environment. For more information on approved collection, reuse, and recycling systems contact your local or regional waste administration or recycling service.

# TROUBLESHOOTING GUIDE

## ■ ERROR MESSAGES

### OUT OF RANGE

If the message OUT OF RANGE is displayed when scanning a sample, the sample may be over range or under range. If the sample is over range the sample should be diluted and tested again (see Sample Dilution Techniques & Volumetric Measurements, page16).

### BATTERY (optional)

If the symbol BAT appears in the upper left corner of the display when using the battery pack, the battery needs to be charged. The SMART Spectro will turn off if the battery power becomes too low.

### ERROR 1 TROUBLE WITH FILTER

There is a problem with filter positioning. This could be due to a dead motor, bad connection to the motor, or a bad positioning detector. Contact LaMotte Technical Service for help.

### ERROR 2 TROUBLE WITH SWITCH

There is a problem with the grating positioning. This could be due to a dead stepping motor, bad connection to stepping motor, or a bad micro switch. Contact LaMotte Technical Service for help.

### ERROR 3 TROUBLE WITH LIGHT

There is a problem locating the zero order light during wavelength calibration. Contact LaMotte Technical Service for help.

### WARNING SIGNAL TOO WEAK

Not enough light is getting to the detector. Check light path for blockage. Check lamp position. Try recalibrating wavelength.

### WARNING SIGNAL TOO STRONG

This can be an indication that the meter was accidently shut-off during wavelength calibration. Shut meter off and restart.

### WARNING RAM BATTERY LOW

Clock battery needs to be replaced soon. If it fails all user tests and Data log Data will be lost. Unit can be run without this battery. Just use line power and leave unit on.

## ■ HELPFUL HINTS

### POWER

The power supply has an internal switch that handles both 110V and 220V input.

### STRAY LIGHT

The SMART Spectro should have no problems with stray light. Make sure that the sample compartment lid is always fully closed.

### ACCIDENTAL LOSS OF POWER

If for any reason the meter experiences a loss of power during wavelength calibration, the next time the meter is powered up a wavelength calibration will automatically be performed.

SMART Spectro

Spectrophotometer

# TEST PROCEDURES

v3.0 and higher • Printed 2.11

2000-01-MN

LaMotte

# SPECTROPHOTOMETER REAGENT SYSTEMS LIST

Call LaMotte Technical Services at 1-800-344-3100 (410-778-3100 outside the USA) or email at tech@lamotte.com for a current list of available calibrations and downloading instructions.

| Test Factor (Test #) | Range (ppm) | MDL | Test Method (# of Reagents) | # of Tests |
|---|---|---|---|---|
| Alkalinity-UDV (2) | 0–200 | 15 | Unit Dose Vials (1) | 100 |
| Aluminum (1) | 0.00–0.30 | 0.01 | Eriochrome Cyanine R (4) | 50 |
| Ammonia Nitrogen-Low Range, Fresh Water (3) | 0.00–1.00 | 0.02 | Salicylate (3) | 25 |
| Ammonia Nitrogen-Low Range, Salt Water (4) | 0.00–1.00 | 0.10 | Salicylate (3) | 25 |
| Ammonia Nitrogen-High Range (5) | 0.00–4.00 | 0.05 | Nesslerization (2) | 50 |
| Benzotriazole (009) | 0.0–30.0 | 1.0 | UV Photolysis (3) | 50 |
| Biguanide (7) | 0–70 | 5 | Colorimetric | 50 |
| Boron (8) | 0.00-0.80 | 0.05 | Azomethine-H (2) | 25 |
| Bromine-Low Range (010) | 0.00–9.00 | 0.04 | DPD (3) | 100 |
| Bromine-UDV (11) | 0.0–20.0 | 0.3 | DPD (1) | 100 |
| Cadmium (12) | 0.00–1.00 | 0.02 | PAN (4) | 50 |
| Carbohydrazide (013) *See Oxygen Scavengers* | 0.000–0.900 | 0.005 | Iron Reduction (3) | 100 |
| Calcium & Magnesium (Total), Hardness-UDV | 10-500 | 10 | Unit Dose Vial (1) | 100 |
| Chloride-TesTab (21) | 0.0–50.0 | 0.5 | Argentometric (1) | 50 |
| Chlorine-Tablet DPD (014) | 0.00–4.00 | 0.02 | DPD (3) | 100 |
| Chlorine-Free-UDV (16) | 0.00–10.00 | 0.10 | DPD (1) | 100 |
| Chlorine-Total-UDV (18) | 0.00–10.00 | 0.10 | DPD (1) | 100 |
| Chlorine-Liquid DPD (17) | 0.00–4.00 | 0.025 | DPD (3) | 144 |
| Chlorine Dioxide (019) | 0.00–7.00 | 0.04 | DPD (2) | 100 |
| Chromium, Hexavalent (22) | 0.00–1.00 | 0.01 | Diphenylcarbohydrazide | 50 |
| Chromium, Hex, Tri, Total (22) | 0.00–1.00 | 0.01 | Diphenylcarbohydrazide | 50 |
| Chromium-TesTab (23) | 0.00-1.00 | 0.01 | Diphenylcarbohydrazide | 50 |
| Cobalt (24) | 0.00–2.00 | 0.02 | PAN (3) | 50 |
| COD-Low Range (25) | 0–150 | 5 | Digestion (1) | 25 |
| COD-Standard Range (26) | 0-1500 | 20 | Digestion (1) | 25 |
| COD-High Range (27) | 0–15,000 | 500 | Digestion (1) | 25 |

| | | | | |
|---|---|---|---|---|
| Color (28) | 0–1,000 | 15 | Platinum Cobalt (0) | – |
| Copper-BCA-Low Range (29) | 0.00–3.50 | 0.05 | Bicinchoninic Acid (1) | 50 |
| Copper-Cuprizone (31) | 0.00–2.00 | 0.01 | Cuprizone (2) | 50 |
| Copper-DDC (32) | 0.00–6.00 | 0.05 | Diethyldithiocarbamate (1) | 50 |
| Copper-UDV (33) | 0.00–4.00 | 0.20 | Bicinchoninic Acid (1) | 100 |
| Cyanide (35) | 0.00-0.50 | 0.50 | Pyridine-Barbituric Acid | 100 |
| Cyanuric Acid (36) | 0–200 | 16 | Melamine (1) | 40 |
| Cyanuric Acid-UDV (37) | 0–150 | 5 | Melamine (1) | 100 |
| DEHA (037)<br>*See Oxygen Scavengers* | 0.000–0.700 | 0.005 | Iron Reduction (3) | 100 |
| Dissolved Oxygen (39) | 0.0–12.0 | 0.25 | Winkler Colorimetric (3) | 100 |
| Erythorbic Acid (049)<br>*See Oxygen Scavengers* | 0.00–3.00 | 0.02 | Iron Reduction (3) | 100 |
| Fluoride (41) | 0.00–2.00 | 0.05 | SPADNS (2) | 50 |
| Hardness (Total) UDV (043) | 10–500 | 10 | Unit dose Vial (1) | 100 |
| Hydrazine (45) | 0.000–0.750 | 0.010 | P-dimethyl-aminobenzaldehyde (2) | 50 |
| Hydrogen Peroxide-Low Range (46) | 0.00–1.50 | 0.02 | DPD (2) | 100 |
| Hydrogen Peroxide-High Range (47) | 0–60 | 1 | DPD (2) | 50 |
| Hydrogen Peroxide-Shock (48) | 0–225 | 4 | DPD (2) | 100 |
| Hydroquinone (049)<br>*See Oxygen Scavengers* | 0.00–1.80 | 0.01 | Iron Reduction (3) | 100 |
| Iodine (050) | 0.00–14.00 | 0.08 | DPD (2) | 100 |
| Iron-Bipyridyl (51) | 0.00–6.00 | 0.06 | Bipyridyl (2) | 50 |
| Iron-Phenanthroline (53) | 0.00–4.50 | 0.04 | 1,10 Phenanthroline (2) | 50 |
| Iron-UDV (52) | 0.00–10.00 | 0.07 | Bipyridyl (1) | 100 |
| Lead (54) | 0.00–5.00 | 0.10 | PAR (5) | 50 |
| Manganese-Low Range (55) | 0.00–0.50 | 0.02 | PAN (3) | 50 |
| Manganese-High Range (56) | 0.0–15.0 | 0.3 | Periodate (2) | 50 |
| Mercury (57) | 0.00–1.50 | 0.02 | TMK (3) | 50 |
| Methylethylketoxime (058)<br>*See Oxygen Scavengers* | 0.00–3.00 | 0.02 | Iron Reduction (3) | 100 |
| Molybdenum-High Range (61) | 0.0–30.0 | 0.2 | Thioglycolate (3) | 50 |
| Nickel (63) | 0.00–8.00 | 0.06 | Dimethylglyoxime (6) | 50 |
| Nitrate-TesTab (66) | 0-60 | 2.5 | Zinc Reucion (1) | 50 |

| | | | | |
|---|---|---|---|---|
| Nitrate Nitrogen-Low Range (64) | 0.00–3.00 | 0.05 | Cadmium Reduction (2) | 20 |
| Nitrite-TesTab (69) | 0.00-1.25 | 0.025 | Zinc Reduction (1) | 50 |
| Nitrite Nitrogen-Low Range (67) | 0.00–0.80 | 0.02 | Diazotization (2) | 20 |
| Nitrogen, Total (62) | 0-25 mg/L | 2 mg/L | Chromotropic Acid/ Digestion (6) | 25 |
| Oxygen Scanvengers | various | various | DEHA (3) | 50 |
| Ozone-Low Range (071) | 0.00–0.40 | 0.02 | Indigo Trisulfonate (3) | 100 |
| Ozone-High Range (072) | 0.00–1.50 | 0.05 | Indigo Trisulfonate (3) | 20 |
| pH-Chlorophenol Red (073) | 5.0-7.0 | – | Chlorophenol Red (1) | 100 |
| pH-Phenol Red (074) | 6.6–8.4 | – | Phenol Red (1) | 100 |
| pH-Thymol Blue (075) | 8.0–9.5 | – | Thymol Blue (1) | 100 |
| Phenol (77) | 0.00-6.00 | 0.05 | Aminoantipyrine (3) | 50 |
| Phosphate-Low Range (78) | 0.00–3.00 | 0.04 | Ascorbic Acid Reduction (2) | 50 |
| Phosphate-High Range (79) | 0.0–70.0 | 1.0 | Vanodomolybd-phosphoric Acid (1) | 50 |
| Phosphorus, Total, Low Range (82) | 0.00–3.00 mg/L | 0.07 | Ascorbic Acid/Digestion | 25 |
| Phosphorus, Total, High-Range (83) | 0.0–70.0 mg/L | 5.0 mg/L | Molybdovanadate/ Digestion (5) | 25 |
| Potassium (81) | 0.0-10.0 | 0.5 | Tetraphenolboron (2) | 100 |
| Silica-Low Range (85) | 0.00–2.50 | 0.03 | Heteropoly Blue (4) | 50 |
| Silica-High Range (86) | 0–50 | 1 | Silicomolybdate (3) | 50 |
| Sulfate-High Range (89) | 5–100 | 5 | Barium Chloride (1) | 100 |
| Sulfide-Low Range (90) | 0.00–1.00 | 0.02 | Methylene Blue (3) | 50 |
| Surfactants (94) | 0.00-8.00 | 0.5 | Bromphenol Blue (3) | 50 |
| Tannin (96) | 0.0–10.0 | 0.2 | Tungsto-molybdophosphoric Acid (2) | 50 |
| Tolytriazole (009) *See Benzotriazole* | 0.0–30.0 | 1.0 | UV Photolysis (3) | 50 |
| Turbidity (98) | 2-400 FTU | 2 FTU | Absorption (0) | – |
| Zinc-Low Range (99) | 0.00–3.00 | 0.025 | Zincon (6) | 50 |

# ALKALINITY, UDV

## UNIT DOSE VIAL METHOD • CODE 4318-J-01

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 1 | Alkalinity Unit Dose Vials, 20 pouches | 4318-J |

Equipment needed but not supplied:

| STANDARD ACCESSORY PACKAGE • CODE 1961 | | |
|---|---|---|
| 1 | Package of 3 Vials (empty) | 0156 |
| 1 | Syringe, 6 mL, plastic | 1184 |
| 1 | Foil Storage Bag | 9467 |

Or:

| ADVANCED ACCESSORY PACKAGE • CODE 1962 | | |
|---|---|---|
| 1 | Pipettor | 30528 |
| 1 | Pipet Tip (0-5 mL) | 30695 |
| 1 | Cuvette Rack | 31695 |
| 1 | Package of 3 Vials (empty) | 0156 |
| 1 | Foil Storage Bag | 9467 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Alkalinity is a measure of the acid-neutralizing capacity of water that enables it to resist abrupt changes in pH. It is the sum of all titratable bases. Alkalinity is significant in maintaining proper pH levels in natural water; water used for irrigation, swimming pools, industrial processes and wastewater treatment processes.

The presence of buffering materials in natural waters helps to neutralize acids as they are added to, or created in, the water ecosystem. A Total Alkalinity of 100 to 200 ppm will stabilize the pH level in a stream. In swimming pools, total alkalinity is commonly known as a pH stabilizer because, when the alkalinity is at a proper level, a consistent pH level can be maintained while treatment chemicals or fresh make-up water is added. In industrial situations, alkalinity is an important factor in preventing fluctuating pH levels that can damage equipment and corrode pipes.

| | |
|---|---|
| APPLICATION: | Drinking and surface water and swimming pool water |
| RANGE: | 0–200 ppm as $CaCO_3$ |
| MDL: | 15 ppm |
| METHOD: | The sample is added to a buffered indicator reagent. The color that develops, ranging from yellow to blue, will indicate the amount of alkalinity in the sample. |
| SAMPLE HANDLING & PRESERVATION: | Samples should be analyzed as soon as possible after collection. Sample may be refrigerated for 24 hours. |
| INTERFERENCES: | Quats and poly quats at high concentrations will interfere. |

# PROCEDURE

1. Use 10 mm square cell adapter
2. Press and hold **ON** button until spectrophotometer turns on.
3. Scroll to and select **PROGRAMMED TESTS**.
4. Scroll to and select **ALL TESTS** (or another sequence containing **2 Alk-UDV**) from **TESTING MENU**.
5. Scroll to and select **2 Alk-UDV** from menu.
6. Rinse a clean vial (0156) with sample water.
7. Use the syringe (1184) to add 3 mL of sample to the vial.
8. Insert the vial into chamber, close lid and select **SCAN BLANK**.
9. Remove vial from Spectro.
10. Use the syringe (1184) to add 3 mL of sample to a Alk UDV vial (4318).
11. Wait 2 minutes.
12. Invert vial 3 times to mix.
    NOTE: If powder residue remains in the bottom of the vial after inverting or air bubbles form, invert once more and tap bottom of vial sharply once or twice to dislodge powder and bubbles. Mix.
13. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
14. Press **OFF** button to turn the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTES: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

UDVs from opened pouches should be used promptly. Store unused vials from opened pouches in the Foil Storage Bag (9467) to extend the shelf life of the reagent. Generally, UDVs stored in the bag should be used within 10 days if the humidity is less than 50% and within 5 days if humidity is greater than 50%. The Foil Storage Bag contains a dessicant pack with indicator. When the indicator in the window turns from blue to pink, the bag should be replaced.

# ALUMINUM

## ERIOCHROME CYANINE R METHOD • CODE 364I-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 5 g | *Aluminum Inhibitor Reagent | *7865-C |
| 2 x 120 mL | *Aluminum Buffer Reagent | *7866-J |
| 120 mL | Aluminum Indicator Reagent | 7867-J |
| 15 mL | Aluminum Complexing Reagent | 7868-E |
| 1 | Spoon, 0.1 g, plastic | 0699 |
| 1 | Spoon, 0.05 g, plastic | 0696 |
| 2 | Pipets, 1.0 mL, plastic | 0354 |
| 1 | Test Tube, glass, 5 mL w/cap | 0230 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Aluminum is the third most common element in the earth's crust, which accounts for its wide appearance in many water supplies. Aluminum exists in water as soluble salts, colloidal compounds, and insoluble compounds. In wastewater that has been treated by alum coagulation it will appear in one or more of the above forms. Properly treated drinking water should have an aluminum concentration below 0.05 mg/L.

| | |
|---|---|
| APPLICATION: | Drinking, surface, and saline waters; domestic and industrial wastewater. |
| RANGE: | 0.00–0.30 ppm Aluminum |
| MDL: | 0.01 ppm |
| METHOD: | Aluminum ions buffered to a pH of 6.0 react with Eriochrome Cyanine R dye to produce a pink to red complex in proportion to the concentration. |
| SAMPLE HANDLING & PRESERVATION: | Collect sample in acid washed glass or plastic bottle. Analyze as soon as possible. |
| INTERFERENCES: | Fluoride and polyphosphate will interfere. Interference from iron and manganese is eliminated by the addition of an inhibitor. |

# PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **1 Aluminum**).
4. Scroll to and select **1 Aluminum** from menu.
5. Rinse a clean Spectro tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into Spectro chamber and select **SCAN BLANK**.
7. Rinse a clean test tube (0230) with sample water. Fill to the 5 mL line with sample.
8. Remove tube from Spectro. Empty sample from Spectro tube (0290).
9. Add 5 mL sample from test tube (0230) to empty Spectro tube (0290).
10. Use the 0.05 g spoon (0696) to add one measure of *Aluminum Inhibitor Reagent (7865). Cap and mix to dissolve powder.
11. Use a 1.0 mL pipet (0354) to add 2 mL of *Aluminum Buffer Reagent (7866). Cap and mix.
12. Use a second 1.0 mL pipet (0354) to add 1 mL of Aluminum Indicator Reagent (7867). Cap and mix contents. Wait 5 minutes for maximum color development.
13. At end of 5 minute waiting period, mix, insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
14. Press **OFF** button to turn the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTE: For the best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Add 5 drops of Aluminum Complexing Reagent (7868). Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

# AMMONIA-NITROGEN, LOW RANGE

## SALICYLATE METHOD • CODE 3659-01-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 60 mL | *Salicylate Ammonia #1 | *3978-H |
| 10 g | *Salicylate #2 | *7457-D |
| 2 x 5 g | *Salicylate #3 Reagent Powder | *7458-C |
| 1 | Spoon, 0.1 g, plastic | 0699 |
| 1 | Spoon, 0.15 g, plastic | 0727 |
| 1 | Pipet, 1.0 mL, plastic | 0354 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Ammonia nitrogen is present in various concentrations in many surface and ground water supplies. Any sudden change in the concentration of ammonia nitrogen in a water supply is cause for suspicion. A product of microbiological activity, ammonia nitrogen is sometimes accepted as chemical evidence of pollution when encountered in natural waters.

Ammonia is rapidly oxidized in natural water systems by special bacterial groups that produce nitrite and nitrate. This oxidation requires that dissolved oxygen be available in the water. Ammonia is an additional source of nitrogen as a nutrient which may contribute to the expanded growth of undesirable algae and other forms of plant growth that overload the natural system and cause pollution.

| | |
|---|---|
| APPLICATION: | Low concentrations of ammonia in fresh, brackish and salt water; fresh and salt water aquariums. |
| RANGE: | 0.00–1.00 ppm Ammonia-Nitrogen |
| MDL: | 0.02 ppm Fresh Waer<br>0.10 ppm Salt Water |
| METHOD: | Salicylate and ammonia react at high pH in the presence of a chlorine donor and an iron catalyst to form a blue indophenol dye, the concentration of which is proportional to the ammonia concentration in the sample. |
| SAMPLE HANDLE & PRESERVATION: | Ammonia solutions tend to be unstable and should be analyzed immediately. Samples may be stored for 24 hours at 4°C or 28 days at –20°C. |
| INTERFERENCES: | There are few interferences in most natural waters. High concentrations of reducing agents, such as hydrazine, react with the chlorine donor and can result in negative interferences. Color and turbidity can also interfere. |

# PROCEDURE–FRESH WATER

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS** from menu.
3. Scroll to and select **ALL TESTS** (or another sequence containing **3 Ammonia-N LF**) from **TESTING MENU**.
4. Scroll to and select **3 Ammonia-N LF** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**. (See Note.)
7. Remove tube from Spectro. Use the 1.0 mL plastic pipet (0354) to add 2.0 mL of *Salicylate Ammonia #1 (3978). Cap and mix.
8. Use the 0.15 g spoon (0727) to add two measures of *Salicylate #2 Reagent (7457). Cap and mix until dissolved. Wait 1 minute.
9. At end of 1 minute waiting period use 0.1 g spoon (0699) to add two measures of *Salicylate #3 Reagent Powder (7458). Cap and shake vigorously for at least 30 seconds and all solid has dissolved. Wait 12 minutes for maximum color development.
10. At the end of 12 minute waiting period, mix, insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
11. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.



CALCULATIONS:

To express results as Unionized Ammonia ($NH_3$):

ppm Unionized Ammonia ($NH_3$) =

ppm Ammonia-Nitrogen ($NH_3$–N) x 1.2

To express results as Ionized Ammonia ($NH_4$):

ppm Ionized Ammonia ($NH_{4+}$) =

ppm Ammonia-Nitrogen ($NH_3$–N) x 1.3

NOTES: For the best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

To determine the percentage of Ammonia-Nitrogen that is unionized and ionized, consult the Appendix.

## PROCEDURE–SALT WATER

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS** from menu.
3. Scroll to and select **ALL TESTS** (or another sequence containing **4 Ammonia-N LS**) from **TESTING MENU**.
4. Scroll to and select **4 Ammonia-N LS** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**. (See Note.)
7. Remove tube from Spectro. Use the 1.0 mL plastic pipet (0354) to add 2.0 mL of *Salicylate Ammonia #1 (3978). Cap and mix.
8. Use the 0.15 g spoon (0727) to add two measures of *Salicylate #2 Reagent (7457). Cap and mix until dissolved. Wait 1 minute.
9. At end of 1 minute waiting period use 0.1 g spoon (0699) to add two measures of *Salicylate #3 Reagent Powder (7458). Cap and shake vigorously for at least 30 seconds and all solid has dissolved. Wait 20 minutes for maximum color development.
10. At the end of 20 minute waiting period, mix, insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
11. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

CALCULATIONS:

To express results as Unionized Ammonia ($NH_3$):

ppm Unionized Ammonia ($NH_3$) =

ppm Ammonia-Nitrogen ($NH_3$–N) x 1.2

To express results as Ionized Ammonia (NH4):

ppm Ionized Ammonia ($NH_{4+}$) =

ppm Ammonia-Nitrogen ($NH_3$–N) x 1.3

NOTES: For the best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

To determine the percentage of Ammonia-Nitrogen that is unionized and ionized, consult the Appendix.

# AMMONIA-NITROGEN, HIGH RANGE

## NESSLERIZATION METHOD • CODE 3642-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 30 mL | Ammonia Nitrogen Reagent #1 | V-4797-G |
| 2 x 30 mL | *Ammonia Nitrogen Reagent #2 | *V-4798-G |
| 1 | Pipet, 1 mL, plastic | 0354 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Ammonia nitrogen is present in various concentrations in many surface and ground water supplies. Any sudden change in the concentration of ammonia nitrogen in a water supply is cause for suspicion. A product of microbiological activity, ammonia nitrogen is sometimes accepted as chemical evidence of pollution when encountered in natural waters.

Ammonia is rapidly oxidized in natural water systems by special bacterial groups that produce nitrite and nitrate. This oxidation requires that dissolved oxygen be available in the water. Ammonia is an additional source of nitrogen as a nutrient which may contribute to the expanded growth of undesirable algae and other forms of plant growth that overload the natural system and cause pollution.

| | |
|---|---|
| APPLICATION: | Drinking, surface, and saline waters; domestic and industrial wastes. |
| RANGE: | 0.00–4.00 ppm Ammonia Nitrogen |
| MDL: | 0.05 ppm |
| METHOD: | Ammonia forms a colored complex with Nessler's Reagent in proportion to the amount of ammonia present in the sample. Rochelle salt is added to prevent precipitation of calcium or magnesium in undistilled samples. |
| SAMPLE HANDLING & PRESERVATION: | Ammonia solutions tend to be unstable and should be analyzed immediately. Sample may be stored for 24 hours at 4°C or 28 days at –20°C. |
| INTERFERENCES: | Sample turbidity and color may interfere. Turbidity may be removed by a filtration procedure. Color interference may be eliminated by blanking the instrument with a sample blank. |

# PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **5 Ammonia-N H**) from **TESTING MENU**.
4. Scroll to and select **5 Ammonia-N H** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**. (See Note)
7. Remove tube from Spectro. Add 8 drops of Ammonia Nitrogen Reagent #1 (V-4797). Cap and mix. Wait 1 minute.
8. Use the 1.0 mL pipet (0354) to add 1.0 mL of *Ammonia Nitrogen Reagent #2 (V-4798). Cap and mix. Allow 5 minutes for maximum color development.
9. At end of 5 minute waiting period, mix, insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
10. Press **OFF** button to turn the spectrophotometer off or press the **EXIT** button exit to a previous menu or make another menu selection.



CALCULATIONS:

To express results as Unionized Ammonia ($NH_3$):

ppm Unionized Ammonia ($NH_3$) =

ppm Ammonia-Nitrogen ($NH_3$–N) x 1.2

To express results as Ionized Ammonia ($NH_4$):

ppm Ionized Ammonia ($NH_{4+}$) =

ppm Ammonia-Nitrogen ($NH_3$–N) x 1.3

NOTES: For the best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

To determine the percentage of Ammonia-Nitrogen that is unionized and ionized, consult the Appendix.

# BIGUANIDE

## COLORIMETRIC METHOD • CODE 4044

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 2 X 60 mL | Biguanide Indicator | 3994-H |
| 1 | Pipet, plastic, 1.0 mL | 0354 |

Biguanide is a non-chlorine, non-bromine chemical sanitizer. It is more stable than chlorine or bromine and has little chemical odor. Biquanide is an effective bacteriacide but, unlike chlorine and bromine, it does not destroy organic contaminants. Therefore, hydrogen peroxide is added to biguanide pools on a regular basis to eliminate organic contaminants. The optimum recommended level of biguanide is 30 to 50 ppm.

| | |
|---|---|
| APPLICATION: | Swimming pools |
| RANGE: | 0-70 ppm |
| MDL: | 5 ppm |
| METHOD: | Biguanide complexes with the proprietary indicator to produce a colored solution. The color ranges from yellow through green to blue depending on the biguanide concentration. |
| SAMPLE HANDLING & PRESERVATION: | Samples should be analyzed as soon as possible. |
| INTERFERENCES: | The only interfering substances that are likely to be encountered in pool water are oxidized manganese and oxidizing agents, such as chlorine, bromine and ozone. |

# PROCEDURE

Use universal sample holder

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Select **ALL TESTS** (or another sequence containing **7 Biguanide** from **TESTING MENU**.
4. Scroll to and select **7 Biguanide** from menu.
5. Rinse a tube (0290) with sample water. Fill to 10 mL with sample.
6. Insert the tube into chamber, close lid and select **SCAN BLANK**.
7. Remove the tube from colorimeter.
8. Use the 1.0 mL pipet (0354) to add 2.0 mL of Biguanide Indicator (3994). Cap and invert three times to mix.
9. Wait 1 minute.
10. Insert the tube into chamber. Close lid.
11. Select **SCAN SAMPLE**. Record result in ppm Biguanide
12. Press **OFF** button to turn the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.



NOTE: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

# BORON

## AZOMETHINE-H METHOD • CODE 4868

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 120 mL | *Boron Buffer | *4869-J |
| 10 g | *Boron Indicator Powder | *4870-D |
| 1 | Pipet, plastic, 1.0 mL | 0354 |
| 1 | Spoon, 0.15 g | 0727 |
| 1 | Dark Storage Chamber, brown | 0108 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Small amounts of boron are necessary for plant growth but large amounts can be toxic. In humans, boron aids in the uptake of calcium and the production of strong bones. An excess of boron can affect the central nervous system resulting in a syndrome known as borism. Some natural waters may contain small amounts of boron. Large concentrations may be due to industrial effluent entering waterways. Boron compounds are used in cleaning compounds, paper and paints, fertilizers, glass and ceramics, fire retardants and the production of alloys. In the atomic energy field, boron is a component of neutron shields and nuclear reactors. Some swimming pools use boron buffering systems.

| | |
|---|---|
| APPLICATION: | Surface and saline waters, hydroponic solutions, industrial waste, swimming pools. |
| RANGE: | 0.00–0.80 ppm Boron |
| MDL: | 0.05 ppm |
| METHOD: | Azomethine-H and borate form a yellow complex at pH 6 in proportion to the concentration of boron present. |
| SAMPLE HANDLING & PRESERVATION: | Store samples in polyethylene bottles. Do not use borate detergents or glassware. |
| INTERFERENCES: | Interferences in drinking water are unlikely. Manganese, zirconium, chromium, titanium, copper, vanadium, aluminum, beryllium and iron may cause high results. |

# PROCEDURE

Use universal sample holder

1. This test requires a Reagent Blank. Rinse a tube (0290) with clear, colorless, boron free water. Fill to 10 mL line with clear, colorless, boron free water.
2. Use the 1.0 mL pipet (0354) to add 2 mL of *Boron Buffer (4869). Cap and mix.
3. Use the 0.15 g spoon (0727) to add one level measure of *Boron Indicator Powder (4870). Press full spoon against side of jar to compress powder. Scrape off excess powder on inside neck of bottle. Tap excess off spoon handle.
4. Cap and shake vigorously for 30 seconds.
5. Insert the tube into meter chamber. Close lid.
6. Start a timer set for 30 minutes. Do not open the lid during the waiting time. The reaction is photosensitive.
7. Rinse a clean tube (0290) with Sample Water. Fill to the 10 mL line with sample water. Repeat steps 2-4.
8. Insert the tube into the Dark Storage Chamber (29849). Close top.
9. Start a second timer set for 30 minutes. Do not open the chamber during the waiting time. The reaction is photosensitive.
10. When 2 minutes remain on the first timer (Reagent Blank), press and hold **ON** button until spectrophotometer turns on.
11. Scroll to and select **PROGRAMMED TESTS**.
12. Scroll to and select **ALL TESTS** (or another sequence containing **8 Boron**) from TESTING MENU.
13. Scroll to and select **8 Boron** from menu.
14. At the end of the Reagent Blank 30 minute waiting period, remove Reagent Blank tube from meter chamber. Invert several times to mix.
15. Insert the tube into meter chamber, close lid and select **SCAN BLANK**.
16. Remove the tube from spectrophotometer.
17. At the end of the Sample Water 30 minute waiting period, remove Sample Water tube from Dark Storage Chamber. Invert several times to mix.
18. Insert tube into meter chamber, close lid and select **SCAN SAMPLE**. Record result in ppm boron.
19. Press **OFF** button to turn the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

# BROMINE, UDV

## DPD UNIT DOSE VIAL METHOD • CODE 4311-J

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 1 | *Free Chlorine Unit Dose Vials, 20 pouches | *4311-J |

Equipment needed but not supplied:

STANDARD ACCESSORY PACKAGE • CODE 1961

| | | |
|---|---|---|
| 1 | Package of 3 Vials (empty) | 0156 |
| 1 | Syringe, 3 mL, plastic | 1184 |
| 1 | Foil Storage Bag | 9467 |

Or:

ADVANCED ACCESSORY PACKAGE • CODE 1962

| | | |
|---|---|---|
| 1 | Pipettor, 3 mL | 30528 |
| 1 | Pipet Tip (0-5 mL) | 30695 |
| 1 | Cuvette Rack | 31695 |
| 1 | Package of 3 Vials (empty) | 0156 |
| 1 | Foil Storage Bag | 9467 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Like chlorine, bromine is an effective germicidal agent employed in drinking water treatment, pool and spa water sanitation, food service sanitation, and other public health applications.

| | |
|---|---|
| APPLICATION: | Drinking, surface, and saline waters; domestic and industrial waters and wastes. |
| RANGE: | 0.0 – 22.0 ppm Bromine |
| MDL: | 0.3 ppm |
| METHOD: | In buffered sample bromine reacts with diethyl-p-phenylene diamine (DPD) to produce a pink-red color in proportion to the concentration of bromine present. |
| SAMPLE HANDLING & PRESERVATION: | Bromine in aqueous solutions is not stable, and the bromine content of samples or solutions, particularly weak solutions, will rapidly decrease. Exposure to sunlight or agitation will accelerate the reduction of bromine present in such solutions. For best results start analysis immediately after sampling. Samples to be analyzed for bromine cannot be preserved or stored. |
| INTERFERENCES: | The only interfering substance likely to be encountered in water is oxidized manganese. The extent of this interference can be determined by treating a sample with sodium arsenite to destroy the bromine present so that the degree of interference can be estimated.<br><br>Iodine and chlorine can also interfere, but these are not normally present unless they have been added as sanitizers. |

# PROCEDURE

Use 10 mm square cell adapter

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **11 Bromine-UDV**) from **TESTING MENU**.
4. Scroll to and select **11 Bromine-UDV** from menu.
5. Rinse a clean vial (0156) with sample water.
6. Use the syringe (1184) to add 3mL of sample to the vial.
7. Insert the vial into chamber, close the lid and select **SCAN BLANK**.
8. Remove the vial from the Spectro.
9. Use the syringe (1184) to add 3mL of sample to a *Free Chlorine UDV (4311).
10. Shake vigorously until powder dissolves completely.
    NOTE: If powder residue remains in the bottom of the vial after inverting or air bubbles form, invert once more and tap bottom of vial sharply once or twice to dislodge powder and bubbles. Mix.
11. Immediately insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result in ppm bromine.
12. Press **OFF** button to turn the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTE: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

NOTE: UDVs from opened pouches should be used promptly. Store unused vials from opened pouches in the Foil Storage Bag (9467) to extend the shelf life of the reagent. Generally, UDVs stored in the bag should be used within 10 days if the humidity is less than 50% and within 5 days if humidity is greater than 50%. The Foil Storage Bag contains a desiccant pack with indicator. When the indicator in the window turns from blue to pink, the bag should be replaced.

# CADMIUM

## PAN METHOD • CODE 4017-01

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 60 mL | Buffered Ammonia Reagent | 4020-H |
| 15 mL | Sodium Citrate, 10% | 6253-E |
| 30 mL | *PAN Indicator | *4021-G |
| 30 mL | Stabilizing Reagent | 4022-G |
| 1 | Pipet, 1.0 mL, plastic | 0354 |
| 2 | Pipet, 0.5 mL, plastic | 0369 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Cadmium is used in batteries, paint pigments, electroplating processes, and with other metals in the preparation of alloys. The solubility of cadmium in natural water is proportional to the hardness or alkalinity of the water. Cadmium is not an essential nutrient for plants and animals. It is extremely toxic and can accumulate in the kidneys and liver.

| | |
|---|---|
| APPLICATION: | Drinking and surface waters; domestic and industrial wastewater. |
| RANGE: | 0.00–1.00 Cadmium |
| MDL: | 0.02 ppm |
| METHOD: | PAN (1-(2-Pyridylazo)-2-Naphthol) forms a red complex with Cadmium (Cd+2) at a pH of 10. |
| SAMPLE HANDLING & PRESERVATION: | Analyze sample as soon as possible. If sample must be stored, acidify with nitric acid to a pH below 2. |
| INTERFERENCES: | $Ag^{+2}$, $Co^{+2}$, $Cu^{+2}$, $Mn^{+2}$, $Ni^{+2}$, $Zn^{+2}$, $Y^{+3}$, $In^{+3}$ |

# PROCEDURE

1. Use universal sample holder.
2. Press and hold **ON** button until spectrophotometer turns on.
3. Scroll to and select **PROGRAMMED TESTS**.
4. Scroll to and select **ALL TESTS** (or another sequence containing **12 Cadmium**) from **TESTING MENU**.
5. Scroll to and select **12 Cadmium** from menu.
6. Rinse a tube (0290) with sample water. Fill to the 10 mL line with sample.
7. Insert the tube into chamber, close lid and select **SCAN BLANK**.
8. Remove tube from Spectro. Use the 1.0 mL pipet (0354) to add 1.0 mL of *Buffered Ammonia Reagent (4020). Swirl to mix.
9. Add two drops of Sodium Citrate, 10% (6253). Swirl to mix.
10. Use a 0.5 mL pipet (0369) to add 0.5 mL of PAN Indicator (4021). Swirl to mix.
11. Use a 0.5 mL pipet (0369) to add 0.5 mL Stabilizing Reagent (4022). Cap and mix.
12. Immediately insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
13. Press **OFF** button to turn the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTE: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

# CALCIUM & MAGNESIUM (TOTAL) HARDNESS, UDV

## UNIT DOSE VIAL METHOD • CODE 4309-J

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 1 | Calcium Hardness Unit Dose Vials, 20 pouches | 4309-J |

Equipment needed but not supplied:

STANDARD ACCESSORY PACKAGE • CODE 1961

| | | |
|---|---|---|
| 1 | Package of 3 Vials (empty) | 0156 |
| 1 | Syringe, 3 mL, plastic | 1184 |
| 1 | Foil Storage Bag | 9467 |

Or:

ADVANCED ACCESSORY PACKAGE • CODE 1962

| | | |
|---|---|---|
| 1 | Pipettor, 3 mL | 30528 |
| 1 | Pipet Tips (0-5 mL) | 30695 |
| 1 | Cuvette Rack | 31695 |
| 1 | Package of 3 Vials (empty) | 0156 |
| 1 | Foil Storage Bag | 9467 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

| | |
|---|---|
| APPLICATION: | Drinking and surface waters; swimming pool water. |
| RANGE: | 10–500 as $CaCO_3$ Total Hardness |
| MDL: | 10 ppm |
| METHOD: | Calcium and magnesium react in a strongly buffered medium with an indicator to develop a pale purple color in proportion to the concentration. |
| SAMPLE HANDLING & PRESERVATION: | Samples should be analyzed as soon as possible after collection. If storage is necessary, add 0.5 mL of 20 % hydrochloric acid per 100 mL of sample. However, the added acid will have to be neutralized with NaOH before testing. |
| INTERFERENCES: | Heavy metals will interfere. |

# PROCEDURE

Use 10 mm square cell adapter

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **13 Ca&Mg Hard-UDV**) from **TESTING MENU**.
4. Scroll to and select **13 Ca&Mg Hard-UDV** from menu.
5. Rinse a clean vial (0156) with sample water.
6. Use the syringe (1184) to add 3mL of sample to the vial.
7. Insert the vial into chamber, close lid and select **SCAN BLANK**.
8. Remove vial from Spectro.
9. Use the syringe (1184) to add 3mL of sample to a Calcium Hardness UDV vial (4309).
10. Shake vigorously for 10 seconds.
    NOTE: If powder residue remains in the bottom of the vial after shaking, or if air bubbles form, invert vial once more and tap bottom of vial sharply once or twice to dislodge powder or bubbles. Mix.
11. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
12. Press **OFF** button to turn the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.



NOTES: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

UDVs from opened pouches should be used promptly. Store unused vials from opened pouches in the Foil Storage Bag (9467) to extend the shelf life of the reagent. Generally, UDVs stored in the bag should be used within 10 days if the humidity is less than 50% and within 5 days if humidity is greater than 50%. The Foil Storage Bag contains a desiccant pack with indicator. When the indicator in the window turns from blue to pink, the bag should be replaced.

# CHLORIDE, TESTAB

## ARGENTOMETRIC TESTAB METHOD • CODE 3693-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 50 | *Chloride Spectrophotometric Grade Tablets | *3885A-H |
| 1 | Tablet Crusher | 0175 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Chloride is one of the major anions found in water and sewage. The presence of chlorides in large amounts may be due to the natural process of water passing through salt formations in the earth, or it may be evidence of the intrusion of seawater or pollution from industrial processes or domestic wastes. The salt content of water affects the distribution of plant and animal life in an aquatic system, based on the amount of salt they can tolerate.

| | |
|---|---|
| APPLICATION: | Drinking, surface, and saline waters; domestic and industrial wastewaters. |
| RANGE: | 0.0–30.0 ppm Chloride |
| MDL: | 0.5 ppm |
| METHOD: | Silver nitrate reacts with chloride to form turbid silver chloride in proportion to the amount of chloride in the sample. |
| SAMPLE HANDLING & PRESERVATION: | Collect samples in clean, chemically-resistant glass or plastic containers. No preservative is needed if sample is to be stored. |
| INTERFERENCES: | Substances in amounts normally found in drinking water will not interfere. Bromide, iodide, cyanide, sulfide, thiosulfate, sulfide and orthophosphate will interfere. |

# PROCEDURE

Use universal sample holder

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **21 Chloride-TT**) from **TESTING MENU**.
4. Scroll to and select **21 Chloride-TT** from menu.
5. Rinse a tube (0290) with sample water. Fill to 10 mL with sample.
6. Insert the tube into chamber, close lid and select **SCAN BLANK**.
7. Remove the tube from Spectro.
8. Add one *Chloride Spectrophotometric Grade Tablet (3885A).
9. Use Tablet Crusher (0175) to crush tablet.
10. Cap tube.
11. Invert 2 times.
12. Wait 3 minutes. Do NOT mix.
13. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result in ppm chloride.
14. Press **OFF** button to turn the colorimeter off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTE: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples.

The reagent system is temperature sensitive. The calibration is for 25°C. If sample is at 30°C, multiply resulting ppm by 1.1. If the sample is at 20°C, multiply resulting ppm by 0.9.

# CHLORINE, BROMINE, IODINE

## DPD METHOD • CODE 3643-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 100 | * DPD #1 Instrument Grade Tablets | *6903A-J |
| 100 | *DPD #3 Instrument Grade Tablets | *6197A-J |
| 15 mL | Glycine Solution | 6811-E |
| 1 | Tablet Crusher | 0175 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

All water for cities and communities must be sanitized; even waters that come from clean sources, protected watersheds, reservoirs, and deep wells, are commonly sanitized to assure safety. Chlorine is the most commonly used sanitizer for several reasons: it is effective against a wide range of microorganisms, the cost is low, and the methods of applying it have been well developed. If an adequate concentration of chlorine is present in the water for a few minutes, disease producing bacteria will be destroyed. A number of conditions affect the sanitizing action of chlorine. In municipal systems these can be controlled so that if chlorine is detectable, it can be assumed that bacteria have been killed. The factors that influence the rate of kill are temperature, pH, presence of other materials that react with chlorine, time, and the concentrations of the various chlorine combinations that are formed in the water with ammonia and other substances that react with chlorine.

The fact that chlorine can be easily detected and measured makes chlorine a favorite water sanitizer of those concerned with the public safety of water supplies. Chlorine concentrations in the range of 0.1 to 0.4 parts per million are usually maintained in municipal supplies.

Chlorine can be added in the form of chlorine gas, liquid sodium hypochlorite (bleach), granular calcium hypochlorite or as organic chlorine compounds. Chlorine is not present in natural water supplies; if it is present it is the result of chlorination of a water supply or of chlorinated compounds being discharged as waste from industrial operations. The presence of chlorine in concentrations above 0.5 parts per million should be considered evidence of pollution from chlorine treated effluents or from a process in which high concentrations of chlorine are used.

| | |
|---|---|
| APPLICATION: | Drinking, surface, and saline waters; swimming pool water; domestic and industrial wastes. |
| RANGE: | 0.00–4.00 ppm Chlorine |
| MDL: | 0.02 ppm |
| METHOD: | In the absence of iodide, free available chlorine reacts instantly with DPD to produce a red color. Subsequent addition of potassium iodide evokes a rapid color response from the combined forms of chlorine (chloramines). |
| SAMPLE HANDLING & PRESERVATION: | Chlorine in aqueous solutions is not stable, and the chlorine content of samples or solutions, particularly weak solutions, will rapidly decrease. Exposure to sunlight or agitation will accelerate the reduction of chlorine present in such solutions. For best results, start analysis immediately after sampling. Samples to be analyzed for chlorine cannot be preserved or stored. |
| INTERFERENCE: | The only interfering substance likely to be encountered in water is oxidized manganese. The extent of this interference can be determined by treating a sample with sodium arsenite to destroy the chlorine present so that the degree of interference can be measured.<br><br>Iodine and bromine can give a positive interference, but these are not normally present unless they have been added as sanitizers. |

## PROCEDURE–FREE CHLORINE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **15 Chlorine**) from **TESTING MENU**.
4. Scroll to and select **15 Chlorine** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Remove tube from Spectro and pour off all but a sufficient amount of sample water to cover a tablet. Add one *Chlorine DPD #1 Instrument Grade Tablet (6903A). Crush tablet with a tablet crusher (0175), then add sample water until tube is filled to 10 mL line. Cap tube and shake until tablet has dissolved. Solution will turn pink if free chlorine is present. Wait 15 seconds, but no longer than 30 seconds. Mix.
8. Insert tube into chamber, close lid and select **SCAN SAMPLE**.

## PROCEDURE–COMBINED CHLORINE

Use universal sample holder.

9. Add one *Chlorine DPD #3 Instrument Grade Tablet (6197A) to sample from Step 8 above. Crush tablet with tablet crusher (0175). Cap tube and shake until tablet dissolves. An increase in color represents combined chlorine.
   NOTE: For wastewater samples, Standard Methods for the Examination of Water and Wastewater recommends waiting 2 minutes for full color development.
10. Insert sample into chamber, close lid and select **SCAN SAMPLE**. Record result as Total Chlorine.
11. Subtract free chlorine reading from total chlorine reading to obtain concentration of combined chlorine.
12. Press the **OFF** button to turn off the spectrophotometer or press the **EXIT** button to exit to a previous menu or make another menu selection.

# BROMINE

Like chlorine, bromine is an effective germicidal agent employed in drinking water treatment, pool and spa water sanitation, food service sanitation, and other public health applications.

| | |
|---|---|
| APPLICATION: | Drinking, surface, and saline waters; swimming pool water; domestic and industrial waters and wastes. |
| RANGE: | 0.00–9.00 ppm Bromine |
| MDL: | 0.04 ppm |
| METHOD: | In buffered sample bromine reacts with diethyl-p-phenylene diamine (DPD) to produce a pink-red color in proportion to the concentration of bromine present. |
| SAMPLE HANDLING & PRESERVATION: | Bromine in aqueous solutions is not stable, and the bromine content of samples or solutions, particularly weak solutions, will rapidly decrease. Exposure to sunlight or agitation will accelerate the reduction of bromine present in such solutions. For best results start analysis immediately after sampling. Samples to be analyzed for bromine cannot be preserved or stored. |
| INTERFERENCE: | The only interfering substance likely to be encountered in water is oxidized manganese. The extent of this interference can be determined by treating a sample with sodium arsenite to destroy the bromine present so that the degree of interference can be estimated.<br><br>Iodine and chlorine can also interfere, but these are not normally present unless they have been added as sanitizers. |

# PROCEDURE A: BROMINE (NO CHLORINE)

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **9 Bromine-LR**) from **TESTING MENU**.
4. Scroll to and select **9 Bromine-LR** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Remove tube from Spectro. Pour out all but a sufficient amount of sample water to cover a tablet. Add one *DPD #1 Instrument Grade Tablet (6903A). Crush tablet with tablet crusher (0175), then add sample water until tube is filled to 10 mL line. Cap tube and shake until tablet is dissolved. Solution will turn pink if bromine is present. Wait 15 seconds. Mix.
8. Insert tube into chamber, close lid and select **SCAN SAMPLE**.
9. Press **OFF** button to turn spectrophotometer off or press the **EXIT** button to exit to a previous menu or make another menu selection.

# PROCEDURE B: BROMINE IN THE PRESENCE OF CHLORINE

Use universal sample holder.

1. Press **USE** button to turn on colorimeter.
2. Scroll to and select **ALL TESTS** (or another sequence containing **9 Bromine-LR**) from **TESTING MENU**.
3. Scroll to and select **9 Bromine-LR** from menu.
4. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
5. Insert tube into chamber close lid and select **SCAN BLANK**.
6. Rinse a second clean tube (0290) with sample water. Fill to the 10 mL line with sample. Add 5 drops of Glycine Solution (6811). Cap and mix.
7. Remove blank from Spectro. Pour out all of the sample water. To this tube add just enough of Glycine treated sample (Step 6) to cover a tablet. Add one *Chlorine DPD#1 Instrument Grade Tablet (6903A). Crush tablet with a tablet crusher (0175). Add all remaining Glycine-treated sample. Cap tube and shake until tablet dissolves. Solution will turn pink if bromine is present. Wait 15 seconds. Mix.

8. Insert tube into chamber, close lid and select **SCAN SAMPLE**.
9. Press **OFF** button to exit to previous menu or make another menu selection.

## PROCEDURE C: FREE AVAILABLE, TOTAL AVAILABLE & COMBINED CHLORINE IN THE PRESENCE OF BROMINE

1. Perform the test for free and combined chlorine as previously described.
2. Perform the test for bromine in the presence of chlorine.
3. Calculations:

Residual Bromine (ppm) = Reading BR

Free Chlorine in the Presence of Bromine = Free Chlorine – 0.45 (Reading BR)

Total Chlorine in the Presence of Bromine = Total Chlorine – 0.45 (Reading BR)

Combined Chlorine in the Presence of Bromine = Total Chlorine – Free Chlorine

NOTE: Combined chlorine is not affected by the presence of bromine, so the calculation is the same as when only chlorine is present.

# IODINE

Like chlorine and bromine, iodine is an effective germicidal agent employed in drinking water treatment, pool and spa water sanitation, food service sanitation, and other public health applications.

| | |
|---|---|
| APPLICATION: | Drinking, surface, and saline waters; swimming pool water; domestic and industrial wastes. |
| RANGE: | 0.00–14.00 ppm Iodine |
| MDL: | 0.08 ppm |
| METHOD: | In a buffered sample iodine reacts with diethyl-p-phenylene-diamine (DPD) to produce a pink-red color in proportion to the concentration of iodine present. |
| SAMPLE HANDLING & PRESERVATION: | Iodine in aqueous solutions is not stable, and the iodine content of samples or solutions, particularly weak solutions, will rapidly decrease. Exposure to sunlight or agitation will accelerate the reduction of iodine present in such solutions. For best results start analysis immediately after sampling. Samples to be analyzed for iodine cannot be preserved or stored. |
| INTERFERENCE: | The only interfering substance likely to be encountered in water is oxidized manganese. The extent of this interference can be determined by treating a sample with sodium arsenite to destroy the iodine present so that the degree of interference can be measured.<br><br>Chlorine and bromine can give a positive interference, but these are not normally present unless they have been added as sanitizers. |

# PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **50 Iodine**) from **TESTING MENU**.
4. Scroll to and select ***50 Iodine*** from menu.
5. Rinse a clean tube (0290) with sample water. Fill tube to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Remove tube from Spectro. Pour off all but a sufficient amount of sample water to cover a tablet. Add one *DPD #1 Tablet Instrument Grade (6903A). Crush tablet with tablet crusher (0175). Add sample water until tube is filled to 10 mL line. Cap and shake until tablet dissolves. Solution will turn pink if iodine is present. Wait 15 seconds. Mix.
8. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
9. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

# CHLORINE-FREE, UDV

## DPD UNIT DOSE VIAL METHOD • CODE 4311-J

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 1 | *Free Chlorine Unit Dose Vials, 20 pouches | *4311-J |

Equipment needed but not supplied:

| STANDARD ACCESSORY PACKAGE • CODE 1961 | | |
|---|---|---|
| 1 | Package of 3 Vials (empty) | 0156 |
| 1 | Syringe, 3 mL, plastic | 1184 |
| 1 | Foil Storage Bag | 9467 |

Or:

| ADVANCED ACCESSORY PACKAGE • CODE 1962 | | |
|---|---|---|
| 1 | Pipettor | 30528 |
| 1 | Pipet Tips (0-5 mL) | 30695 |
| 1 | Cuvette Rack | 31695 |
| 1 | Package of 3 Vials (empty) | 0156 |
| 1 | Foil Storage Bag | 9467 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

All water for cities and communities must be sanitized; even waters that come from clean sources, protected watersheds, reservoirs, and deep wells, are commonly sanitized to assure safety. Chlorine is the most commonly used sanitizer for several reasons: it is effective against a wide range of microorganisms, the cost is low, and the methods of applying it have been well developed. If an adequate concentration of chlorine is present in the water for a few minutes, disease producing bacteria will be destroyed. A number of conditions affect the sanitizing action of chlorine. In municipal systems these can be controlled so that if chlorine is detectable, it can be assumed that bacteria have been killed. The factors that influence the rate of kill are temperature, pH, presence of other materials that react with chlorine, time, and the concentrations of the various chlorine combinations that are formed in the water with ammonia and other substances that react with chlorine.

The fact that chlorine can be easily detected and measured makes chlorine a favorite water sanitizer of those concerned with the public safety of water supplies. Chlorine concentrations in the range of 0.1 to 0.4 parts per million are usually maintained in municipal supplies.

Chlorine can be added in the form of chlorine gas, liquid sodium hypochlorite

(bleach), granular calcium hypochlorite or as organic chlorine compounds. Chlorine is not present in natural water supplies; if it is present it is the result of chlorination of a water supply or of chlorinated compounds being discharged as waste from industrial operations. The presence of chlorine in concentrations above 0.5 parts per million should be considered evidence of pollution from chlorine treated effluents or from a process in which high concentrations of chlorine are used.

| | |
|---|---|
| APPLICATION: | Drinking, surface, and saline waters; domestic and industrial wastes. |
| RANGE: | 0.00–10.00 ppm |
| MDL: | 0.10 ppm |
| METHOD: | In the absence of iodide, free available chlorine reacts instantly with DPD to produce a red color. Subsequent addition of potassium iodide evokes a rapid color response from the combined forms of chlorine (chloramines). |
| SAMPLE HANDLING & PRESERVATION: | Chlorine in aqueous solutions is not stable, and the chlorine content of samples or solutions, particularly weak solutions, will rapidly decrease. Exposure to sunlight or agitation will accelerate the reduction of chlorine present in such solutions. For best results, start analysis immediately after sampling. Samples to be analyzed for chlorine cannot be preserved or stored. |
| INTERFERENCES: | The only interfering substance likely to be encountered in water is oxidized manganese. The extent of this interference can be determined by treating a sample with sodium arsenite to destroy the chlorine present so that the degree of interference can be measured.<br><br>Iodine and bromine can give a positive interference, but these are not normally present unless they have been added as sanitizers. |

# PROCEDURE

Use 10 mm square cell adapter

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **16 Cl Free-UDV**) from **TESTING MENU**.
4. Scroll to and select **16 Cl Free-UDV** from menu.
5. Rinse a clean vial (0156) with sample water.
6. Use the syringe (1184) to add 3mL of sample to the vial.
7. Insert the vial into chamber, close the lid and select **SCAN BLANK**.
8. Remove the vial from the Spectro.
9. Use the syringe (1184) to add 3mL of sample to a *Free Chlorine UDV (4311).
10. Shake vigorously until powder dissolves completely.
    NOTE: If powder residue remains in the bottom of the vial after inverting or air bubbles form, invert once more and tap bottom of vial sharply once or twice to dislodge powder and bubbles. Mix.
11. Immediately insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result in ppm free chlorine.
12. Press **OFF** button to turn the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTES: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

UDVs from opened pouches should be used promptly. Store unused vials from opened pouches in the Foil Storage Bag (9467) to extend the shelf life of the reagent. Generally, UDVs stored in the bag should be used within 10 days if the humidity is less than 50% and within 5 days if humidity is greater than 50%. The Foil Storage Bag contains a desiccant pack with indicator. When the indicator in the window turns from blue to pink, the bag should be replaced.

# CHLORINE

## LIQUID DPD METHOD • CODE 4859

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 30 mL | DPD 1A Free Chlorine Reagent | P-6740-G |
| 30 mL | *DPD 1B Free Chlorine Reagent | *P-6741-G |
| 30 mL | *DPD 3 Total Chlorine Reagent | *P-6743-G |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

All water for cities and communities must be sanitized; even waters that come from clean sources, protected watersheds, reservoirs, and deep wells, are commonly sanitized to assure safety. Chlorine is the most commonly used sanitizer for several reasons: it is effective against a wide range of microorganisms, the cost is low, and the methods of applying it have been well developed. If an adequate concentration of chlorine is present in the water for a few minutes, disease producing bacteria will be destroyed. A number of conditions affect the sanitizing action of chlorine. In municipal systems these can be controlled so that if chlorine is detectable, it can be assumed that bacteria have been killed. The factors that influence the rate of kill are temperature, pH, presence of other materials that react with chlorine, time, and the concentrations of the various chlorine combinations that are formed in the water with ammonia and other substances that react with chlorine.

The fact that chlorine can be easily detected and measured makes chlorine a favorite water sanitizer of those concerned with the public safety of water supplies. Chlorine concentrations in the range of 0.1 to 0.4 parts per million are usually maintained in municipal supplies.

Chlorine can be added in the form of chlorine gas, liquid sodium hypochlorite (bleach), granular calcium hypochlorite or as organic chlorine compounds. Chlorine is not present in natural water supplies; if it is present it is the result of chlorination of a water supply or of chlorinated compounds being discharged as waste from industrial operations. The presence of chlorine in concentrations above 0.5 parts per million should be considered evidence of pollution from chlorine treated effluents or from a process in which high concentrations of chlorine are used.

| | |
|---|---|
| APPLICATION: | Drinking, surface, and saline waters; swimming pool water; domestic and industrial wastes. |
| RANGE: | 0.00–4.00 ppm Chlorine |
| MDL: | 0.025 ppm |
| METHOD: | In the absence of iodide, free available chlorine reacts instantly with DPD to produce a red color. Subsequent addition of potassium iodide evokes a rapid color response from the combined forms of chlorine (chloramines). |
| SAMPLE HANDLING & PRESERVATION: | Chlorine in aqueous solutions is not stable, and the chlorine content of samples or solutions, particularly weak solutions, will rapidly decrease. Exposure to sunlight or agitation will accelerate the reduction of chlorine present in such solutions. For best results, start analysis immediately after sampling. Samples to be analyzed for chlorine cannot be preserved or stored. |
| INTERFERENCE: | The only interfering substance likely to be encountered in water is oxidized manganese. The extent of this interference can be determined by treating a sample with sodium arsenite to destroy the chlorine present so that the degree of interference can be measured.<br><br>Iodine and bromine can give a positive interference, but these are not normally present unless they have been added as sanitizers. |

## PROCEDURE–FREE CHLORINE

Use universal sample holder

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **17 Cl DPD-Liq**) from **TESTING MENU**.
4. Scroll to and select **17 Cl DPD-Liq** from menu.
5. Rinse a tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert the tube into chamber, close lid and select **SCAN BLANK**.
7. Remove the tube from spectrophotometer.
8. Add 5 drops of DPD 1A Free Chlorine Reagent (P-6740).
9. Add 5 drops of *DPD 1B Free Chlorine Reagent (P-6741). Cap and mix.
10. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result as ppm free chlorine.

## PROCEDURE–TOTAL CHLORINE

11. Add 5 drops of *DPD 3 Total Chlorine Reagent (P-6743). Cap and mix. NOTE: For wastewater samples, Standard Methods for the Examination of Water and Wastewater recommends waiting 2 minutes for full color development.
12. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result as ppm total chlorine.
13. Subtract the Free Chlorine reading from the Total Chlorine reading to determine ppm combined chlorine.
14. Press **OFF** button to turn the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTE: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

# CHLORINE–TOTAL, UDV

## DPD UNIT DOSE VIAL METHOD • CODE 4312-J

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 1 | *Total Chlorine Unit Dose Vials, 20 pouches | *4312-J |

Equipment needed but not supplied:

STANDARD ACCESSORY PACKAGE • CODE 1961

| | | |
|---|---|---|
| 1 | Package of 3 Vials (empty) | 0156 |
| 1 | Syringe, 3 mL, plastic | 1184 |
| 1 | Foil Storage Bag | 9467 |

Or:

ADVANCED ACCESSORY PACKAGE • CODE 1962

| | | |
|---|---|---|
| 1 | Pipettor, 3 mL | 30528 |
| 1 | Pipet Tips (0-5 mL) | 30695 |
| 1 | Cuvette Rack | 31695 |
| 1 | Package of 3 Vials (empty) | 0156 |
| 1 | Foil Storage Bag | 9467 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

All water for cities and communities must be sanitized; even waters that come from clean sources, protected watersheds, reservoirs, and deep wells, are commonly sanitized to assure safety. Chlorine is the most commonly used sanitizer for several reasons: it is effective against a wide range of microorganisms, the cost is low, and the methods of applying it have been well developed. If an adequate concentration of chlorine is present in the water for a few minutes, disease producing bacteria will be destroyed. A number of conditions affect the sanitizing action of chlorine. In municipal systems these can be controlled so that if chlorine is detectable, it can be assumed that bacteria have been killed. The factors that influence the rate of kill are temperature, pH, presence of other materials that react with chlorine, time, and the concentrations of the various chlorine combinations that are formed in the water with ammonia and other substances that react with chlorine.

The fact that chlorine can be easily detected and measured makes chlorine a favorite water sanitizer of those concerned with the public safety of water supplies. Chlorine concentrations in the range of 0.1 to 0.4 parts per million are usually maintained in municipal supplies.

Chlorine can be added in the form of chlorine gas, liquid sodium hypochlorite

(bleach), granular calcium hypochlorite or as organic chlorine compounds. Chlorine is not present in natural water supplies; if it is present it is the result of chlorination of a water supply or of chlorinated compounds being discharged as waste from industrial operations. The presence of chlorine in concentrations above 0.5 parts per million should be considered evidence of pollution from chlorine treated effluents or from a process in which high concentrations of chlorine are used.

| | |
|---|---|
| APPLICATION: | Drinking, surface, and saline waters; domestic and industrial wastes. |
| RANGE: | 0.00-10.00 ppm |
| MDL: | 0.10 ppm |
| METHOD: | In the absence of iodide, free available chlorine reacts instantly with DPD to produce a red color. Subsequent addition of potassium iodide evokes a rapid color response from the combined forms of chlorine (chloramines). |
| SAMPLE HANDLING & PRESERVATION: | Chlorine in aqueous solutions is not stable, and the chlorine content of samples or solutions, particularly weak solutions, will rapidly decrease. Exposure to sunlight or agitation will accelerate the reduction of chlorine present in such solutions. For best results, start analysis immediately after sampling. Samples to be analyzed for chlorine cannot be preserved or stored. |
| INTERFERENCES: | The only interfering substance likely to be encountered in water is oxidized manganese. The extent of this interference can be determined by treating a sample with sodium arsenite to destroy the chlorine present so that the degree of interference can be measured.<br><br>Iodine and bromine can give a positive interference, but these are not normally present unless they have been added as sanitizers. |

# PROCEDURE

Use 10 mm square cell adapter

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **18 Cl Total-UDV**) from **TESTING MENU**.
4. Scroll to and select **18 Cl Total-UDV** from menu.
5. Rinse a clean vial (0156) with sample water
6. Use the syringe (1184) to add 3mL of sample to the vial.
7. Insert the vial into chamber, close the lid and select **SCAN BLANK**.
8. Remove the vial from the Spectro.
9. Use the syringe (1184) to add 3mL of sample to a *Total Chlorine UDV (4312).
10. Shake vigorously until powder dissolves completely.
    NOTE: If powder residue remains in the bottom of the vial after inverting or air bubbles form, invert once more and tap bottom of vial sharply once or twice to dislodge powder and bubbles. Mix.
11. Wait 2 minutes.
12. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result in ppm total chlorine.
13. Press **OFF** button to turn the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTES: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

UDVs from opened pouches should be used promptly. Store unused vials from opened pouches in the Foil Storage Bag (9467) to extend the shelf life of the reagent. Generally, UDVs stored in the bag should be used within 10 days if the humidity is less than 50% and within 5 days if humidity is greater than 50%. The Foil Storage Bag contains a desiccant pack with indicator. When the indicator in the window turns from blue to pink, the bag should be replaced.

# CHLORINE DIOXIDE

## DPD METHOD • CODE 3644-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 100 | *DPD #1 Instrument Grade Tablets | *6903A-J |
| 15 mL | Glycine Solution | 6811-E |
| 1 | Tablet Crusher | 0175 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Chlorine dioxide is used as a substitute for and an adjunct to chlorine in water treatment. It is better than chlorine in eliminating taste and odor in certain cases. Chlorine dioxide, unlike chlorine, does not produce carcinogenic chlorinated organic compounds when reacted with organic materials. A disadvantage is the higher cost of producing chlorine dioxide compared to chlorine.

| | |
|---|---|
| APPLICATION: | Drinking water; swimming pool water; domestic and industrial wastewater; food sanitation. |
| RANGE: | 0.00–7.00 ppm Chlorine Dioxide |
| MDL: | 0.04 ppm |
| METHOD: | Chlorine dioxide reacts with DPD to form a red color in proportion to the concentration. |
| SAMPLE HANDLING & PRESERVATION: | Test as soon as possible to avoid loss of chlorine dioxide. |
| INTERFERENCE: | Chlorine interference can be removed with the use of glycine. Very high levels of chloramines may interfere if the test result is not read immediately. Oxidized manganses interferes but can be removed with arsenite. Bromine and iodine interfere. Chromate interference can be removed with a thioacetamide blank correction. |

# PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS** from menu.
3. Scroll to and select **ALL TESTS** (or another sequence containing **20 CHLOR DIOX**) from **TESTING MENU**.
4. Scroll to and select 20 CHLOR DIOX from menu.
5. Rinse a clean tube (0290) with sample water. Fill to 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK.**
7. Remove tube from Spectro. Pour out all but a sufficient amount of sample water to cover tablet. Add 5 drops of Glycine Solution (6811).
8. Add one *Chlorine DPD #1 Instrument Grade Tablet (6903A). Crush tablet with tablet crusher. Cap and shake until tablet dissolves. Fill to 10 mL line with sample water. Solution will turn pink if chlorine dioxide is present. Wait 15 seconds, but no longer than 30 seconds. Mix.
9. Insert tube into chamber, close lid and select **SCAN SAMPLE**.
10. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

# CHROMIUM, HEXAVALENT

## DIPHENYLCARBOHYDRAZIDE METHOD
## CODE 3645-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 10 g | *Chromium Reagent Powder | *V-6276-D |
| 1 | Spoon, 0.1 g, plastic | 0699 |
| 50 | Filter Paper | 0465-H |
| 1 | Funnel, Plastic | 0459 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Chromium may be present in water containing waste from industries such as metal plating. It is considered to be a toxic chemical and, if present in an amount of over 0.5 ppm, is evidence of contamination from untreated or incompletely treated industrial waste.

Chromium is one of a class of heavy metals found in the bottom mud of polluted bodies of water. Certain shellfish are capable of concentrating this element, endangering the health of its ultimate consumer, human or animal.

| | |
|---|---|
| APPLICATION: | Drinking, surface, and saline waters; domestic and industrial wastewaters. |
| RANGE: | 0.00–1.00 ppm Chromium |
| MDL: | 0.01 ppm |
| METHOD: | Hexavalent chromium reacts with 1,5 diphenylcarbohydrazide under acidic conditions to form a red-purple color in proportion to the amount of chromium present. |
| SAMPLE HANDLING & PRESERVATION: | Analysis for chromium should be made as quickly as possible after sample collection since storage in glass or plastic containers may result in low chromate values. |
| INTERFERENCES: | High concentrations of mercurous and mercuric ions may impart a blue color to the chromium determination. Iron and vanadium in concentrations above 1 mg/L may result in a yellow color. However, the vanadium color becomes negligible 10 minutes after the addition of diphenylcarbohydrazide. |

# PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS** from menu.
3. Scroll to and select **ALL TESTS** (or another sequence containing **22 Chromium**) from **TESTING MENU**.
4. Scroll to and select **22 Chromium** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Remove tube from Spectro. Use the 0.1g spoon (0699) to add one measure of *Chromium Reagent Powder (V-6276). Cap and shake until powder dissolves. Wait 3 minutes for full color development.
8. During waiting period, fold a piece of filter paper (0465) in half then half again to form a cone. Push corners together to open end, and insert into funnel (0459).
9. At the end of 3 minute waiting period, filter sample into a clean tube. Mix. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
10. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTES: To convert result to ppm chromate ($CrO_4^{2-}$) multiply by 2.23. To convert result to ppm sodium chromate ($Na_2CrO_4$) multiply by 3.12.

Highly buffered waters may give poor results and require a more careful pH adjustment. Before adding *Chromium Reagent Powder, adjust pH of sample to pH 3-4.

# CHROMIUM-HEXAVALENT, TRIVALENT & TOTAL

## DIPHENYLCARBOHYDRAZIDE METHOD
## CODE 3698-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 60 mL | *Sulfuric Acid, 5N | *7681-H |
| 10 g | *Chromium Reagent Powder | *V-6276-D |
| 15 mL | *Sodium Azide, 5% | *7683-E |
| 30 mL | Potassium Permanganate, 0.5% | 7682-G |
| 60 mL | Deionized Water | 5115PT-H |
| 1 | Pipet, plain, glass, w/cap | 0341 |
| 1 | Pipet, 1.0 mL, plastic | 0354 |
| 1 | Spoon, 0.1 g, plastic | 0699 |
| 1 | Graduated Cylinder, 50 mL, glass | 0418 |
| 1 | Erlenmeyer Flask, 125 mL, glass | 0431 |
| 1 | Test tube holder | 1113 |
| 1 | Filter Paper | 0465 |
| 1 | Funnel, Plastic | 0459 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

A toxic chemical, chromium is found in two forms in the water; trivalent chromium ($Cr^{3+}$) and hexavalent chromium ($Cr^{6+}$). Chromium enters the water from industrial waste. Hexavalent chromium is more toxic than trivalent chromium. Levels greater than 0.5 ppm indicate improperly treated industrial waste. It is important to maintain chromium levels at or below 0.5 ppm, because clams and other shellfish will store chromium in their systems, accumulating levels which may be dangerous to the consumer, whether human or animal.

| | |
|---|---|
| APPLICATION: | Drinking, surface, and saline waters; domestic and industrial wastes. |
| RANGE: | 0.00–1.00 ppm Chromium |
| MDL: | 0.01 ppm |
| METHOD: | The trivalent chromium is converted to hexavalent chromium by permanganate under acidic conditions. Hexavalent chromium reacts with 1,5 diphenyl-carbohydrazide under acidic conditions to form a red-purple color in proportion to the amount of chromium present. |
| SAMPLE HANDLING & PRESERVATION: | Analysis for chromium should be made as quickly as possible after sample collection since storage in glass or plastic containers may result in low chromate values. |
| INTERFERENCES: | High concentrations of mercurous and mercuric ions may interfere. |

# HEXAVALENT CHROMIUM PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **22 Chromium** from menu.
3. Scroll to and select **ALL TESTS** (or another sequence containing **22 Chromium**) from **TESTING MENU**.
4. Scroll to and select 22 Chromium from menu.
5. Rinse a clean tube (0290) with sample water. Fill to 10 mL line with sample water.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Remove tube from Spectro. Use 0.1 g spoon (0699) to add one level measure of *Chromium Reagent Powder (V-6276). Cap and shake for one minute. Wait 3 minutes.
8. During the waiting period, fold a piece of filter paper in half, then in half again to form a cone. Push corners together to open end, and insert into funnel (0459).
9. At the end of 3 minute waiting period, filter sample into a clean tube (0290). Cap and mix. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
10. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

# TOTAL CHROMIUM WITH ACID DIGESTION PROCEDURE

1. Fill graduated cylinder (0418) to 50 mL line with sample water. Transfer to Erlenmeyer flask (0431).
2. Use the 1 mL pipet (0354) to add 5 mL (five measures) of *Sulfuric Acid, 5N (7681). Swirl to mix.
3. NOTE: Highly buffered waters may require pH adjustment. Adjust the pH of highly buffered samples to 7.0 ±0.5. Continue procedure.
4. Place flask on burner or hot plate. Bring solution to a gentle boil.
5. Fill pipet (0341) with Potassium Permanganate, 0.5% (7682). While gently swirling flask, add Potassium Permanganate, 0.5% (7682), 2 drops at a time to boiling solution, until solution turns a dark pink color which persists for 10 minutes. Continue boiling.
6. Add one drop of *Sodium Azide, 5% (7683) to boiling solution. Boil for approximately 30 seconds. If pink color does not fade, add another drop of *Sodium Azide, 5%. Continue adding *Sodium Azide, 5% one drop at a time

until pink color disappears.

7. Remove flask from heat. Cool sample under running water. This is the digested sample.
8. Pour digested sample into clean graduated cylinder (0418). Dilute to the 50 mL line with Deionized Water (5115).
9. Press and hold **ON** button until spectrophotometer turns on.
10. Scroll to and select **PROGRAMMED TESTS** from menu.
11. Scroll to and select **ALL TESTS** (or another sequence containing **22 Chromium**) from **TESTING MENU**.
12. Scroll to and select **22 Chromium** from menu.
13. Rinse a clean tube (0290) with sample water. Fill to
14. 10 mL line with sample water.
15. Insert tube into chamber, close lid and select **SCAN BLANK**.
16. Remove tube from Spectro. Use 0.1 g spoon (0699) to add one level measure of *Chromium Reagent Powder (V-6276). Cap and shake for one minute. Wait 3 minutes.
17. During the waiting period, fold a piece of filter paper in half, then in half again to form a cone. Push corners together to open end, and insert into funnel (0459).
18. Filter sample into a clean tube (0290). Cap and mix. Insert tube of filtered sample into chamber, close lid and select **SCAN SAMPLE**. Record result.
19. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.



## TRIVALENT CHROMIUM PROCEDURE

Subtract hexavalent chromium from total chromium. Record as ppm trivalent chromium.

Trivalent Chromium = Total Chromium – Hexavalent Chromium

# CHROMIUM, TESTAB

## DIPHENYLCARBOHYDRAZIDE TESTAB METHOD
## CODE 3697-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 50 | *Chromium Spectrophotometric Grade Tablets | *3889A-H |
| 1 | Tablet Crusher | 0175 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Chromium is one of a class of heavy metals found in the bottom mud of polluted bodies of water. It is considered to be a toxic chemical. Chromium will become concentrated in some shellfish, endangering the health of the human or animal that consumes them. Chromium may be present in water containing waste from industries such as metal plating. If more than 0.5 ppm chromium is present, it is evidence of contamination from untreated or incompletely treated industrial waste.

| | |
|---|---|
| APPLICATION: | Drinking, surface, and saline waters; domestic and industrial wastewaters. |
| RANGE: | 0.00–1.00 ppm Chromium |
| MDL: | 0.03 ppm |
| METHOD: | Hexavalent chromium reacts with 1,5 diphenylcarbohydrazide under acidic conditions to form a red-purple color in proportion to the amount of chromium present. |
| SAMPLE HANDLING & PRESERVATION: | Analysis for chromium should be made as quickly as possible. Storage in plastic or glass containers may result in low results. |
| INTERFERENCES: | High concentrations of mercurous and mercuric ions may impart a blue color to the chromium determination. Iron and vanadium in concentrations above 1 ppm may result in a yellow color. |

# PROCEDURE

Use universal sample holder

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **23 Chromium-TT**) from **TESTING MENU**.
4. Scroll to and select **23 Chromium-TT** from menu.
5. Rinse a tube (0290) with sample water. Fill to 10 mL with sample.
6. Insert the tube into chamber, close lid and select **SCAN BLANK**.
7. Remove the tube from Spectro.
8. Add one *Chromium Spectrophotometric Grade Tablet (3889).
9. Use Tablet Crusher (0175) to crush tablet.
10. Cap tube.
11. Shake vigorously for 30 seconds.
12. Wait 3 minutes.
13. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result in ppm chromium.
14. Press **OFF** button to turn the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTES: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples.

To convert results to ppm chromate ($CrO_4^{-2}$), multiply by 2.23. To convert result to ppm sodium chromate ($Na_2CrO_4$) multiply by 3.12.

# COBALT

## PAN METHOD • CODE 4851

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 60 mL | *Cobalt Buffer | *4852-H |
| 60 mL | *Cobalt Indicator Reagent | *4853-H |
| 30 mL | *Stabilizer Solution | *4854-G |
| 2 | Pipet, 1.0 mL, plastic | 0354 |
| 1 | Pipet, 0.5 mL, plastic | 0353 |

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Cobalt rarely occurs in natural water. It is used in the manufacture of alloys to increase corrosion resistance and strength. It is found in wastewaters as a corrosion by-product.

| | |
|---|---|
| APPLICATION: | Industrial wastewater. |
| RANGE: | 0.00–2.00 Cobalt |
| MDL: | 0.02 ppm |
| METHOD: | PAN (1-(2-Pyridylazo)-2-Naphthol) forms a greenish complex with Cobalt ($Co^{+2}$) at a pH of 5. |
| SAMPLE HANDLING & PRESERVATION: | Store samples in acid-washed plastic bottles. Adjust pH to less than 2 with nitric acid. Adjust sample pH to 5 before testing. |
| INTERFERENCES: | Iron (+2) and high concentrations of heavy metals. |

# PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **24 Cobalt**) from **TESTING MENU**.
4. Scroll to and select **24 Cobalt** from menu.
5. Rinse a tube (0290) with sample water. Fill to 10 mL with sample.
6. Insert the tube into chamber, close lid and select **SCAN BLANK**.
7. Remove the tube from Spectro.
8. Use the 1.0 mL pipet (0354) to add 1 mL of *Cobalt Buffer (4852). Cap and mix.
9. Use the other 1.0 mL pipet (0354) to add 1 mL of *Cobalt Indicator Reagent (4853). Cap and mix.
10. Wait 3 minutes.
11. Use the 0.5 mL pipet (0353) to add 0.5 mL *Stabilizer Solution (4854). Cap and invert 15 times to thoroughly mix.
12. Wait 5 minutes. DO NOT MIX.
13. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result in ppm cobalt.
14. Press **OFF** button to turn the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTE: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

# COD, LOW RANGE

## MERCURY FREE DIGESTION METHOD • Code 0072-SC
## MERCURY DIGESTION METHOD • Code 0075-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 25 | *COD Low Level Mercury Free Tubes | *0072-SC |
| or 25 | *COD Low Level Mercury Tubes | *0075-SC |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

COD Low Level Mercury Free Tubes are not USEPA approved.

COD Low Level Mercury Tubes are USEPA approved.

NOTE: These reagents are for use with the SMART Spectro version 1.5 or higher.

Equipment needed but not supplied:

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 1 | COD Adapter | 5-0087 |
| 1 | COD Reactor, 12 tube, 110V | 5-0102 |
| or 1 | COD Reactor, 12 tube, 230V | 5-0102-EX2 |
| 1 | Measuring Pipet, 1.0 mL | 2-2110 |
| 1 | Pipet Bulb | 2-2164 |

Chemical Oxygen Demand (COD) is a measure of the amount of organic matter in water which is susceptible to oxidation by chemical oxidants. COD can be empirically related to the Biological Oxygen Demand (BOD) and organic carbon content of a specific source of water. This correlation must be determined experimentally for each source of water.

| | |
|---|---|
| APPLICATION: | Domestic and industrial wastes. |
| RANGE: | 0–150 mg/L COD |
| MDL: | 5 mg/L |
| METHOD: | Dichromate in the presence of silver salts, at high temperature in a closed system, oxidizes most organic compounds to 95-100% of the theoretical amount. This process is called digestion. As dichromate oxidizes the organic compounds, the amount of yellow color is reduced. The remaining yellow color is measured colorimetrically at the 420 nm and is directly proportional to the COD of the sample. |
| SAMPLE HANDLING & PRESERVATION: | Collect samples in glass and test as soon as possible. If samples must be stored, preservation is accomplished by the addition of concentrated H2SO4 to adjust the pH below 2. Samples with suspended solids should be homogenized in a blender (100 mL for 30 seconds) and then stirred gently with a magnetic stirrer. |
| INTERFERENCES: | Volatile organic compounds are not oxidized to the extent that they are in the vapor above the digestion solution. Therefore, they do not contribute to the COD reading. Chloride concentrations above 10% of COD interfere with the mercury free tubes. Chloride above 2000 ppm will interfere with the mercury tubes. Nitrite gives a positive interference of 1.1 ppm $O_2$ per ppm $NO_2$–N which is insignificant unless nitrite concentrations are very high. Other reduced inorganic compounds are stoichiometrically oxidized, causing a positive interference. Corrections can be made for these compounds based upon their stoichiometry and concentrations. |

# PROCEDURE

Use universal sample holder

1. Homogenize sample if necessary.
2. Preheat COD heater block to 150±2°C.
3. Remove cap from COD tube. Hold tube at a 45° angle. Use a volumetric pipet, to carefully add 2.0 mL sample water allowing the sample to run down the side of the tube.
4. Cap and mix thoroughly.
5. Rinse the outside of the tube with distilled water. Wipe dry with a paper towel.
6. Repeat steps 3 through 5 using 2.0 mL distilled water. This is the reagent blank.
7. Place tubes in preheated COD block heater and maintain temperature at 150±2°C for two hours.
8. At the end of the heating period turn the heater off. Wait 20 minutes for the tubes to cool to 120°C or less.
9. Remove tubes from block heater. Invert several times to mix.
10. Allow to cool to room temperature.
11. Press **ON** button until spectrophotometer turns on.
12. Scroll to and select **PROGRAMMED TESTS** from menu.
13. Scroll to and select **ALL TESTS** (or another sequence containing **25 COD LR 0-150**) from **PROGRAMMED TESTS** menu.
14. Scroll to and select ***25 COD LR 0-150*** from menu.
15. Wipe the blank tube with a damp towel to remove fingerprints and smudges. Wipe with a dry towel.
16. Insert reagent blank tube into chamber. Align the center of the LaMotte logo on the tube with the arrow shaped mark molded into the housing at the front edge of the light chamber. Select **SCAN BLANK**.
17. Remove tube from Spectro.
18. Insert digested water sample tube into chamber. Position tube as instructed above. Select **SCAN SAMPLE**. Record result. For the most accurate results, take three readings on each sample and average the results.
19. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTES: Reagents are light sensitive. Unused reagents should be stored in the shipping container, and in the refrigerator if possible, until needed.

A reagent blank should be run with each set of samples and with each lot of reagents.

The reacted blank will be stable if stored in the dark.

To eliminate error caused by contamination, wash all glassware with 20% sulfuric acid.

For greater accuracy, a minimum of three repetitions should be performed and the results averaged.

Some samples may be digested completely in less than two hours. The concentration may be measured at 15 minute intervals while the vials are still hot until the reading remains unchanged. The vials should be cooled to room temperature before the final measurement is taken.

# COD, STANDARD RANGE

## MERCURY FREE DIGESTION METHOD • CODE 0073-SC
## MERCURY DIGESTION METHOD • CODE 0076-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 25 | *COD Standard Level Mercury Free Tubes | *0073-SC |
| or 25 | *COD Standard Level Mercury Tubes | *0076-SC |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

COD Standard Level Mercury Free Tubes are not USEPA approved.

COD Standard Level Mercury Tubes are USEPA approved.

NOTE: These reagents are for use with the SMART Spectro version 1.5 or higher.

Equipment needed but not supplied:

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 1 | COD Adapter | 5-0087 |
| 1 | COD Reactor, 12 tube, 110V | 5-0102 |
| or 1 | COD Reactor, 12 tube, 230V | 5-0102-EX2 |
| 1 | Measuring Pipet, 1.0 mL | 2-2110 |
| 1 | Pipet Bulb | 2-2164 |

Chemical Oxygen Demand (COD) is a measure of the amount of organic matter in water which is susceptible to oxidation by chemical oxidants. COD can be empirically related to the Biological Oxygen Demand (BOD) and organic carbon content of a specific source of water. This correlation must be determined experimentally for each source of water.

| | |
|---|---|
| APPLICATION: | Domestic and industrial wastes. |
| RANGE: | 0–1500 mg/L COD |
| MDL: | 20 mg/L |
| METHOD: | Dichromate in the presence of silver salts, at high temperature in a closed system, oxidizes most organic compounds to 95-100% of the theoretical amount. This process is called digestion. As dichromate oxidizes the organic compounds, a green complex is formed. The concentration of the green complex is measured at 620 nm and is directly proportional to the COD of the sample. |
| SAMPLE HANDLING & PRESERVATION: | Collect samples in glass and test as soon as possible. If samples must be stored, preservation is accomplished by the addition of concentrated $H_2SO_4$ to adjust the pH below 2. Samples with suspended solids should be homogenized in a blender (100 mL for 30 seconds) and then stirred gently with a magnetic stirrer. |
| INTERFERENCES: | Volatile organic compounds are not oxidized to the extent that they are in the vapor above the digestion solution. Therefore, they do not contribute to the COD reading. Chloride concentrations above 10% of COD interfere with the mercury free tubes. Chloride above 2000 ppm will interfere with the mercury tubes. Nitrite gives a positive interference of 1.1 ppm $O_2$ per ppm $NO_2$–N which is insignificant unless nitrite concentrations are very high. Other reduced inorganic compounds are stoichiometrically oxidized, causing a positive interference. Corrections can be made for these compounds based upon their stoichiometry and concentrations. |

# PROCEDURE

Use universal sample holder

1. Homogenize sample if necessary.
2. Preheat COD heater block to 150±2°C.
3. Remove cap from COD tube. Hold tube at a 45° angle. Use a volumetric pipet, to carefully add 2.0 mL sample water allowing the sample to run down the side of the tube.
4. Cap and mix thoroughly.
5. Rinse the outside of the tube with distilled water. Wipe dry with a paper towel.
6. Repeat steps 2 through 5 using 2.0 mL distilled water. This is the reagent blank.
7. Place tubes in preheated COD block heater and maintain temperature at 150±2°C for two hours.
8. At the end of the heating period turn the heater off. Wait 20 minutes for the tubes to cool to 120°C or less.
9. Remove tubes from block heater. Invert several times to mix.
10. Allow to cool to room temperature.
11. Press **ON** button until spectrophotometer turns on.
12. Scroll to and select **PROGRAMMED TESTS** from menu.
13. Scroll to and select **ALL TESTS** (or another sequence containing **26 COD SR 0-1500**) from **PROGRAMMED TESTS** menu.
14. Wipe the blank tube with a damp towel to remove fingerprints and smudges. Wipe with a dry towel.
15. Scroll to and select **26 COD SR 0-1500** from menu.
16. Insert reagent blank tube into chamber. Align the center of the LaMotte logo on the tube with the arrow shaped mark molded into the housing at the front edge of the light chamber. Select **SCAN BLANK**.
17. Remove tube from Spectro.
18. Insert digested water sample tube into chamber. Position tube as instructed above. Select **SCAN SAMPLE**. Record result. For the most accurate results, take three readings on each sample and average the results.
19. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTES: Reagents are light sensitive. Unused reagents should be stored in the shipping container, and in the refrigerator if possible, until needed.

A reagent blank should be run with each set of samples and with each lot of reagents.

The reacted blank will be stable if stored in the dark.

To eliminate error caused by contamination, wash all glassware with 20% sulfuric acid.

For greater accuracy, a minimum of three repetitions should be performed and the results averaged.

Some samples may be digested completely in less than two hours. The concentration may be measured at 15 minute intervals while the vials are still hot until the reading remains unchanged. The vials should be cooled to room temperature before the final measurement is taken.

# COD, HIGH RANGE

## MERCURY FREE DIGESTION METHOD • Code 0074-SC
## MERCURY DIGESTION METHOD • Code 0077-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 25 | *COD High Level Mercury Free Tubes | *0074-SC |
| or 25 | *COD High Level Mercury Tubes | *0077-SC |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

COD High Level Mercury Free Tubes and COD High Level Mercury Tubes are not USEPA approved.

NOTE: These reagents are for use with the SMART Spectro version 1.5 or higher.

Equipment needed but not supplied:

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 1 | COD Adapter | 5-0087 |
| 1 | COD Reactor, 12 tube, 110V | 5-0102 |
| or 1 | COD Reactor, 12 tube, 230V | 5-0102-EX2 |
| 1 | Measuring Pipet, 1.0 mL | 2-2110 |
| 1 | Pipet Bulb | 2-2164 |

Chemical Oxygen Demand (COD) is a measure of the amount of organic matter in water which is susceptible to oxidation by chemical oxidants. COD can be empirically related to the Biological Oxygen Demand (BOD) and organic carbon content of a specific source of water. This correlation must be determined experimentally for each source of water.

| | |
|---|---|
| APPLICATION: | Domestic and industrial wastes. |
| RANGE: | 0–15,000 mg/L COD |
| MDL: | 500 mg/L |
| METHOD: | Dichromate in the presence of silver salts, at high temperature in a closed system, oxidizes most organic compounds to 95-100% of the theoretical amount. This process is called digestion. As dichromate oxidizes the organic compounds, a green complex is formed. The concentration of the green complex is measured at 605 nm and is directly proportional to the COD of the sample. |
| SAMPLE HANDLING & PRESERVATION: | Collect samples in glass and test as soon as possible. If samples must be stored, preservation is accomplished by the addition of concentrated $H_2SO_4$ to adjust the pH below 2. Samples with suspended solids should be homogenized in a blender (100 mL for 30 seconds) and then stirred gently with a magnetic stirrer. |
| INTERFERENCES: | Volatile organic compounds are not oxidized to the extent that they are in the vapor above the digestion solution.<br><br>Therefore, they do not contribute to the COD reading. Contains mercury sulfate to prevent interference from chloride. Nitrite gives a positive interference of 1.1 ppm $O_2$ per ppm $NO_2$–N, which is insignificant unless nitrite concentrations are very high. Other reduced inorganic compounds are stoichiometrically oxidized, causing a positive interference. Corrections can be made for these compounds based upon their stoichiometry and concentrations. |

# PROCEDURE

Use universal sample holder

1. Homogenize sample if necessary.
2. Preheat COD heater block to 150±2°C.
3. Remove cap from COD tube. Hold vial at a 45° angle. Use a graduated pipet, to carefully add 0.2 mL sample water allowing the sample to run down the side of the tube.
4. Cap and mix thoroughly.
5. Rinse the outside of the tube with distilled water. Wipe dry with a paper towel.
6. Repeat steps 3 through 5 using 0.2 mL distilled water. This is the reagent blank.
7. Place tubes in preheated COD block heater and maintain temperature at 150±2°C for two hours.
8. At the end of the heating period turn the heater off. Wait 20 minutes for the tubes to cool to 120°C or less.
9. Remove tubes from block heater. Invert several times to mix.
10. Allow to cool to room temperature.
11. Press **ON** button until spectrophotometer turns on.
12. Scroll to and select **PROGRAMMED TESTS** from menu.
13. Scroll to and select **ALL TESTS** (or another sequence containing **27 COD HR 0-15000**) from **PROGRAMMED TESTS** menu.
14. Wipe the blank tube with a damp towel to remove fingerprints and smudges. Wipe with a dry towel.
15. Scroll to and select **27 COD HR 0-15000** from menu.
16. Insert reagent blank tube into chamber. Align the center of the LaMotte logo on the tube with the arrow shaped mark molded into the housing at the front edge of the light chamber. Select **SCAN BLANK**.
17. Remove tube from Spectro.
18. Insert digested water sample tube into chamber. Position tube as instructed above. Select **SCAN SAMPLE**. Record result. For the most accurate results, take three readings on each sample and average the results.
19. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTES: Reagents are light sensitive. Unused reagents should be stored in the shipping container, and in the refrigerator if possible, until needed.

A reagent blank should be run with each set of samples and with each lot of reagents.

The reacted blank will be stable if stored in the dark.

To eliminate error caused by contamination, wash all glassware with 20% sulfuric acid.

For greater accuracy, a minimum of three repetitions should be performed and the results averaged.

Some samples may be digested completely in less than two hours. The concentration may be measured at 15 minute intervals while the vials are still hot until the reading remains unchanged. The vials should be cooled to room temperature before the final measurement is taken.

# COLOR

## PLATINUM COBALT METHOD
## NO REAGENTS REQUIRED

Color in water may be attributed to humus, peat, plankton, vegetation, and natural metallic ions, such as iron and manganese, or industrial waste. Color is removed to make water suitable for domestic and industrial use. Color may have to be removed from industrial waste before it is discharged to a waterway.

| | |
|---|---|
| APPLICATION: | Potable water and water with color due to natural materials. |
| RANGE: | 0–1,000 color units |
| MDL: | 15 cu |
| METHOD: | Color is determined by a meter that has been calibrated with colored standards of known platinum cobalt concentration. True color, the color of water in which the turbidity has been removed, is measured. |
| SAMPLE HANDLING & PRESERVATION: | Collect all samples in clean glassware. Determine color as soon as possible to avoid biological or chemical changes that could occur in the sample during storage. |
| INTERFERENCES: | Turbidity will interfere. Filter before testing. |

# PROCEDURE

Use universal sample holder.

1. Press and hold **ON** burton until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **28 Color**) from **TESTING MENU**.
4. Scroll to and select **28 Color** from menu.
5. Rinse a tube (0290) with color-free water (distilled or deionized water). Fill to 10 mL line with color-free water.
6. Insert the tube into chamber, close lid and select **SCAN BLANK**.
7. Remove tube from spectrophotometer. Empty tube.
8. Rinse tube with sample water. Fill to 10 mL line with water sample.
9. Insert tube with sample water, close lid and select **SCAN SAMPLE**. Record result in color units.
10. Press **OFF** button to turn the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

# COPPER BCA, LOW RANGE

## BICINCHONINIC ACID METHOD • CODE 3640-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 50 | *Copper Tablets | *T-3808-H |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

The copper content of drinking water generally falls below 0.03 parts per million, but copper levels as high as 1.0 part per million will give water a bitter taste. Waters testing as high as 1.0 part per million copper have probably been treated with a copper compound, like those used in the control of algae, or have become contaminated from untreated industrial wastes. The addition of copper sulfate to lakes causes an increase in the copper content of the sediments. Acid waters and those high in free carbon dioxide may cause the corrosion or "eating away" of copper, brass and bronze pipes and fittings. This corrosion results in the addition of copper into the water supply.

| | |
|---|---|
| APPLICATION: | Drinking, surface, and saline waters; domestic and industrial wastes. |
| RANGE: | 0.00–3.50 ppm Copper |
| MDL: | 0.05 ppm |
| METHOD: | Copper ions form a purple complex with bicinchoninic acid around pH 6-7, in proportion to the concentration of copper in the sample. |
| SAMPLE HANDLING & PRESERVATION: | Copper has a tendency to be adsorbed to the surface of the sample container. Samples should be analyzed as soon as possible after collection. If storage is necessary, 0.5 mL of 20% HCl per 100 mL of sample will prevent "plating out." However, a correction must be made to bring the reaction into the optimum pH range. |
| INTERFERENCES: | High concentrations of oxidizing agents, calcium, and magnesium interfere. Silver can also interfere. |

# PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TEST** from menu.
3. Scroll to and select **ALL TESTS** (or another sequence containing **29 Copper BCA-LR**) from **TESTING MENU**.
4. Scroll to and select **29 Copper BCA-LR** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Remove tube from Spectro and add one *Copper Tablet (T-3808). Cap and shake vigorously until tablet dissolves. Solution will turn purple if copper is present. Wait 2 minutes.
8. At end of 2 minute waiting period, mix, insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
9. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

# COPPER

## CUPRIZONE METHOD • CODE 4023

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 15 mL | Copper A | P-6367-E |
| 15 mL | Copper B | P-6368-E |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

The copper content of drinking water generally falls below 0.03 parts per million, but copper levels as high as 1.0 part per million will give water a bitter taste. Waters testing as high as 1.0 part per million copper have probably been treated with a copper compound, like those used in the control of algae, or have become contaminated from untreated industrial wastes. The addition of copper sulfate to lakes causes an increase in the copper content of the sediments. Acid waters and those high in free carbon dioxide may cause the corrosion or “eating away” of copper, brass and bronze pipes and fittings. This corrosion results in the addition of copper to the water supply.

| | |
|---|---|
| APPLICATION: | Drinking, surface, and domestic waters; swimming pool water. |
| RANGE: | 0.00–2.00 ppm Copper |
| MDL: | 0.01 ppm |
| METHOD: | Copper ions form a blue complex with cuprizone, in a 1 to 2 ratio, at a pH of about 8, in proportion to the concentration of copper in the sample. |
| SAMPLE HANDLING & PRESERVATION: | Copper has a tendency to be adsorbed to the surface of the sample container. Samples should be analyzed as soon as possible after collection. If storage is necessary, 0.5 mL of 20% hydrochloric acid per 100 mL of sample will prevent “plating out”. However, a correction must be made to bring the reaction into the optimum pH range. |
| INTERFERENCES: | Hg+1 at 1 ppm. Cr+3, Co+2, and silicate at 10 ppm. $As^{+3}$, $Bi^{+3}$, $Ca^{+2}$, $Ce^{+3}$, $Ce^{+4}$, $Hg^{+2}$, $Fe^{+2}$, $Mn^{+2}$, $Ni^{+2}$ and ascorbate at 100 ppm. |

Many other metal cations and inorganic anions at 1000 ppm. EDTA at all concentrations.

# PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **31 Cu-Cuprizone**) from **TESTING MENU**.
4. Scroll to and select **31 Cu-Cuprizone** from menu.
5. Rinse a tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert the tube into chamber, close lid and select **SCAN BLANK**.
7. Remove tube from Spectro and add 5 drops of Copper A (P-6367). Cap and mix.
8. Add 5 drops of *Copper B (P-6368). Cap and mix.
9. Wait 5 minutes. Mix.
10. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
11. Press **OFF** button to turn the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.



NOTES: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

The reaction may stain the tubes. Scrub tubes thoroughly after each use.

# COPPER, DDC

## DIETHYLDITHIOCARBAMATE METHOD • CODE 3646-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 15 mL | *Copper 1 | *6446-E |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

The copper content of drinking water generally falls below 0.03 parts per million, but copper levels as high as 1.0 part per million will give water a bitter taste. Waters testing as high as 1.0 part per million copper have probably been treated with a copper compound, like those used in the control of algae, or have become contaminated from untreated industrial wastes. The addition of copper sulfate to lakes causes an increase in the copper content of the sediments. Acid waters and those high in free carbon dioxide may cause the corrosion or "eating away" of copper, brass and bronze pipes and fittings. This corrosion results in the addition of copper into the water supply.

| | |
|---|---|
| APPLICATION: | Cupric ions form a yellow colored chelate with diethyldithiocarbamate around pH 9-10 in proportion to the concentration of copper in the sample.<br><br>Drinking, surface, and saline waters; domestic and industrial wastes. |
| RANGE: | 0.00–6.00 ppm Copper |
| ML: | 0.05 ppm |
| METHOD: | Cupric ions form a yellow colored chelate with diethyldithiocarbamate around pH 9-10 in proportion to the concentration of copper in the sample. |
| SAMPLE HANDLING & PRESERVATION: | Copper has a tendency to be adsorbed to the surface of the sample container. Samples should be analyzed as soon as possible after collection. If storage is necessary, 0.5 mL of 20% hydrochloric acid per 100 mL of sample will prevent "plating out." However, a correction must be made to bring the reaction into the optimum pH range. |
| INTERFERENCES: | Bismuth, cobalt, mercurous, nickel and silver ions and chlorine (6 ppm or greater) interfere and must be absent. |

# PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS** from menu.
3. Scroll to and select **ALL TESTS** (or another sequence containing **32 Copper DDC**) from **TESTING MENU**.
4. Scroll to and select **32 Copper DDC** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Remove tube from Spectro and add 5 drops of *Copper 1 (6446). Cap and mix. Solution will turn yellow if copper is present.
8. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
9. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTE: The reaction may stain the tubes. Scrub the tubes thoroughly after each use.

# COPPER, UDV

## BICINCHONINIC ACID–UNIT DOSE VIAL METHOD
## CODE 4314-J

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 1 | Copper Unit Dose Vials, 20 pouches | 4314-J |

Equipment needed but not suppled:

STANDARD ACCESSORY PACKAGE • CODE 1961

| | | |
|---|---|---|
| 1 | Package of 3 Vials (empty) | 0156 |
| 1 | Syringe, 3 mL, plastic | 1184 |
| 1 | Foil Storage Bag | 9467 |

Or:

ADVANCED ACCESSORY PACKAGE • CODE 1962

| | | |
|---|---|---|
| 1 | Pipettor, 3 mL | 30528 |
| 1 | Pipet Tip (0-5 mL) | 30695 |
| 1 | Cuvette Rack | 31695 |
| 1 | Package of 3 Vials (empty) | 0156 |
| 1 | Foil Storage Bag | 9467 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

The copper content of drinking water generally falls below 0.03 parts per million, but copper levels as high as 1.0 part per million will give water a bitter taste. Waters testing as high as 1.0 part per million copper have probably been treated with a copper compound, like those used in the control of algae, or have become contaminated from untreated industrial wastes. The addition of copper sulfate to lakes causes an increase in the copper content of the sediments. Acid waters and those high in free carbon dioxide may cause the corrosion or “eating away” of copper, brass and bronze pipes and fittings. This corrosion results in the addition of copper to the water supply.

| | |
|---|---|
| APPLICATION: | Drinking, surface, and saline waters; domestic and industrial wastes. |
| RANGE: | 0.00–4.00 Copper |
| MDL: | 0.20 ppm |
| METHOD: | Cupric ions form a purple complex with bicinchoninic acid around pH 6–7, in proportion to the concentration of copper in the sample. |
| SAMPLE HANDLING & PRESERVATION: | Copper has a tendency to be adsorbed to the surface of the sample container. Samples should be analyzed as soon as possible after collection. If storage is necessary, 0.5 mL of 20% hydrochloric acid per 100 mL of sample will prevent “plating out”. However, a correction must be made to bring the reaction into the optimum pH range. |
| INTERFERENCES: | High concentrations of oxidizing agents, calcium, and magnesium interfere. Silver can also interfere. |

# PROCEDURE

Use 10 mm square cell adapter.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **33 Copper-UDV**) from **TESTING MENU**.
4. Scroll to and select **33 Copper-UDV** from menu.
5. Rinse a clean vial (0156) with sample water.
6. Use the syringe (1184) to add 3 mL of sample to the vial.
7. Insert the vial into chamber, close lid and select **SCAN BLANK**.
8. Remove vial from Spectro.
9. Use the syringe (1184) to add 3 mL of sample to a Copper UDV vial (4314).
10. Wait 2 minutes.
11. Invert vial 3 times to mix.
    NOTE: If powder residue remains in the bottom of the vial after inverting, or air bubbles form, invert once more and tap bottom of vial sharply once or twice to dislodge powder or bubbles. Mix.
12. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
13. Press **OFF** button to turn the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTE: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

UDVs from opened pouches should be used promptly. Store unused vials from opened pouches in the Foil Storage Bag (9467) to extend the shelf life of the reagent. Generally, UDVs stored in the bag should be used within 10 days if the humidity is less than 50% and within 5 days if humidity is greater than 50%. The Foil Storage Bag contains a dessicant pack with indicator. When the indicator in the window turns from blue to pink, the bag should be replaced.

# CYANIDE

## PYRIDINE-BARBITURIC ACID METHOD
## CODE 3660-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 60 mL | Cyanide Buffer | 2850PS-H |
| 5 g | *Cyanide Cl Reagent | *2794DS-C |
| 5 g | *Cyanide Indicator Reagent | *2793DS-C |
| 15 mL | *Hydrochloric Acid 1N | *6130-E |
| 15 mL | *Sodium Hydroxide 1N | *4004-E |
| 2 | Spoons, 0.1 g, plastic | 0699 |
| 1 | Pipet, plastic, 1.0 mL | 0354 |
| 1 | pH Short Range Test Paper, pH 9–14 | 2955 |
| 1 | Stirring Rod, Plastic | 0519 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

The presence of cyanide in water has a significant effect on the biological activity of the system. Cyanides may exist in water in a variety of forms which vary in toxicity. Cyanide is a by-product of industrial waste from petroleum refining and plating.

| | |
|---|---|
| APPLICATION: | Low level concentrations in drinking and surface waters; domestic and industrial waters. This method determines only those cyanides amenable to chlorination. |
| RANGE: | 0.00–0.500 ppm Cyanide |
| MDL: | 0.05 ppm |
| METHOD: | Cyanides react with a chlorine donor to form cyanogen chloride, which subsequently reacts with Pyridine and Barbituric Acid to form a red-blue compound in proportion to the amount of cyanide originally present. The concentration of the red-blue compound is determined spectrophotometrically. |
| SAMPLE HANDLING & PRESERVATION: | Cyanide solutions tend to be unstable and should be analyzed as soon as possible. Samples can be stabilized by adjusting the pH to greater than 12 with NaOH. However, the pH will have to be readjusted to pH 10.5 before performing the test. |
| INTERFERENCES: | Oxidizing agents and aldehydes can react with cyanide, while reducing agents, such as sulfite, react with the chlorine donor; both can cause negative interferences. Thiocyanate and cyanogen chloride both react as cyanide in this test and will give a positive interference. Color and turbidity can also interfere. |

# PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS** from menu.
3. Scroll to and select **ALL TESTS** (or another sequence containing **35 Cyanide**) from **TESTING MENU**.
4. Scroll to and select **35 Cyanide** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Dip the end of plastic rod (0519) into water sample and touch it to a small piece (1/4 inch) of pH test paper (2955) to wet paper. Read pH immediately from color chart.

   a) If pH is below 10, raise the pH by adding *Sodium Hydroxide, 1N (4004) one drop at a time with stirring. Check pH after each drop with a new piece of pH test paper. Continue adjustment until pH is between 10.5 and 11.0.

   b) If pH is above 11.5, lower pH by adding *Hydrochloric Acid (6130) one drop at a time with stirring. Check pH after each drop with a new piece of pH test paper. Continue adjustment until pH is between 10.5 and 11.0.
7. Insert tube into chamber, close lid and select **SCAN BLANK**.
8. Remove tube from Spectro. Use the 1.0 mL pipet (0354) to add 1.0 mL of Cyanide Buffer (2850PS) to tube. Cap and mix.
9. Use one 0.1 g spoon (0699) to add one level measure of *Cyanide Cl Reagent (2794DS). Cap and invert 10 times to mix. Wait 30 seconds.
10. During the 30 second waiting period, carefully fill a second 0.1 g spoon (0699) with one level measure of *Cyanide Indicator Reagent (2793DS).
11. At the end of the 30 second waiting period, immediately add the level measure of *Cyanide Indicator Reagent (2793DS). Cap and shake vigorously for 20 seconds. Wait 20 minutes for maximum color development.
12. At the end of the twenty minute waiting period, mix, insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
13. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

# CYANURIC ACID

## MELAMINE METHOD–TURBIDITY • CODE 366I-01-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 2 x 100 mL | *Cyanuric Acid Test Solution | *4856-J |
| 1 | Syringe, 5 mL | 0807 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Cyanuric acid is added to swimming pool water as a stabilizing agent for free chlorine residuals. It minimizes the loss of chlorine from the action of ultraviolet rays in sunlight. Cyanuric acid levels in pools should be maintained between 25 and 75 ppm and various public health associations recommend that the concentration should never exceed 100-150 ppm.

| | |
|---|---|
| APPLICATION: | Swimming pool water. |
| RANGE: | 0–200 ppm Cyanuric Acid |
| MDL: | 16 ppm |
| METHOD: | A buffered solution of melamine forms a precipitate with cyanuric acid in proportion to the amount of cyanuric acid present. The amount of particles in suspension is measured turbidimetrically. |
| SAMPLE HANDLING & PRESERVATION: | Cyanuric acid samples should be analyzed as soon as possible after collection. Deterioration of the sample can be minimized by keeping samples in the dark or refrigerated until analysis can be performed. |
| INTERFERENCES: | No known interference from compounds normally found in pool water. Temperature of the sample should be maintained between 70°F and 80°F for best results. Check for stray light interference (see page 15). |

# PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **36 Cyanuric**) from **TESTING MENU**.
4. Scroll to and select **36 Cyanuric** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Remove tube from Spectro and pour out water. Use a graduated cylinder or similar to measure 5 mL of sample water and pour into colorimeter tube.
8. Use the 5 mL syringe (0807) to add 5 mL of *Cyanuric Acid Test Solution (4856). Cap and mix thoroughly. A precipitate will form if cyanuric acid is present. Wait 1 minute.
   NOTE: This reagent bottle has a special fitting which enables the syringe to be inserted into the top of the bottle. With syringe in place, invert bottle and withdraw syringe plunger until 5 mL of reagent is contained in the syringe barrel. Remove syringe from reagent bottle and depress plunger to dispense into the tube.
9. At end of 1 minute waiting period, mix thoroughly, insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
10. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTE: For the most accurate results, the sample and reagents should be at 25 ±4°C.

# CYANURIC ACID, UDV

## MELAMINE–TURBIDITY–UNIT DOSE VIAL METHOD
## CODE 4313-J

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 1 | Cyanuric Acid Unit Dose Vials, 20 pouches | 4313-J |

Equipment but not suppled:

STANDARD ACCESSORY PACKAGE • CODE 1961

| | | |
|---|---|---|
| 1 | Package of 3 Vials (empty) | 0156 |
| 1 | Syringe, 3 mL, plastic | 1184 |
| 1 | Foil Storage Bag | 9467 |

Or:

ADVANCED ACCESSORY PACKAGE • CODE 1962

| | | |
|---|---|---|
| 1 | Pipettor, 3 mL | 30528 |
| 1 | Pipet Tip (0-5 mL) | 30695 |
| 1 | Cuvette Rack | 31695 |
| 1 | Package of 3 Vials (empty) | 0156 |
| 1 | Foil Storage Bag | 9467 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Cyanuric acid is added to swimming pool water as a stabilizing agent for free chlorine residuals. It minimizes the loss of chlorine from the action of ultraviolet rays in sunlight. Cyanuric acid levels should be maintained between 25 and 75 ppm and various public health associations recommend that the concentration should never exceed 100–150 ppm.

| | |
|---|---|
| APPLICATION: | Swimming pool water. |
| RANGE: | 0–150 Cyanuric Acid |
| MDL: | 5 ppm |
| METHOD: | A buffered solution of melamine forms a precipitate with cyanuric acid in proportion to the amount of cyanuric acid present. The amount of particles in suspension is measured turbidimetrically. |
| SAMPLE HANDLING & PRESERVATION: | Cyanuric acid samples should be analyzed as soon as possible after collection. Deterioration of the sample can be minimized by keeping samples in the dark or refrigerated until analysis can be performed. |
| INTERFERENCES: | No known interference from compounds normally found in pool water. Temperature of the sample should be maintained between 70°F and 80°F for best results. Check for stray light interference (see page 16). |

# PROCEDURE

Use 10 mm square cell adapter.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **37 Cyanuric-UDV**) from **TESTING MENU**.
4. Scroll to and select **37 Cyanuric-UDV** from menu.
5. Rinse a clean vial (0156) with sample water.
6. Use the syringe (1184) to add 3 mL of sample to the vial.
7. Insert the vial into chamber, close lid and select **SCAN BLANK**.
8. Remove vial from Spectro.
9. Use the syringe (1184) to add 3 mL of sample to a Cyanuric Acid UDV vial (4313).
10. Invert vial 3 times to mix.
11. Wait 2 minutes.
12. Invert vial 3 times to mix.
    NOTE: If powder residue remains in the bottom of the vial after inverting, or air bubbles forms, invert vial once more and tap bottom of vial sharply once or twice to dislodge powder or bubbles. Mix.
13. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
14. Press **OFF** button to turn the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTES: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

UDVs from opened pouches should be used promptly. Store unused vials from opened pouches in the Foil Storage Bag (9467) to extend the shelf life of the reagent. Generally, UDVs stored in the bag should be used within 10 days if the humidity is less than 50% and within 5 days if humidity is greater than 50%. The Foil Storage Bag contains a desiccant pack

# DISSOLVED OXYGEN

## WINKLER COLORIMETRIC METHOD • CODE 3688-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 30 mL | *Manganese Sulfate Solution | *4167-G |
| 30 mL | *Alkaline Potassium Iodide Azide | *7166-G |
| 30 mL | *Sulfuric Acid 1:1 | *6141WT-G |
| 1 | Sample Tube, screw cap | 29180 |
| 1 | Cap | 28570 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Dissolved oxygen is vital to the survival of aquatic organisms. Naturally present, dissolved oxygen enters the water when plants photosynthesize. Wind and wave action also cause oxygen from the air to dissolve into water. Dissolved oxygen is consumed by aquatic animals and by the oxidation, or chemical breakdown, of dead and decaying plants and animals. The concentration of dissolved oxygen in natural waters can range from 0 to 14 ppm and is effected by temperature and salinity.

| | |
|---|---|
| APPLICATION: | Drinking and surface waters; domestic and industrial wastewaters. |
| RANGE: | 0.00–12.00 ppm Dissolved Oxygen |
| MDL: | 0.25 ppm |
| METHOD: | This method uses the azide modification of the Winkler Method with a colorimetric determination of the yellow iodine produced from the reaction with the dissolved oxygen. |
| INTERFERENCES: | The presence of other oxidizing agents may cause positive interferences. Reducing may cause negative interferences. Nitrite interferences are eliminated with the azide modification. |

# COLLECTION & TREATMENT OF THE WATER SAMPLE

Steps 1 through 4 below describe proper sampling technique in shallow water. For sample collection at depths beyond arm's reach, special water sampling apparatus is required (e.g. the LaMotte Water Sampling Chamber, Code 1060; Model JT-1 Water Samplers, Code 1077; Water Sampling Outfit, Code 3103; or Water Sampling Bottle, Code 3-0026).

1. To avoid contamination, thoroughly rinse the screw cap Sample Tube (29180) with sample water.
2. Tightly cap Sample Tube and submerge to the desired depth. Remove cap and allow the Sample Tube to fill.
3. Tap the sides of the submerged tube to dislodge any air bubbles clinging to the inside. Replace the cap while the Sample Tube is still submerged.
4. Retrieve Sample Tube and examine it carefully to make sure that no air bubbles are trapped inside. Once a satisfactory sample has been collected, proceed immediately with Steps 5 and 6 to "fix" the sample.
   NOTE: Be careful not to introduce air into the sample while adding the reagents in steps 5 and 6. Simply drop the reagents into the sample. Cap carefully, and mix gently.
5. Add 2 drops of *Manganese Sulfate Solution (4167) and 2 drops of *Alkaline Potassium Iodide Azide (7166). Cap and mix by inverting several times. A precipitate will form. Allow the precipitate to settle below the shoulder of the tube before proceeding.
6. Add 8 drops of *Sulfuric Acid, 1:1 (6141WT). Cap and gently mix until the reagent and the precipitate have dissolved. A clear-yellow to brown-orange color will develop, depending on the oxygen content of the sample.

NOTE: It is very important that all "brown flakes" are dissolved completely. If the water has a high DO level this could take several minutes. If flakes are not completely dissolved after 5 minutes, add 2 drops of *Sulfuric Acid 1:1 (6141WT) and continue mixing.

Following the completion of step 6, contact between the water sample and the atmosphere will not affect the test result. Once the sample has been "fixed" in this manner, it is not necessary to perform the actual test procedure immediately. Thus, several samples can be collected and "fixed" in the field, and then carried back to a testing station or laboratory where the test procedure is to be performed.

# PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **39 OXYGEN**) from **TESTING MENU**.
4. Scroll to and select **39 OXYGEN** from menu.
5. Rinse a clean tube (0290) with untreated sample water. Fill to the 10 mL line with sample. This tube is the BLANK.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Fill a second tube (0290) to the 10 line with the treated “Fixed” sample. This tube is the SAMPLE.
8. Remove BLANK from Spectro, insert SAMPLE tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
9. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

# FLUORIDE

## SPADNS METHOD • CODE 3647-02-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 4 x 30 mL | *Acid-Zirconyl-SPADNS Reagent | *3875-G |
| 2 x 30 mL | *Sodium Arsenite Solution | *4128-G |
| 1 | Pipet, 0.5 mL, plastic | 0353 |
| 1 | Pipet, 1.0 mL, plastic | 0354 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Fluoride may occur naturally in some ground waters or it may be added to public drinking water supplies to maintain a 1.0 mg/L concentration to prevent dental cavities. At higher concentrations, fluoride may produce an objectionable discoloration of tooth enamel called fluorosis, though levels up to 8 mg/L have not been found to be physiologically harmful.

NOTE: This procedure uses the EPA approved Reagent System for fluoride found in method 4500-F-D, 18th Edition of Standard Methods, page 1-27.

| | |
|---|---|
| APPLICATION | Drinking and surface waters; domestic and industrial waters. |
| RANGE: | 0.00–2.00 ppm Fluoride |
| MDL: | 0.05 ppm |
| METHOD: | Colorimetric test based upon the reaction between fluoride and zirconium dye lake. The fluoride reacts with the dye lake, dissociating a portion of it into a colorless complex ion and dye. As the fluoride concentration increases, the color produced becomes progressively lighter. |
| SAMPLE HANDLING & PRESERVATION: | Samples may be stored and refrigerated in plastic containers. |
| INTERFERENCES: | The following substances produce a positive interference at the concentration given: |

Chloride (Cl–)
Phosphate ($PO_4^{-3}$)
Hexametaphosphate $(NaPO_3)_6$

The following substances produce a negative interference at the concentration given:

| | |
|---|---|
| Alkalinity ($CaCO_3$) | 5000 mg/L |
| Aluminum ($Al^{3+}$) | 0.1 mg/L |
| Iron ($Fe^{3+}$) | 10 mg/L |
| Sulfate ($SO_4^{-2}$) | 200 mg/L |

Color and turbidity must be removed or compensated for in the procedure. Temperature should be maintained within 5°C of room temperature.

# PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **41 Fluoride**) from **TESTING MENU**.
4. Scroll to and select **41 Fluoride** from menu
5. This test requires a reagent blank. Rinse a clean tube (0290) with clear, colorless, fluoride free water. Fill to the 10 mL line with clear, colorless, fluoride free water.
6. Use the 0.5 mL pipet (0353) to add 0.5 mL of *Sodium Arsenite Solution (4128). Cap and mix.
7. Use the 1.0 mL pipet (0354) to add 2 measures of *Acid-Zirconyl SPADNS Reagent (3875). Cap and mix thoroughly. (This is the reagent blank.)
8. Insert tube into chamber, close lid and select **SCAN BLANK**.
9. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample water. Repeat steps 6 and 7.
10. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
11. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

# HYDRAZINE

## p-DIMETHYLAMINOBENZALDEHYDE METHOD
## CODE 3656-01-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 2x60 mL | *Hydrazine Reagent A | *4841-H |
| 10 g | *Hydrazine Reagent B Powder | *4842-D |
| 1 | Pipet, 1.0 mL, plastic | 0354 |
| 1 | Spoon, 0.15 g, plastic | 0727 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Hydrazine, $N_2H_4$, is added to the water in high pressure boilers to reduce corrosion by acting as an oxygen scavenger.

| | |
|---|---|
| APPLICATION: | Boiler and cooling waters; industrial wastewaters. |
| RANGE: | 0.000–1.000 ppm Hydrazine |
| MDL: | 0.010 ppm |
| METHOD: | p-Dimethylaminobenzaldehyde reacts with hydrazine under acidic conditions to form a yellow color in proportion to the amount of hydrazine present. |
| SAMPLE HANDLING & PRESERVATION: | Samples should be analyzed as soon as possible after collection due to the ease with which hydrazine becomes oxidized. Acidification of the sample may increase the time between collection and analysis. |
| INTERFERENCES: | The substances normally present in water do not interfere with the test, with the exception of strong oxidizing agents. |

# PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **45 Hydrazine**) from **TESTING MENU**.
4. Scroll to and select **45 Hydrazine** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Remove tube from Spectro. Use the 1 mL pipet (0354) to add 4 mL of *Hydrazine Reagent A (4841). Cap and mix.
8. Use the 0.15 g spoon (0727) to add one measure of *Hydrazine Reagent B Powder (4842). Cap and shake vigorously for 10 seconds. Wait 2 minutes for maximum color development. An undissolved portion of Hydrazine Reagent B may remain in bottom of tube without adversely affecting results.
9. At the end of the 2 minute waiting period, mix, insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
10. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTE: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

# HYDROGEN PEROXIDE, LOW RANGE

## DPD METHOD • CODE 3662-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 30 mL | *Hydrogen Peroxide Reagent #1 | *6452-G |
| 100 | *Hydrogen Peroxide LR Tablets | *6454A-J |
| 1 | Tablet Crusher | 0175 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Hydrogen peroxide, $H_2O_2$, is a colorless compound that is widely used as a bleaching or decolorizing agent in the manufacture of many commercial products. As an oxidizing compound it is also used in the treatment of sewage to reduce odors and corrosion due to hydrogen sulfide. It may also be used as a sanitizing agent for water treatment. Hydrogen peroxide is relatively unstable, and for this reason it dissipates quickly and leaves no residuals.

| | |
|---|---|
| APPLICATION: | Drinking and surface waters; domestic and industrial wastes. |
| RANGE: | 0.00–1.50 ppm Hydrogen Peroxide |
| MDL: | 0.02 ppm |
| METHOD: | Hydrogen peroxide reacts with an excess of potassium iodide through the action of a catalyst and buffer to release an equivalent amount of iodine. The iodine in turn reacts with diethyl-p-phenylenediamine (DPD) to produce a pink-red color in proportion to the iodine released. |
| SAMPLE HANDLING & PRESERVATION: | Hydrogen peroxide is not stable in aqueous solutions. Exposure to sunlight and agitation will accelerate the reduction of hydrogen peroxide in dilute solutions. For best results start analysis immediately after sampling. |
| INTERFERENCE: | The likelihood of other oxidizing compounds interfering with this method is eliminated by the presence of hydrogen peroxide. Manganese may interfere and should be removed before analysis. |

# PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **46 H Peroxide-LR**) from **TESTING MENU**.
4. Scroll to and select **46 H Peroxide-LR** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**. (See Note)
7. Remove tube from Spectro and add 4 drops of *Hydrogen Peroxide Reagent #1 (6452). Cap and mix.
8. Add one *Hydrogen Peroxide LR Tablet (6454A). Crush tablet with tablet crusher (0175). Cap and mix for 30 seconds. Solution will turn pink if hydrogen peroxide is present. Wait 5 minutes for full color development.
9. At end of 5 minute waiting period, mix, insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
10. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTES: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

For the most accurate results, the sample and reagents should be at 25±4°C.

# HYDROGEN PEROXIDE, HIGH RANGE

## DPD METHOD • CODE 4045-01

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 30 mL | *Hydrogen Peroxide Reagent #1 | *6452-G |
| 100 | *Hydrogen Peroxide LR Tablets | *6454A-J |
| 1 | Tablet Crusher | 0175 |
| 1 | Pipet, glass | 0342 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Large quantities of hydrogen peroxide are added to a swimming pool to "shock" it. Shocking breaks down waste products and re-establishes a positive level of sanitizer. While many types of shock can be used with chlorine or bromine pools, only hydrogen peroxide can be used to shock biguanide pools.

Hydrogen peroxide, $H_2O_2$, is a colorless compound that is widely used as a bleaching or decolorizing agent in the manufacture of many commercial products. As an oxidizing compound it is also used in the treatment of sewage to reduce odors and corrosion due to hydrogen sulfide. It may also be used as a sanitizing agent for water treatment. Hydrogen peroxide is relatively unstable, and for this reason it dissipates quickly and leaves no residuals.

| | |
|---|---|
| APPLICATION: | Drinking, industrial, domestic and swimming pool waters |
| RANGE: | 0–60 ppm Hydrogen Peroxide |
| MDL: | 1 ppm |
| METHOD: | Hydrogen peroxide reacts with an excess of potassium iodide through the action of a catalyst and buffer to release an equivalent amount of iodine. The iodine in turn reacts with diethyl-p-phenylenediamine (DPD) to produce a pink-red color in proportion to the iodine released. |
| SAMPLE HANDLING & PRESERVATION: | Hydrogen peroxide is not stable in aqueous solutions. Exposure to sunlight and agitation will accelerate the reduction of hydrogen peroxide in dilute solutions. For best results start analysis immediately after sampling. |
| INTERFERENCES: | The likelihood of other oxidizing compounds interfering with this method is eliminated by the presence of hydrogen peroxide. Manganese may interfere and should be removed before analysis |

# PROCEDURE

Use universal sample holder

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Select **ALL TESTS** (or another sequence containing **47 H Per-HR**) from **TESTING MENU**.
4. Scroll to and select **47 H Per-HR** from menu.
5. Use the pipet (0342) to add 5 drops of the sample water to a tube (0290).
6. Dilute to the 10 mL line with distilled or hydrogen peroxide-free water.
7. Insert the tube into chamber, close lid and select **SCAN BLANK**.
8. Remove the tube from spectrophotometer and add 4 drops of *Hydrogen Peroxide Reagent #1 (6452). Cap and mix.
9. Add one *Hydrogen Peroxide LR Tablet (6454A). Crush tablet with Tablet Crusher (0175). Cap and mix for 30 seconds. Solution will turn pink if hydrogen peroxide is present. Wait 5 minutes for full color development.
10. At the end of 5 minute waiting period, mix, insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
11. Press **OFF** button to turn the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.



NOTES: For best possible results, a blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

For the most accurate results, the sample and reagents should be at 25 ±4°C.

# HYDROGEN PEROXIDE, SHOCK

## DPD METHOD • CODE 4045

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 30 mL | *Hydrogen Peroxide Reagent #1 | *6452-G |
| 100 | *Hydrogen Peroxide LR Tablets | *6454A-J |
| 1 | Tablet Crusher | 0175 |
| 1 | Pipet, glass | 0342 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Large quantities of hydrogen peroxide shock are added to a swimming pool to "shock" it. Shocking breaks down waste products and re-establishes a positive level of sanitizer. While many types of shock can be used with chlorine or bromine pools, only hydrogen peroxide shock can be used to shock biguanide pools.

| | |
|---|---|
| APPLICATION: | Swimming pools |
| RANGE: | 0–225 ppm Hydrogen Peroxide Shock |
| MDL: | 4 ppm |
| METHOD: | Hydrogen peroxide shock reacts with an excess of potassium iodide through the action of a catalyst and buffer to release an equivalent amount of iodine. The iodine in turn reacts with diethyl-p-phenylenediamine (DPD) to produce a pink-red color in proportion to the iodine released. |
| SAMPLE HANDLING & PRESERVATION: | Hydrogen peroxide shock is not stable in aqueous solutions. Exposure to sunlight and agitation will accelerate the reduction of hydrogen peroxide in dilute solutions. For best results start analysis immediately after sampling. |
| INTERFERENCES: | The likelihood of other oxidizing compounds interfering with this method is eliminated by the presence of hydrogen peroxide. Manganese may interfere and should be removed before analysis. |

# PROCEDURE

Use universal sample holder

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Select **ALL TESTS** (or another sequence containing **48 H Per Shock**) from **TESTING MENU**.
4. Scroll to and select **48 H Per Shock** from menu.
5. Use the pipet (0342) to add 5 drops of the sample water to a tube (0290).
6. Dilute to the 10 mL line with distilled or hydrogen peroxide-free water.
7. Insert the tube into chamber, close lid and select **SCAN BLANK**.
8. Remove the tube from spectrophotometer and add 4 drops of *Hydrogen Peroxide Reagent #1 (6452). Cap and mix.
9. Add one *Hydrogen Peroxide LR Tablet (6454A). Crush tablet with Tablet Crusher (0175). Cap and mix for 30 seconds. Solution will turn pink if hydrogen peroxide is present. Wait 5 minutes for full color development.
10. At the end of 5 minute waiting period, mix, insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
11. Press **OFF** button to turn the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTES: For best possible results, a blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

For the most accurate results, the sample and reagents should be at 25 ±4°C.

# IRON

## BIPYRIDYL METHOD • CODE 3648-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 30 mL | *Iron Reagent #1 | *V-4450-G |
| 5 g | *Iron Reagent #2 Powder | *V-4451-C |
| 1 | Pipet, 0.5 mL, plastic | 0353 |
| 1 | Spoon, 0.1 g, plastic | 0699 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Most natural waters contain some iron. Its presence may vary from small traces to very large amounts in water which is contaminated by acid mine wastes. For domestic use, the concentration should not exceed 0.2 ppm and for some industrial applications not even a trace of iron can be tolerated. There are many means available for removing or reducing the iron content. Water softening resins are effective for removing small amounts of iron and special ion exchange materials are selective for iron removal. High concentrations of iron can be removed by such chemical processes as oxidation and lime or lime-soda softening. Because of the many means of removing or reducing the amount of iron in water, the particular method employed will depend largely on the form of iron which is present and the end use of the treated water.

| | |
|---|---|
| APPLICATION: | Drinking, surface, and saline waters; domestic and industrial wastes. |
| RANGE: | 0.00–6.00 Iron |
| MDL: | 0,06 ppm |
| METHOD: | Ferric iron is reduced to ferrous iron and subsequently forms a colored complex with bipyridyl for a quantitative measure of total iron. |
| SAMPLE HANDLING & PRESERVATION: | The sample container should be cleaned with acid and rinsed with deionized water. Addition of acid to adjust the sample to pH 2–3 will prevent deposition of iron on the container walls. Samples should be analyzed as soon as possible. |
| INTERFERENCES: | Strong oxidizing agents interfere, as well as copper and cobalt in excess of 5.0 mg/L. |

# PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **51 Iron Bipyr**) from **TESTING MENU**.
4. Scroll to and select **51 Iron Bipyr** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Remove the tube from Spectro. Use the 0.5 mL pipet (0353) to add on measure of *Iron Reagent #1 (V-4450). Cap and mix.
8. Use the 0.1 g spoon (0699) to add 0.1 g of *Iron Reagent #2 Powder (V4451). Cap and shake vigorously for 30 seconds. Wait three minutes for maximum color development.
9. At the end of 3 minute waiting period, do not mix. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
10. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTE: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

# IRON

## I,I0-PHENANTHROLINE METHOD • CODE 3668-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 15 mL | *Acid Phenanthroline Indicator | *2776-E |
| 5 g | *Iron Reducing Reagent | *2777-C |
| 1 | Spoon, 0.1 g, plastic | 0699 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Most natural waters contain some iron. Its presence may vary from small traces to very large amounts in water which is contaminated by acid mine wastes. For domestic use, the concentration should not exceed 0.2 ppm and for some industrial applications not even a trace of iron can be tolerated. There are many means available for removing or reducing the iron content. Water softening resins are effective for removing small amounts of iron and special ion exchange materials are selective for iron removal. High concentrations of iron can be removed by such chemical processes as oxidation and lime or lime-soda softening. Because of the many means of removing or reducing the amount of iron in water, the particular method employed will depend largely on the form of iron which is present and the end use of the treated water.

| | |
|---|---|
| APPLICATION: | Drinking, surface, and saline waters; domestic and industrial wastes. |
| RANGE: | 0.00–4.50 ppm Iron |
| MDL: | 0.04 ppm |
| METHOD: | Ferric iron is reduced to ferrous iron and subsequently forms a colored complex with phenanthroline for a quantitative measure of total iron. |
| SAMPLE HANDLING & PRESERVATION | The sample container should be cleaned with acid and rinsed with deionized water. Addition of acid to adjust the sample to pH 2–3 will prevent deposition of iron on the container walls. Samples should be analyzed as soon as possible after collection since ferrous iron undergoes oxidation to ferric iron. |
| INTERFERENCES: | Strong oxidizing agents, cyanide, nitrite, and phosphates, chromium, zinc in concentrations exceeding 10 times that of iron; cobalt and copper in excess of 5 mg/L, and nickel in excess of 2 mg/L. Bismuth, cadmium, mercury, , and silver precipitate phenanthroline. |

# PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing ***53 Iron Phen***) from **TESTING MENU**.
4. Scroll to and select **53 Iron Phen** from menu.
5. Rinse a clean tube (0290)with sample water. Fill to the 10 mL mark with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Remove the tube from Spectro. Remove the cap and add 6 drops of *Acid Phenanthroline Indicator (2776). Cap and invert the tube 4 times to mix reagents. Wait five minutes for maximum color development.
8. After five minutes, mix, insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result as ppm Ferrous Iron.
9. Remove tube from Spectro. Use the 0.1g spoon (0699) to add one measure of *Iron Reducting Reagent (2777). Cap and invert 15-20 times to mix, wait 5 minutes for maximum color delelopment.
10. After 5 minutes, mix insert tube into Spectro. Close lid and select **SCAN SAMPLE**. Record result as ppm Total Iron.
11. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.
12. Total Iron (ppm) - Ferrous Iron (ppm) = Ferric Iron (ppm)

NOTE: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

# IRON, UDV

## BIPYRIDYL–UNIT DOSE VIAL METHOD • CODE 4315-J

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 1 | *Total Iron Unit Dose Vials, 20 pouches | *4315-J |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Equipment needed but not supplied:

STANDARD ACCESSORY PACKAGE • CODE 1961

| | | |
|---|---|---|
| 1 | Package of 3 Vials (empty) | 0156 |
| 1 | Syringe, 3 mL, plastic | 1184 |
| 1 | Foil Storage Bag | 9467 |

Or:

ADVANCED ACCESSORY PACKAGE • CODE 1962

| | | |
|---|---|---|
| 1 | Pipettor, 3 mL | 30528 |
| 1 | Pipet Tip (0-5 mL) | 30695 |
| 1 | Cuvette Rack | 31695 |
| 1 | Package of 3 Vials (empty) | 0156 |
| 1 | Foil Storage Bag | 9467 |

Most natural waters contain some iron. Its presence may vary from small traces to very large amounts in water which is contaminated by acid mine wastes. For domestic use, the concentration should not exceed 0.2 ppm and for some industrial applications not even a trace of iron can be tolerated. There are many means available for removing or reducing iron content. Water softening resins are effective for removing small amounts of iron and special ion exchange materials are selective for iron removal. High concentrations of iron can be removed by such chemical processes as oxidation and lime or lime-soda softening. Because of the many means of removing or reducing the amount of iron in water, the particular method employed will depend largely on the form of iron which is present and the end use of the treated water.

| | |
|---|---|
| APPLICATION: | Drinking, surface, and saline waters; domestic and industrial wastes. |
| RANGE: | 0.00–10.00 ppm |
| MDL: | 0.07 ppm |
| METHOD: | Ferric iron is reduced to ferrous iron and subsequently forms a colored complex with for a quantitative measure of total iron. |
| SAMPLE HANDLING & PRESERVATION: | The sample container should be cleaned with acid and rinsed with deionized water. Addition of acid to adjust the sample. The pH 2-3 will prevent deposition of iron on the container walls. Samples should be analyzed as soon as possible. |
| INTERFERENCES: | Strong oxidizing agents interfere, as well as copper and cobalt in excess of 5.0 ppm. |

# PROCEDURE

Use 10 mm square cell adapter.

1. Press and hold **ON** button.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **52 Iron-UDV**) from **TESTING MENU**.
4. Scroll to and select **52 Iron-UDV** from menu.
5. Rinse a clean vial (0156) with sample water.
6. Use the syringe (1184) to add 3 mL of sample to the vial.
7. Insert the vial into the chamber, close the lid and select **SCAN BLANK**.
8. Remove the vial from the Spectro.
9. Use the syringe (1184) to add 3 mL of sample to an *Iron UDV vial (4315).
10. Shake vigorously for 15 seconds.
11. Wait 2 minutes.
12. Invert vial 3 times to mix.
    NOTE: If powder residue remains in the bottom of the vial after inverting, or air bubbles forms, invert vial once more and tap bottom of vial sharply once or twice to dislodge powder or bubbles. Mix.
13. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
14. Press **OFF** button to turn the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTES: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

UDVs from opened pouches should be used promptly. Store unused vials from opened pouches in the Foil Storage Bag (9467) to extend the shelf life of the reagent. Generally, UDVs stored in the bag should be used within 10 days if the humidity is less than 50% and within 5 days if humidity is greater than 50%. The Foil Storage Bag contains a desiccant pack with indicator. When the indicator in the window turns from blue to pink, the bag should be replaced.

# LEAD

## PAR METHOD • CODE 4031

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 250 mL | *Ammonium Chloride Buffer | *4032-K |
| 15 mL | *Sodium Cyanide, 10% | *6565-E |
| 30 mL | *PAR Indicator | *4033-G |
| 30 mL | Stabilizing Reagent | 4022-G |
| 15 mL | *DDC Reagent | *4034-E |
| 1 | Syringe, 5 mL, plastic | 0807 |
| 2 | Pipet, 0.5 mL, plastic | 0353 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

The average concentration of lead is 0.003 ppm in streams and less than 0.1 ppm in groundwater. Lead in a water supply may come from mine and smelter discharges or from industrial waste. Lead is used in the production of batteries, solder, pigments, insecticides, ammunition and alloys. Tetraethyl Lead has been used for years as an anti-knock reagent in gasoline. Lead may also enter water supplies when corrosive water dissolves pipes, plumbing fixtures and materials containing lead. Lead accumulates in the body and is toxic by ingestion.

| | |
|---|---|
| APPLICATION: | Drinking and surface waters; domestic and industrial wastewaters. |
| RANGE: | 0.00–5.00 Lead |
| MDL: | 0.10 ppm |
| METHOD: | Lead and calcium ions form a red complex with PAR (4-(2'-pyridylazo)resorcinol), at a pH of about 10. When sodium diethyldithiocarbamate is added, the lead/PAR complex is destroyed leaving the calcium/PAR complex. The difference between the two measurements is due to the lead concentration. |
| SAMPLE HANDLING & PRESERVATION: | Analyze sample as soon as possible. If sample must be stored, acidify with nitric acid to a pH of below 2. |
| INTERFERENCES: | Calcium greater than 100 ppm (250 ppm $CaCO_3$) will interfere. Low concentrations of cerium, iron, manganese, magnesium, sulfur, tin, and EDTA will also interfere. |

# PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **54 Lead**) from **TESTING MENU**.
4. Scroll to and select **54 Lead** from menu.
5. Rinse a tube (0290) with sample water. Fill to 10 mL with sample.
6. Insert the tube into chamber, close lid and select **SCAN BLANK**.
7. Remove the tube from Spectro. Empty the tube. Use the Syringe (0807) to add 5mL of sample to the tube.
8. Add 5 mL *Ammonium Chloride Buffer (4032) to fill the tube to the 10 mL line. Swirl to mix.
9. Add 3 drops *Sodium Cyanide, 10% (6565). Swirl to mix.
10. Use the 0.5 mL pipet (0353) to add 0.5 mL *PAR Indicator (4033). Swirl to mix.
11. Use the 0.5 mL pipet (0353) to add 0.5 mL Stabilizing Reagent (4022). Cap and mix.
12. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result in ppm as Reading A.
13. Remove tube from Spectro. Add 3 drops *DDC Reagent (4034). Cap and mix.
14. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result in ppm as Reading B.
15. ppm Lead = Reading A–Reading B
16. Press **OFF** button to turn the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTE: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

# MANGANESE, LOW RANGE

## PAN METHOD • CODE 3658-01-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 2 x 60 mL | *Hardness Buffer Reagent | *4255-H |
| 30 mL | *Manganese Indicator Reagent | *3956-G |
| 15 mL | *Sodium Cyanide, 10% | *6565-E |
| 1 | Pipet, 0.5 mL, plastic | 0369 |
| 1 | Pipet, 1.0 mL, plastic | 0354 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Manganese is present in ground water in the divalent state due to the lack of oxygen. In surface waters manganese may be in various oxidation states as soluble complexes or as suspended compounds. Manganese is rarely present in excess of 1 mg/L. It may cause an objectionable taste or cause staining problems in laundry, but manganese levels normally encountered in water seldom produce any health hazard.

Manganese is removed from water by various means including chemical precipitation, pH adjustment, aeration, superchlorination and the use of ion exchange resins.

| | |
|---|---|
| APPLICATION: | Drinking and surface waters; domestic and industrial wastewaters. |
| RANGE: | 0.00–0.70 ppm Manganese |
| MDL: | 0.02 ppm |
| METHOD: | PAN (1–(2–Pyridylazo)–2–Naphthol) forms a red complex with Manganese ($Mn^{2+}$) at a pH of 10 to 11. |
| SAMPLE HANDLING & PRESERVATION: | Manganese may oxidize readily in neutral water and precipitate from solution. It may adhere to or be absorbed by container walls, especially glass. Acidified sample can be stored in plastic. |
| INTERFERENCES: | None. Test is quite specific. |

# PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **55 Manganese L**) from **TESTING MENU**.
4. Scroll to and select **55 Manganese L** from menu.
5. Rinse a tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Remove tube from Spectro. Use the 1.0 mL pipet (0354) to add 2.0 mL (two measures) of *Hardness Buffer Reagent (4255). Swirl to mix.
8. Add 2 drops of *Sodium Cyanide, 10% (6565). Cap and mix.
9. Use the 0.5 mL pipet (0369) to add 0.5 mL of *Manganese Indicator Reagent (3956). Cap and mix.
10. Immediately insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
11. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTE: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

# MANGANESE, HIGH RANGE

## PERIODATE METHOD • CODE 3669-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 10 g | Manganese Buffer Reagent | 6310-D |
| 15 g | *Manganese Periodate Reagent | *6311-E |
| 1 | Spoon, 0.1 g, plastic | 0699 |
| 1 | Spoon, 0.15 g, plastic | 0727 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Manganese is present in ground water in the divalent state due to the lack of oxygen. In surface waters, manganese may be in various oxidation states as soluble complexes or as suspended compounds. Manganese is rarely present in excess of 1 mg/L. It may impart an objectionable taste or cause staining problems in laundry, but manganese levels normally encountered in water seldom produce any health hazards. Manganese is removed from water by various means, including chemical precipitation, pH adjustment, aeration, superchlorination and the use of ion exchange resins.

| | |
|---|---|
| APPLICATION: | Drinking and surface waters; domestic and industrial wastewaters. |
| RANGE: | 0.0–15.0 ppm Manganese |
| MDL: | 0.3 ppm |
| METHOD: | Periodate oxidizes soluble manganous compounds into permanganate. |
| SAMPLE HANDLING & PRESERVATION: | Manganese may oxidize readily in a neutral water and precipitate from solution. It may adhere to or be absorbed by container walls, especially glass. Acidified samples can be stored in plastic. |
| INTERFERENCES: | Reducing substances capable of reacting with periodate or permanganate must be removed or destroyed before the periodate oxidation is attempted. |

# PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **56 Manganese H**) from **TESTING MENU**.
4. Scroll to and select **56 Manganese H** from menu.
5. Rinse a tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Remove tube from Spectro. Use the 0.1 g spoon (0699) to add two measures of Manganese Buffer Reagent (6310). Cap and mix until powder dissolves.
8. Use the 0.15 g spoon (0727) to add one measure of *Manganese Periodate Reagent (6311). Cap and shake for one minute. An undissolved portion of the reagent may remain in the bottom of the tube without adversely affecting the test results. Wait two minutes for maximum color development. Solution will turn pink if manganese is present.
9. At the end of the two minute waiting period, mix, insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
10. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

# MERCURY

## TMK METHOD • CODE 4861

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 50 | *TMK Tablets | *4862-H |
| 2 x 250 mL | *Propyl Alcohol | *4863-K |
| 250 mL | *Acetate Buffer | *4864-K |
| 1 | Tablet Crusher | 0175 |
| 1 | Test Tube, 10 mL, glass, w/cap | 0778 |
| 1 | Pipet, 1.0 mL, plastic | 0354 |
| 1 | Pipet, 0.5 mL, plastic | 0353 |

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Mercury occurs in small amounts in soil, streams and groundwater. It is used in the production of amalgams, mirror coatings and measuring devices such as thermometers, barometers and manometers. Pharmaceuticals and paints contain mercury. It is also used in fungicides and pesticides and as a mold retardant on paper. Some forms of mercury are very toxic and can accumulate in the aquatic food chain.

| | |
|---|---|
| APPLICATION: | Drinking and surface waters; domestic and industrial wastewater. |
| RANGE: | 0.00–1.50 ppm Mercury |
| MDL: | 0.02 ppm |
| METHOD: | Mercuric ions ($Hg^{+2}$) form a colored complex with 4, 4'-bis (dimethylamino) thiobenzophenone (Thio-Michler's ketone, TMK) at pH 3. |
| SAMPLE HANDLING & PRESERVATION: | Analyze sample as soon as possible. If sample must be stored, treat with $HNO_3$ to reduce th pH to less than 2 and store in a glass container. |
| INTERFERENCES: | Palladium and other noble metals (gold, platinum, rhodium, iridium, ruthenium), iodide and reducing agents such as hydroxylamine hydrochloride, ascorbic acid, sulfite and thiosulfate. Interference due to silver is eliminated if chloride is present. |

## PREPARATION OF *TMK INDICATOR

NOTE: Prepare *TMK Indicator daily. Keep out of direct sunlight.

1. Fill test tube (0778) to the 10 mL line with *Propyl Alcohol (4863).
2. Add one *TMK Tablet (4862).
3. Use tablet crusher (0175) to completely crush tablet.
4. Cap and mix. Shake vigorously for 30 seconds.

## PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll and select **PROGRAMMED TESTS**.
3. Scroll and select **ALL TESTS** (or another sequence containing **57 Mercury**) from **TESTING MENU**.
4. Scroll to and select **57 Mercury** from menu.
5. Rinse a tube (0290) with sample water. Fill to 10 mL with sample.
6. Insert the tube into chamber, close lid and select **SCAN BLANK**.
7. Remove the tube from spectrophotometer.
8. Use the 1.0 mL pipet (0354) to add 3 mL of *Acetate Buffer (4864). Cap and mix.
9. Use the 0.5 mL pipet (0353) to add 0.5 mL of prepared *TMK Indicator. Cap and mix.
10. Wait one minute.
11. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result as ppm Mercury.
12. Press **OFF** button to turn the spectrphotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTE: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure using distilled or deionized water. This test result is the reagent blank. Subtract the reagent blank results from all subsequent test results of unknown samples. It is recommended that a reagent blank be determined each time *TMK Indicator is prepared.

# MOLYBDENUM

## THIOGLYCOLATE METHOD • CODE 3699-02-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 2 x 30 mL | *Mo Buffer | *3997-G |
| 2 x 30 mL | *Molybdenum Oxidizing Reagent | *6485-G |
| 2.5g | *Molybdenum Indicator Powder | *6486-S |
| 1 | Spoon, 0.05g, plastic | 0696 |
| 2 | Pipets, 1.0 mL, plastic w/cap | 0372 |

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Molybdenum occurs naturally in the earth's crust as molybdenite and wolfenite, and is an important element in many biochemical reactions, including nitrogen fixation. In industrial processes, such as the operation of boilers and cooling towers, molybdenum, in the form of sodium molybdate, is used as a corrosion inhibitor.

| | |
|---|---|
| APPLICATION: | Boiler and cooling waters. |
| RANGE: | 0.0–15.0 ppm Molybdenum |
| MDL: | 0.2 ppm |
| METHOD: | Calcium thioglycolate reacts with molybdenum to give a yellow color with an intensity proportional to the amount of molybdenum present. |
| SAMPLE HANDLING & PRESERVATION: | Molybdenum samples may be stored in either plastic or glass containers. |
| INTERFERENCES: | Nickel levels less than 50 ppm do not interfere; aluminum levels less than 10 ppm do not interfere; chromate at higher concentrations interferes due to the intense yellow color. Ferrous iron levels below 50 ppm do not interfere, but low levels of ferric iron will cause a large blank. Highly buffered samples may exceed the capacity of the system possibly producing inaccurate results. Samples with high levels of nitrite will eventually develop a pale orange color. Scan the sample immediately to avoid this interference. |

# PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **61 Molybdenum-HR**) from **TESTING MENU**.
4. Scroll to and select **61 MOLYBDENUM-HR** from menu.
5. Fill clean tube (0290) to 10 mL line with sample water.
6. Insert tube into chamber, close lid and select SCAN BLANK.
7. Remove tube from Spectro. Use a 1.0 mL pipet (0372) to add 1.0 mL of *Mo Buffer (3997). Cap and mix.
8. Use a second 1.0 mL pipet (0372) to add 1.0 mL of *Molybdenum Oxidizing Reagent (6485). Cap and mix.
9. Use 0.05 g spoon (0696) to add one measure of Molybdenum Indicator Powder (6486). Cap and mix until powder dissolves. Solution will turn yellow if molybdenum is present.
10. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
11. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

# NICKEL

## DIMETHYLGLYOXIME METHOD • CODE 3663-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 60 mL | *Hydrochloric Acid, 2.5N | *6251PS-H |
| 30 g | *Ammonium Persulfate Reagent | *6566-G |
| 30 mL | *Silver Nitrate Solution, 0.0141N | *6346WT-G |
| 250 mL | Sodium Citrate, 10% | 6253-K |
| 60 mL | *Dimethylglyoxime, 1% | *6254-H |
| 60 mL | *Ammonium Hydroxide, Conc. | *6537-H |
| 3 | Pipets, 1.0 mL, plastic | 0354 |
| 1 | Spoon, 0.1 g, plastic | 0699 |
| 1 | Test tube, 5-10-12.9-15-20-25, glass, w/cap | 0608 |
| 1 | Graduated Cylinder, 10 mL, glass | 0416 |

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Nickel is not usually found in natural waters except as a result of contamination from industrial wastewaters as a corrosion product of stainless steel and nickel alloys. Nickel may also enter surface waters from plating bath process water.

| | |
|---|---|
| APPLICATION: | Drinking and surface waters; domestic and industrial wastewaters. |
| RANGE: | 0.00–8.00 ppm Nickel |
| MDL: | 0.06 ppm |
| METHOD: | Nickel under basic conditions forms a colored complex with dimethylglyoxime in proportion to the concentration of nickel. |
| SAMPLE HANDLING & PRESERVATION: | Samples may be collected in either plastic or glass containers and preserved by adding 5 mL of concentrated nitric acid per liter. |
| INTERFERENCES: | Organic matter interferes. Cobalt, iron, copper, manganese and chromium do not interfere if each of the concentrations is below 15 ppm. |

# PROCEDURE

Use universal sample holder.

1. Use the 10 mL graduated cylinder (0416) to measure 10 mL of sample water. Pour into glass test tube (0608).
2. Use the 1 mL pipet (0354) to add 1 mL of *Hydrochloric Acid, 2.5N (6251).
3. Use the 0.1 g spoon (0699) to add 2 measures of *Ammonium Persulfate Reagent (6566). Add two drops of *Silver Nitrate Solution, 0.0141N (6346WT). Mix until the powder has dissolved. The solution will be slightly cloudy at this point.
4. Use 10 mL graduated cylinder (0416) to add 5 mL of Sodium Citrate, 10% (6253).
5. Use a second 1 mL pipet (0354) to add 1 mL of *Ammonium Hydroxide, Conc. (6537). Mix, then dilute to 25 mL with deionized water.
6. Use a third 1 mL pipet (0354) to add 1 mL of *Dimethylglyoxime, 1% (6254). Mix. Wait 20 minutes for color development.
7. At end of 20 minute waiting period fill a clean tube (0290) to the 10 mL line with the developed test sample.
8. Fill a second clean tube (0290) to 10 mL line with deionized water or untreated sample water. This is the blank.
9. Press and hold **ON** button until spectrophotometer turns on.
10. Scroll to and select **PROGRAMMED TESTS**.
11. Scroll to and select **ALL TESTS** (or another sequence containing **63 Nickel**) from **TESTING MENU**.
12. Scroll to and select **63 Nickel** from menu.
13. Insert the blank into chamber, close lid and select **SCAN BLANK**.
14. Insert test sample into chamber, close lid and select **SCAN SAMPLE**. Record result.
15. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

# NITRATE

## ZINC REDUCTION TESTAB METHOD • CODE 3689-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 50 | *Nitrate Spectrophotometic Grade Tablets | *3881A-H |
| 1 | Tablet Crusher | 0175 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Nitrogen is essential for plant growth, but excessive amounts in water supplies can result in nutrient pollution. Nitrates, in conjunction with phosphate, stimulate the growth of algae creating water quality problems. Nitrogen compounds may enter water as nitrates or be converted to nitrates from agricultural fertilizers, sewage, industrial and packing house wastes, drainage from livestock feeding areas and manure. Nitrates in large amounts in drinking water can cause “blue baby syndrome” (methemoglobenemia) in infants in less than 6 months of age and other health problems. US Public Health Service Drinking Water Standards state that 44 ppm nitrate should not be exceeded. To the sanitary and industrial engineer, concentrations of less than 4 ppm are acceptable.

| | |
|---|---|
| APPLICATION: | Drinking, surface, and saline waters; domestic and industrial waters. |
| RANGE: | 0–60 ppm Nitrate |
| MDL: | 2.5 ppm |
| METHOD: | Zinc is used to reduce nitrate to nitrite. The nitrite that was originally present, plus the reduced nitrate, reacts with chromotropic acid to form a red color in proportion to the amount of nitrite in the sample. |
| SAMPLE HANDLING & PRESERVATION: | Analysis should be made as soon as possible. If analysis cannot be made within 24 hours, the sample should be refrigerated at 4°C. When samples must be stored for more than 24 hours, add 2 mL of concentrated sulfuric acid per liter of sample. For best results, the analysis for nitrate should be determined at temperatures between 20°C and 25°C. |
| INTERFERENCES: | Nitrite interferes at all concentrations. Strong oxidizing and reducing substances interfere. Low results might be obtained for samples that contain high concentrations of copper and iron. |

# PROCEDURE

Use universal sample holder

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **66 Nitrate-TT**) from **TESTING MENU**.
4. Scroll to and select **66 Nitrate-TT** from menu.
5. Rinse a tube (0290) with sample water. Fill to 10 mL with sample.
6. Insert the tube into chamber, close lid and select **SCAN BLANK**.
7. Remove the tube from Spectro.
8. Add one *Nitrate Spectrophotometric Grade Tablet (3881A).
9. Use Tablet Crusher (0175) to crush tablet.
10. Cap tube.
11. Invert tube 60 times per minute for 2 minutes. (One inversion equals 180°).
12. Wait 5 minutes. Do NOT mix.
13. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result in ppm nitrate.
14. Press **OFF** button to turn the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTES: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples.

To convert nitrate ($NO_3$) results to nitrate-nitrogen ($NO_3$-N), divide by 4.4.

# NITRATE-NITROGEN, LOW RANGE

## CADMIUM REDUCTION METHOD • CODE 3649-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 2 x 60 mL | *Mixed Acid Reagent | *V-6278-H |
| 5 g | *Nitrate Reducing Reagent | *V-6279-C |
| 1 | Spoon, 0.1 g, plastic | 0699 |
| 1 | Dispenser Cap | 0692 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Nitrogen is essential for plant growth, but the presence of excessive amounts in water supplies presents a major pollution problem. Nitrogen compounds may enter water as nitrates or be converted to nitrates from agricultural fertilizers, sewage, industrial and packing house wastes, drainage from livestock feeding areas, farm manures and legumes. Nitrates in large amounts can cause “blue babies” (methemoglobinemia) in infants less than six months of age. Nitrate concentration is an important factor to be considered in livestock products, where, in addition to causing methemoglobinemia, it is responsible for many other problems. Nitrates in conjunction with phosphate stimulate the growth of algae with all of the related difficulties associated with excessive algae growth.

U.S. Public Health Service Drinking Water Standards state that 10 ppm nitrate nitrogen should not be exceeded. To the sanitary and industrial engineer, concentrations of less than 1 ppm are acceptable.

| | |
|---|---|
| APPLICATION: | Drinking, surface, and saline waters; domestic and industrial waters. |
| RANGE: | 0.00–3.00 ppm Nitrate Nitrogen |
| MDL: | 0.02 ppm |
| METHOD: | Powdered cadmium is used to reduce nitrate to nitrite. The nitrite that is originally present plus reduced nitrate is determined by diazotization of sulfanilamide and nitrite followed by coupling with N-(1 naphthyl)-ethylenediamine dihydrochloride to form a highly colored azo dye which is measured colorimetrically. |
| SAMPLE HANDLING & PRESERVATION: | Analysis should be made as soon as possible. If analysis cannot be made within 24 hours, the sample should be preserved by refrigeration at 4°C. When samples must be stored for more than 24 hours, they can be preserved by adding 2 mL of concentrated sulfuric acid per liter of sample. For best results, the analysis for nitrate should be determined at temperatures between 20°C and 25°C. |
| INTERFERENCES: | Nitrite interferes at all levels. Strong oxidizing and reducing substances interfere. Low results might be obtained for samples that contain high concentrations of iron and copper. |

# PROCEDURE

Use universal sample holder.

NOTE: Place Dispenser Cap (0692) on *Mixed Acid Reagent (V-6278). Save this cap for refill reagents.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **64 Nitrate-N LR**) from **TESTING MENU**.
4. Scroll to and select **64 Nitrate-N LR** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Remove tube from Spectro and pour off 5 mL into graduated cylinder or similar. Discard the remaining sample.
8. Pour the 5 mL sample from a graduated cylinder or similar into the tube. Use the graduated cylinder or similar to measure 5 mL of *Mixed Acid Reagent (V-6278) and add to tube. Cap and mix. Wait 2 minutes before proceeding to Step 9.
9. Use the 0.1 g spoon (0699) to add two measures of *Nitrate Reducing Reagent (V-6279). Cap.
10. Hold tube by index finger and thumb and mix by inverting approximately 50-60 times a minute for four minutes. Wait 10 minutes for maximum color development.
    NOTE: At end of waiting period an undissolved portion of Nitrate Reducing Reagent may remain in bottom of the tube without affecting results.
11. At the end of the 10 minute waiting period, mix, insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
12. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTES: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

To convert Nitrate Nitrogen ($NO_3$–N) results to ppm Nitrate ($NO_3$), multiply by 4.4.

# NITRITE

## ZINC REDUCTION TESTAB METHOD • CODE 3694-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 50 | *Nitrite Spectrophotometric Grade Tablets | *3886A-H |
| 1 | Tablet Crusher | 0175 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Nitrite represents an intermediate stage of the nitrogen cycle, usually resulting from the bacterial decomposition of compounds containing organic nitrogen. Under aerobic conditions bacteria oxidize ammonia to nitrites; and under anaerobic conditions, bacteria reduce nitrates to nitrites. Nitrites are often used as food preservatives. The nitrite concentration of drinking water rarely exceeds 0.1 ppm.

| | |
|---|---|
| APPLICATION: | Drinking, surface, and saline waters; domestic and industrial waters. |
| RANGE: | 0.00–1.25 ppm Nitrite |
| MDL: | 0.025 ppm |
| METHOD: | The compound formed by diazotization of sulfanilamide and nitrite is coupled with N-(1-naphthyl)-ethylenediamine to produce a reddish purple color in proportion to the nitrite concentration. |
| SAMPLE HANDLING & PRESERVATION: | Samples should be analyzed as soon as possible. They may be stored for 24 to 48 hours at 4°C. |
| INTERFERENCES: | There are few known interfering substances at concentrations at less than 1000 times the nitrite-nitrogen concentration; however, the presence of strong oxidizing agents or reductants may readily affect nitrite concentrations. |

# PROCEDURE

Use universal sample holder

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **69 Nitrite-TT**) from **TESTING MENU**.
4. Scroll to and select **69 Nitrite-TT** from menu .
5. Rinse a tube (0290) with sample water. Fill to 10 mL with sample.
6. Insert the tube into chamber, close lid and select **SCAN BLANK**.
7. Remove the tube from Spectro.
8. Add one *Nitrite Spectrophotometric Grade Tablet (3886A).
9. Use Tablet Crusher (0175) to crush tablet.
10. Cap tube.
11. Shake vigorously for 20 seconds.
12. Wait 2 minutes.
13. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result in ppm nitrite.
14. Press **OFF** button to turn the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTES: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples.

To convert nitrite ($NO_2$) results to nitrite-nitrogen ($NO_2$–N), divide results by 3.3.

# NITRITE-NITROGEN, LOW RANGE

## DIAZOTIZATION METHOD • CODE 3650-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 2 x 60 mL | *Mixed Acid Reagent | *V-6278-H |
| 5 g | *Color Developing Reagent | *V-6281-C |
| 1 | Spoon, 0.1 g, plastic | 0699 |
| 1 | Dispenser Cap | 0692 |

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Nitrite represents an intermediate state in the nitrogen cycle, usually resulting from the bacterial decomposition of compounds containing organic nitrogen. Under aerobic conditions bacteria oxidize ammonia to nitrites; and under anaerobic conditions, bacteria reduce nitrates to nitrites. Nitrites are often used as preservatives when added to certain foods.

The nitrite concentration of drinking water rarely exceeds 0.1 ppm (mg/L).

| | |
|---|---|
| APPLICATION: | Drinking, surface and saline waters; domestic and industrial wastes. |
| RANGE: | 0.00–0.80 ppm Nitrite-Nitrogen |
| MDL: | 0.02 ppm |
| METHOD: | The compound formed by diazotization of sulfanilamide and nitrite is coupled with N–(1–naphthyl)–ethylenediamine to produce a reddish-purple color, which is read colorimetrically. |
| SAMPLE HANDLING & PRESERVATION: | Samples should be analyzed as soon as possible. They may be stored for 24 to 48 hours at 4°C. |
| INTERFERENCES: | There are few known interfering substances at concentration less than 1000 times the nitrite-nitrogen concentration; however, the presence of strong oxidants or reductants may readily affect nitrite concentrations. High alkalinity (above 600 mg/L) will give low results due to a shift in pH. |

# PROCEDURE

Use universal sample holder.

NOTE: Place Dispenser Cap (0692) on *Mixed Acid Reagent (V-6278). Save this cap for refill reagents.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **67 Nitrite-N LR**) from **TESTING MENU**.
4. Scroll to and select **67 Nitrite-N LR** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Remove tube from Spectro and pour off 5 mL into a graduated cylinder or similar. Discard the remaining sample.
8. Pour the 5 mL sample from the graduated cylinder into the colorimeter tube. Use graduated cylinder or similar to measure 5 mL of *Mixed Acid Reagent (V-6278) and add to tube. Cap and mix.
9. Use the 0.1 g spoon (0699) to add two measures of *Color Developing Reagent (V-6281). Cap and mix by gently inverting for 1 minute. Wait 5 minutes for maximum color development.
10. At the end of the 5 minute waiting period, mix, insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
11. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTE: To convert nitrite-nitrogen ($NO_2$–N) results to ppm nitrite ($NO_2$), multiply results by 3.3.

# NITROGEN, TOTAL

## CHROMOTROPIC ACID WITH PERSULFATE DIGESTION METHOD • CODE 4026

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 25 | Total Nitrogen Hydroxide Reagent Tubes | 4040-G |
| 5 g | *Digestion Reagent Powder | 4036-C |
| 60 mL | Deionized Water | *5115PS-H |
| 5 g | *Total Nitrogen Reagent A Powder | *4041-C |
| 30 | *Total Nitrogen Reagent B Tablets | *4042A-G |
| 25 | *Total Nitrogen Acid Reagent Tubes | *4043-G |
| 2 | Spoon, 0.15 g, plastic | 0727 |
| 4 | Pipets, 1.0 mL, plastic | 0354 |
| 2 | Funnels, plastic | 0459 |

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Note: for greater accuracy, use laboratory grade pipets.

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 1 | COD Adapter | 5-0087 |
| 1 | COD Reactor, 12 vial, 120V | 5-0102 |
| or 1 | COD Reactor, 12 vial, 230V | 5-0102-EX2 |

Optional Equipment:

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 1 | Pipet, Measuring , 1.0 mL | 2-2110 |
| 1 | Pipet Bulb | 2-2164 |
| 1 | Wipes | 2-2069 |
| 1 | Test Tube Holder | 2-2190 |

Nitrogen is essential for plant growth, but the presence of excessive amounts in water supplies presents a major pollution problem. Nitrogen compounds may enter water as nitrates or be converted to nitrates from agricultural fertilizers, sewage, industrial and packing house wastes, drainage from livestock feeding areas, farm manures and legumes. Nitrates in large amounts can cause “blue babies” (methemoglobinemia) in infants less than six months of age. Nitrate concentration is an important factor to be considered in livestock products, where, in addition to causing methemoglobinemia, it is responsible for many other problems. Nitrates in conjunction with phosphate stimulate the growth of algae with all of the related difficulties associated with excessive algae growth.

U.S. Public Health Service Drinking Water Standards state that 10 ppm nitrate nitrogen should not be exceeded. To the sanitary and industrial engineer, concentrations of less than 1 ppm are acceptable.

| | |
|---|---|
| APPLICATION: | Drinking, surface, saline, domestic and industrial waters. |
| RANGE: | 0–25 mg/L Total Nitrogen |
| MDL: | 2 mg/L |
| METHOD: | All forms of nitrogen are converted to nitrate by an alkaline persulfate digestion. Interference from halogen oxides is eliminated by the addition of sodium metabisulfite. Nitrate in acid reacts with chromotropic acid to form a yellow color in proportion to the amount of nitrate in the treated sample. |
| SAMPLE HANDLING & PRESERVATION: | If the sample can not be analyzed immediately, the sample should be preserved by adjusting the pH to 2 or less with concentrated sulfuric acid and refrigerated at 4°C. Warm the sample to room temperature and neutralize with 5.0 N sodium hydroxide before analyzing. |
| INTERFERENCES: | Bromide (>60 ppm) and chloride (>1000 ppm) will have a positive interference. |

# PROCEDURE

Use universal sample holder

1. Preheat COD reactor to 100 ±2°C. Follow safety precautions.
2. Remove caps from two *Total Nitrogen Hydroxide Reagent Tubes (4040).
3. Use a 0.15 g spoon (0727) and a funnel (0459) to add one level measure of *Digestion Reagent Powder (4036) to each tube. Tap funnel to dispense powder completely.
4. Use a 1.0 mL pipet (0354) to add 2.0 mL of Deionized Water (5115PS), or organic-free water, to one tube. This is the blank.
5. Use another 1.0 mL pipet (0354) to add 2.0 mL of sample to the other tube. This is the sample.
6. Cap both tubes and shake vigorously for 30 seconds.
7. Place the tubes in the COD reactor for 30 minutes.
8. After exactly 30 minutes, turn the reactor off. Carefully remove the tubes from the reactor and allow them to cool to room temperature.
9. At the end of the cooling period, press **ON** button until spectrophotometer turns on.
10. Scroll to and select **PROGRAMMED TESTS** from the menu.
11. Scroll to and select **ALL TESTS** (or another sequence containing **62 Nitrogen T**) from **PROGRAMMED TESTS** menu.
12. Scroll to and select **62 Nitrogen T** from the menu.
13. Carefully remove caps from the digested tubes.
14. Use a 0.15 g spoon (0727) and a funnel (0459) to add one level measure of *Total Nitrogen Reagent A Powder (4041). Tap funnel to dispense powder completely. Cap the tubes and shake for 15 seconds.
15. Wait 3 minutes.
16. Remove the caps from the tubes. Add one *Total Nitrogen Reagent B Tablet (4042A) to each tube. Cap the tubes and shake for 45 seconds or until the tablet disintegrates.
17. Wait 2 minutes.
18. Remove the caps from the reacted tubes. Carefully remove the caps from two *Total Nitrogen Acid Reagent Tubes (4043). CAUTION: Tubes contain a strong acid.
19. Use another 1.0 mL pipet (0354) to add 2 mL of digested, treated blank to one Total Nitrogen Acid Reagent Tube. This is the blank.
20. Use another 1.0 mL pipet (0354) to add 2 mL of digested, treated sample to the other Total Nitrogen Acid Reagent Tube. This is the sample.
21. Cap the tubes and invert 10 times to mix. CAUTION: The tubes will be hot.

NOTE: Invert slowly and completely for accurate results. Hold tubes with caps up. Invert the tube and wait for the air bubble to flow to the bottom of the tube. Turn the tube upright and wait for the air bubble to return to the top of the tube. This is one inversion.

22. Wait 5 minutes.
23. Wipe the tubes with a damp towel to remove fingerprints and smudges. Wipe with a dry towel.
24. Insert the blank tube into the chamber. Select **SCAN BLANK**. Remove the blank tube from the spectrophotometer.
25. Insert the sample tube into the chamber. Select **SCAN SAMPLE**. Record the result as Total Nitrogen in mg/L N.
26. Press **OFF** button to turn the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTE: For greater accuracy, use laboratory grade pipets. To order reagent refills, order code R-4026.

# OXYGEN SCAVENGERS

**TEST FOR DEHA (DIETHYLHYDROXYLAMINE), CARBOHYDRAZIDE, ERYTHORBIC ACID, HYDROQUINONE, METHYLETHYLKETOXIME**

## IRON REDUCTION METHOD • CODE 4857-01

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 15 mL | *DEHA Reagent #1 | *4791-E |
| 15 mL | *DEHA Reagent #2 | *4792-E |
| 15 mL | *DEHA Reagent #3 | *4793-E |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Oxygen can lead to corrosion in many parts of a boiler. Oxygen scavengers are added to the water to eliminate oxygen and thus decrease the chance of corrosion. Diethylhydroxylamine (DEHA) is a volatile oxygen scavenger used in boilers. It can also passivate steel and has a low toxicity.

| | |
|---|---|
| APPLICATION: | Boilers |
| RANGE: | 0.000–0.700 ppm DEHA (Diethylhydroxylamine)<br>0.000–0.900 ppm Carbohydrazide<br>0.00–3.00 ppm Erythorbic Acid<br>0.00–1.80 ppm Hydroquinone<br>0.00–3.00 ppm Methylethylketoxime |
| MDL: | 0.005 ppm DEHA<br>0.005 ppm Carbohydrazide<br>0.02 ppm Erythorbic Acid<br>0.01 ppm Hydroquanine<br>0.02 ppm Methylethylketoxime |
| METHOD: | Ferric iron is reduced to ferrous iron by oxygen scavengers in proportion to the concentration in the sample. The resulting ferrous iron reacts with an indicator to produce a purple color. |
| SAMPLE HANDLING & PRESERVATION: | Analyze samples immediately. Rinse sample containers and glassware with 1:1 hydrochloric acid to avoid iron contamination. |
| INTERFERENCES: | Other oxygen scavengers, such as DEHA, carbohydrazide, erythorbic acid, hydroquinone and methylethylketoxime will interfere. Stray light and substances which complex iron or reduce ferric iron will also interfere. |

# DEHA PROCEDURE

Use universal sample holder

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **38 DEHA**) from **TESTING MENU**.
4. Scroll to and select **38 DEHA** from menu.
5. Rinse a tube (0290) with sample water. Fill to 10 mL with sample.
6. Insert the tube into chamber, close lid and select **SCAN BLANK**.
7. Remove the tube from spectrophotometer.
8. Add 3 drops of *DEHA Reagent #1 (4791). Swirl to mix.
9. Add 3 drops of *DEHA Reagent #2 (4792). Swirl to mix.
10. Add 3 drops of *DEHA Reagent #3 (4793). Invert 3 times to mix.
11. Insert the tube into chamber. Close lid.
12. Wait 15 minutes. Do not open the lid during the waiting time. The reaction is photosensitive.
13. Remove tube from chamber. Invert 2 times to mix.
14. Immediately insert tube into chamber, close lid and select **SCAN SAMPLE**. Read within 30 seconds. Record result in ppm DEHA.
15. Press **OFF** button to turn the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTE: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

# CARBOHYDRAZIDE PROCEDURE

Use universal sample holder

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **14 c-hydrazide**) from **TESTING MENU**.
4. Scroll to and select **14 c-hydrazide** from menu.
5. Rinse a tube (0290) with sample water. Fill to 10 mL with sample.
6. Insert the tube into chamber, close lid and select **SCAN BLANK**.
7. Remove the tube from spectrophotometer.
8. Add 3 drops of *DEHA Reagent #1 (4791). Swirl to mix.
9. Add 3 drops of *DEHA Reagent #2 (4792). Swirl to mix.
10. Add 3 drops of *DEHA Reagent #3 (4793). Invert 3 times to mix.
11. Insert the tube into chamber. Close lid.
12. Wait 15 minutes. Do not open the lid during the waiting time. The reaction is photosensitive.
13. Remove tube from chamber. Invert 2 times to mix.
14. Immediately insert tube into chamber, close lid and select **SCAN SAMPLE**. Read within 30 seconds. Record result in ppm carbohydrazide.
15. Press **OFF** button to turn the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTE: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

# ERYTHORBIC ACID PROCEDURE

Use universal sample holder

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **40 E-thorbic A**) from **TESTING MENU**.
4. Scroll to and select **40 E-thorbic A** from menu.
5. Rinse a tube (0290) with sample water. Fill to 10 mL with sample.
6. Insert the tube into chamber, close lid and select **SCAN BLANK**.
7. Remove the tube from spectrophotometer.
8. Add 3 drops of *DEHA Reagent #1 (4791). Swirl to mix.
9. Add 3 drops of *DEHA Reagent #2 (4792). Swirl to mix.
10. Add 3 drops of *DEHA Reagent #3 (4793). Invert 3 times to mix.
11. Insert the tube into chamber. Close lid.
12. Wait 15 minutes. Do not open the lid during the waiting time. The reaction is photosensitive.
13. Remove tube from chamber. Invert 2 times to mix.
14. Immediately insert tube into chamber, close lid and select **SCAN SAMPLE**. Read within 30 seconds. Record result in ppm erythorbic acid.
15. Press **OFF** button to turn the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTE: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

# HYDROQUINONE PROCEDURE

Use universal sample holder

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **49 H-quinone**) from **TESTING MENU**.
4. Scroll to and select **49 H-quinone** from menu.
5. Rinse a tube (0290) with sample water. Fill to 10 mL with sample.
6. Insert the tube into chamber, close lid and select **SCAN BLANK**.
7. Remove the tube from spectrophotometer.
8. Add 3 drops of *DEHA Reagent #1 (4791). Swirl to mix.
9. Add 3 drops of *DEHA Reagent #2 (4792). Swirl to mix.
10. Add 3 drops of *DEHA Reagent #3 (4793). Invert 3 times to mix.
11. Insert the tube into chamber. Close lid.
12. Wait 15 minutes. Do not open the lid during the waiting time. The reaction is photosensitive.
13. Remove tube from chamber. Invert 2 times to mix.
14. Immediately insert tube into chamber, close lid and select **SCAN SAMPLE**. Read within 30 seconds. Record result in ppm hydroquinone.
15. Press **OFF** button to turn the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTE: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

# METHYLETHYLKETOXIME PROCEDURE

Use universal sample holder

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **58 m-e-ketoxim**) from **TESTING MENU**.
4. Scroll to and select **58 m-e-ketoxim** from menu.
5. Rinse a tube (0290) with sample water. Fill to 10 mL with sample.
6. Insert the tube into chamber, close lid and select **SCAN BLANK**.
7. Remove the tube from spectrophotometer.
8. Add 3 drops of *DEHA Reagent #1 (4791). Swirl to mix.
9. Add 3 drops of *DEHA Reagent #2 (4792). Swirl to mix.
10. Add 3 drops of *DEHA Reagent #3 (4793). Invert 3 times to mix.
11. Insert the tube into chamber. Close lid.
12. Wait 15 minutes. Do not open the lid during the waiting time. The reaction is photosensitive.
13. Remove tube from chamber. Invert 2 times to mix.
14. Immediately insert tube into chamber, close lid and select **SCAN SAMPLE**. Read within 30 seconds. Record result in ppm methylethylketoxime.
15. Press **OFF** button to turn the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTE: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

# OZONE

## INDIGO METHOD • CODE 365I-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 15 mL | Chlorine Inhibitor | 3990-E |
| 250 mL | *Ozone Buffer | *3991-K |
| 30 mL | Indigo Blue Stock Solution | 3989-G |
| 1 | Sampling Apparatus | 0681 |
| 1 | Pipet, transfer, 1.0 mL | 2-2170 |
| 1 | Pipet, transfer, 5 mL | 0329 |
| 1 | Pump, 10 mL | 30527 |
| 1 | Bottle, HR Reagent, amber glass | 0680-J |
| 1 | Graduated Cylinder, 50 mL, glass | 0418 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Ozone is sometimes used in place of, or in conjunction with, chlorine or other halogens for disinfection of pool, spa, or drinking waters. Recently, large aquatic facilities have begun using ozone as a disinfectant in many artificial habitats.

| | |
|---|---|
| APPLICATION: | Drinking water; swimming pool water. |
| RANGE: | 0.00–0.40 ppm Ozone, Low Range<br>0.00–1.50 ppm Ozone, High Range |
| MDL: | 0.02 ppm, Low Range<br>0.05 ppm, High Range |
| METHOD: | Ozone rapidly and stoichiometrically decolorizes Indigo Trisulfonate under acidic conditions. |
| SAMPLE HANDLING & PRESERVATION: | Ozone is extremely unstable in aqueous solutions. Test must be performed immediately and the sample must not be agitated. |
| INTERFERENCES: | Manganese at any level interferes. |

# PROCEDURE–LOW RANGE

Use universal sample holder.

### A. PREPARATION OF HR REAGENT

NOTE: The quantity of Indigo Blue Stock solution (3989) supplied will prepare one batch of HR Reagent for the High Range Ozone procedure or five batches of HR Reagent for the Low Range Ozone procedure.

1. Use the 50 mL graduated cylinder to carefully add 45 mL of *Ozone Buffer (3991) to amber glass bottle marked HR Reagent (0680).
2. Use the 5 mL transfer pipet (0329) and pump (30527) to add 5 mL of Indigo Blue Stock Solution (3989) to the amber glass bottle. Cap and mix.

### B. DETERMINATION OF OZONE

3. Use the 1.0 mL transfer pipet (2-2170) and pump (30527) to add 1.0 mL of HR Reagent to each of 2 clean tubes (0290).
4. If chlorine is present add 3 drops Chlorine Inhibitor (3990) to each tube. Cap tubes.
5. Take one of the prepared tubes (0290) and sampling apparatus (0681) to sampling site.
6. Lower end of tubing of sampling apparatus to desired depth. Slowly withdraw and depress plunger several times to purge syringe and tubing. Slowly withdraw plunger to fill purged syringe.
7. Remove plastic tubing from syringe. Remove cap from the prepared tube. Place tip of syringe against inside of the prepared tube. Slowly depress plunger and fill to the 10 mL line and cap. This is the Sample Tube.
   NOTE: Do not shake or invert the sample.
8. Fill the second prepared tube (0290) to the 10 mL line with ozone free water. This is the Reagent Blank.
9. Press and hold **ON** button until spectrophotometer turns on.
10. Scroll to and select **PROGRAMMED TESTS**.
11. Scroll to and select **ALL TESTS** (or another sequence containing **71 OZONE-LR**) from **TESTING MENU**.
12. Scroll to and select **71 OZONE-LR** from menu.
13. Insert the Reagent Blank tube into chamber, close lid and select **SCAN BLANK**.
14. Insert reacted Sample Tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
15. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTE: HR Reagent must be made fresh each week. If reagent is refrigerated, it may be kept up to 3 weeks.

## PROCEDURE–HIGH RANGE

Use universal sample holder.

### A. PREPARATION OF HR REAGENT

NOTE: The quantity of Indigo Blue Stock solution (3989) supplied will prepare one batch of HR Reagent for the High Range Ozone procedure or five batches of HR Reagent for the Low Range Ozone procedure.

1. Use the 50 mL graduated cylinder to carefully add 35 mL of *Ozone Buffer (3991) to amber glass bottle marked HR Reagent (0680).
2. Use the 50 mL graduated cylinder to carefully add 15 mL of Indigo Blue Stock Solution (3989) to the amber glass bottle. Cap and mix.

### B. DETERMINATION OF OZONE

3. Use the 1.0 mL transfer pipet (2-2170) and pump (30527) to add 1.0 mL of HR Reagent to each of 2 clean tubes (0290).
4. If chlorine is present add 3 drops Chlorine Inhibitor (3990) to each tube. Cap tubes.
5. Take one of the prepared tubes (0290) and sampling apparatus (0681) to sampling site.
6. Lower end of tubing of sampling apparatus to desired depth. Slowly withdraw and depress plunger several times to purge syringe and tubing. Slowly withdraw plunger to fill purged syringe.
7. Remove plastic tubing from syringe. Remove cap from the prepared tube. Place tip of syringe against inside of the prepared tube. Slowly depress plunger and fill to the 10 mL line and cap. This is the Sample Tube.
   NOTE: DO NOT SHAKE OR INVERT THE SAMPLE.
8. Fill the second prepared tube (0290) to the 10 mL line with ozone free water. This is the Reagent Blank.
9. Press and hold **ON** button until spectrophotometer turns on.
10. Scroll to and select **PROGRAMMED TESTS**.
11. Scroll to and select **ALL TESTS** (or another sequence containing **72 OZONE-HR**) from **TESTING MENU**.
12. Scroll to and select **72 OZONE-HR** from menu.
13. Insert the Reagent Blank tube into chamber, close lid and select **SCAN BLANK.**

14. Insert reacted Sample Tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
15. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTE: HR Reagent must be made fresh each week. If reagent is refrigerated, it may be kept up to 3 weeks.

# pH

## COLORIMETRIC METHOD • CODE 3700-01-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 60 mL | Chlorphenol Red Indicator | V-2209-H |
| 60 mL | Phenol Red Indicator | V-2304-H |
| 60 mL | Thymol Blue Indicator | V-2213-H |
| 3 | Pipets, 0.5 mL, plastic w/caps | 0369 |

The term pH (always written with a lower case p and an upper case H) is correctly defined as the negative logarithm of the hydrogen ion concentration. More simply, the term pH can be considered to be an index of the amount of hydrogen ion present in a substance, or is a measure of the acidity of the substance. This index is important as it can be used to quickly identify the acid, neutral or alkaline (basic) nature of materials. Acidic substances have a pH less than 7.0, neutral substances have a pH equal to 7.0 and alkaline substances have a pH greater than 7.0.

Most natural waters have pH values from pH 5.0 to pH 8.5. Acidic, freshly fallen rain water may have a pH value of pH 5.5 to pH 6.0. When it reacts with soils and minerals containing weakly alkaline materials, the hydroxyl ion concentration will increase and the hydrogen ion concentration will decrease. Then the water may become slightly alkaline with a pH of 8.0 to 8.5. Natural sea water has a pH value of 8.1, and changes from this value indicate that water from an inland source is entering the body of sea water.

Waters more acidic than pH 5.0 and more alkaline than pH 8.5 to 9.0 should be viewed with suspicion. Mine drainage and acidic industrial wastes are the principal factors in increasing the acidity of water, and alkaline industrial wastes are the cause of high pH values.

Because pH measurements can be made so simply, and because they can tell so much about the past and future reactions of water, they are routinely made in water quality studies. Sudden changes in pH values serve as warning signals that water quality may be adversely affected through the introduction of contaminants.

APPLICATION: Drinking, surface, and saline waters; swimming pool water; domestic and industrial wastes.

RANGE: The various pH indicators exhibit a specific color change over a narrow pH range. The color changes are measured colorimetrically.

METHOD: Sample should be analyzed immediately after collection.

SAMPLE HANDLING & PRESERVATION: Sample color and turbidity interfere with the colorimetric pH measurement. Color interference may be removed by standardizing the instrument with the original water sample. Two drops of 0.1N sodium thiosulfate per 100 mL of sample will eliminate chlorine interference.

INTERFERENCES:

| pH Indicator | pH | SMART Spectro Test Range |
|---|---|---|
| Chlorphenol Red | 5.0–7.0 | 74 pH CPR |
| Phenol Red | 6.6–8.4 | 75 pH PR |
| Thymol Blue | 8.0–9.5 | 76 pH TB |

# PROCEDURE

Use universal sample holder.

1. Use Indicator, Range, & Test Name chart to select the indicator, corresponding to anticipated pH range and to determine corresponding test name to select from spectrophotometer menu.
2. Press and hold **ON** button until spectrophotometer turns on.
3. Scroll to and select **PROGRAMMED TESTS**.
4. Scroll to and select **ALL TESTS** (or another sequence containing the appropriate pH test name) from **TESTING MENU**.
5. Scroll to and select the appropriate pH test name from menu.
6. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
7. Insert tube into chamber, close lid and select **SCAN BLANK**.
8. Remove tube from Spectro. Use the 0.5 mL pipet (0369) to add exactly 0.5 mL of the pH indicator for the chosen range. Cap and mix.
9. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
10. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

# PHENOL

## AMINOANTIPYRINE METHOD • CODE 3652-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 5 g | Aminoantipyrine Reagent | 7825-C |
| 30 mL | *Ammonium Hydroxide Solution | *7826-G |
| 2 x 60 mL | *Potassium Ferricyanide Solution | *7827-H |
| 1 | Spoon, 0.1 g, plastic | 0699 |
| 1 | Pipet, plain, plastic | 0352 |
| 1 | Pipet, 1.0 mL, plastic | 0354 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Phenols may occur in domestic and industrial waste waters and in drinking water supplies. Chlorination of waters containing phenols may produce odiferous and objectionable tasting chlorophenols. Natural waters seldom contain more than 1 mg/L phenol.

Phenols may be removed from water by various treatment processes including chlorination and activated carbon absorption.

| | |
|---|---|
| APPLICATION: | Drinking and surface waters; domestic and industrial wastewaters. |
| RANGE: | 0.00–6.00 ppm Phenol |
| MDL: | 0.05 ppm |
| METHOD: | 4-Aminoantipyrine is oxidized in the presence of all ortho- and meta- substituted phenols to form a colored complex in proportion to the amount of phenol present. |
| SAMPLE HANDLING & PRESERVATION: | Phenols are subject to biological and chemical oxidation. Samples should be analyzed within 4 hours after collection. If sample cannot be analyzed within 4 hours it can be preserved by acidification with phosphoric acid to pH 4.0. |
| INTERFERENCES: | Oxidizing and reducing chemicals, alkaline pH values, and phenol decomposing bacteria may interfere with the test. |

# PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **77 Phenol**) from **TESTING MENU**.
4. Scroll to and select 77 Phenol from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Remove tube from Spectro. Use the 0.1 g spoon (0699) to add one measure of Aminoantipyrine Reagent (7825-C). Cap and mix until powder dissolves.
8. Use the plain pipet (0352) to add 4 drops of *Ammonium Hydroxide Solution (7826). Cap and mix.
9. Use the 1 mL pipet (0354) to add 2 mL of *Potassium Ferricyanide Solution (7827). Cap and mix. Solution will almost immediately develop a reddish hue if phenols are present.
10. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
11. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

# PHOSPHATE–LOW RANGE

## ASCORBIC ACID REDUCTION METHOD
## CODE 3653-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 60 mL | *Phosphate Acid Reagent | *V-6282-H |
| 5 g | *Phosphate Reducing Reagent | *V-6283-C |
| 1 | Pipet, 1 mL, plastic | 0354 |
| 1 | Spoon, 0.1 g, plastic | 0699 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Phosphorus is an important nutrient for aquatic plants. The amount found in water is generally not more than 0.1 ppm unless the water has become polluted from waste water sources or excessive drainage from agricultural areas. When phosphorus is present in excess of the concentrations required for normal aquatic plant growth, a process called eutrophication takes place. This creates a favorable environment for the increase in algae and weeds. When algae cells die, oxygen is used in the decomposition and fish kills often result. Rapid decomposition of dense algae scums with associated organisms give rise to foul odors and hydrogen sulfide gas.

| | |
|---|---|
| APPLICATION: | Drinking, surface, and saline waters; domestic and industrial wastes (Method based on reactions that are specific for orthophosphate). |
| RANGE: | 0.00–3.00 ppm Orthophosphate |
| MDL: | 0.04 ppm |
| METHOD: | Ammonium molybdate and antimony potassium tartrate react in a filtered acid medium with dilute solution of $PO_4^{-3}$ to form an antimony-phosphomolybdate complex. This complex is reduced to an intense blue colored complex by ascorbic acid. The color is proportional to the amount of phosphate present. (Only orthophosphate forms a blue color in this test.) Polyphosphates (and some organic phosphorus compounds) may be converted to the orthophosphate form by sulfuric acid digestion. Organic phosphorus compounds may be converted to the orthophosphate form by persulfate digestion. |
| SAMPLE HANDLING & PRESERVATION: | If benthic deposits are present in the area being sampled, great care should be taken not to include these deposits. If the analysis cannot be performed the same day of collection, the sample should be preserved by the addition of 2 mL of concentrated sulfuric acid or 40 mg mercuric chloride per liter and refrigerated at 4°C. |
| INTERFERENCES: | a. No interference from copper, iron, or silicate at concentrations many times the concentration of sea water. However, high iron concentrations can cause precipitation and subsequent loss of phosphorus.<br><br>b. Salt error for samples ranging from 5% to 20% salt content was found to be less than 1%.<br><br>c. Mercuric chloride, $HgCl_2$, when used as the preservative, interferes when the chloride levels are low (less than 50 mg/L). This interference is overcome by spiking samples with a minimum of 50 mg/L of sodium chloride. |

# PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **78 Phosphate-L**) from **TESTING MENU**.
4. Scroll to and select **78 Phosphate-L** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Remove tube from Spectro. Use 1.0 mL pipet (0354) to add 1.0 mL of *Phosphate Acid Reagent (V-6282). Cap and mix.
8. Use the 0.1 g spoon (0699) to add one measure of *Phosphate Reducing Reagent (V-6283). Cap and shake until powder dissolves. Wait 5 minutes for full color development. Solution will turn blue if phosphates are present.
9. At end of 5 minute waiting period, mix, insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
10. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

# PHOSPHATE–HIGH RANGE

## VANADOMOLYBDOPHOSPHORIC ACID METHOD
## CODE 3655-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 4 x 30 mL | *VM Phosphate Reagent | *4410-G |
| 1 | Pipet, 1.0 mL, plastic | 0354 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Phosphate treatments in boiler and cooling water and other industrial water systems are run at levels up to 100 ppm orthophosphate. These high levels permit the use of a simpler, high range test.

| | |
|---|---|
| APPLICATION: | Boiler, cooling, and industrial waters. |
| RANGE: | 0.0–70.0 ppm Phosphate |
| MDL: | 1.0 ppm |
| METHOD: | Orthophosphate reacts in acid conditions with ammonium vanadomolybdate to form vanadomolybdophosphoric acid. This yellow color is proportional to the concentration of orthophosphate and is read colorimetrically. |
| SAMPLE HANDLING & PRESERVATION: | If the analysis cannot be performed the same day of collection, the sample should be preserved by the addition of 2 mL of concentrated sulfuric acid or 40 mg mercuric chloride per liter and refrigerated at 4°C. |
| INTERFERENCES: | Silica interferes only if the sample is heated. Arsenate, fluoride, thorium, bismuth, sulfide, thiosulfate, and thiocyanate cause negative interference. |

# PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **79 Phosphate-H**) from **TESTING MENU**.
4. Scroll to and select **79 Phosphate-H** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Remove tube from Spectro. Use the 1.0 mL pipet (0354) to add 2.0 mL of *VM Phosphate Reagent (4410). Cap and mix. Wait 5 minutes for full color development.
8. After 5 minute waiting period, mix, insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
9. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

# PHOSPHORUS-TOTAL, LOW RANGE

## ASCORBIC ACID REDUCTION WITH PERSULFATE DIGESTION METHOD • CODE 4024-01

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 25 | *Total Phosphorus Acid Reagent Tubes | *4035-G |
| 5 g | *Digestion Reagent Powder | *4036-C |
| 2 X 30 mL | *Total Phosphorus LR Hydroxide Reagent | *4038-G |
| 2 X 30 mL | *Phosphate Acid Reagent | *V-6282-G |
| 5 g | Phosphate Reducing Reagent | V-6283-C |
| 1 | Spoon, 0.15 g, plastic | 0727 |
| 3 | Pipets, 1.0 mL, plastic | 0354 |
| 1 | Spoon, 0.1 g, plastic | 0699 |
| 2 | Funnels, plastic | 0459 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Note: for greater accuracy, use laboratory grade pipets.

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 1 | COD Adapter | 5-0087 |
| 1 | COD Reactor, 12 vial, 120V | 5-0102 |
| or 1 | COD Reactor, 12 vial, 230V | 5-0102-EX2 |

Optional Equipment:

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 1 | Volumetric pipet, 5.0 mL | 2-2174 |
| 2 | Volumetric pipets, 1.0 mL | 2-2170 |
| 1 | Pipet Bulb | 2-2164 |
| 1 | Wipes | 2-2069 |
| 1 | Test Tube Holder | 2-2190 |

Phosphorus in natural waters and wastewaters occurs almost exclusively in the form of orthophosphates, condensed phosphates (pyro-, meta- and other polyphosphates) and organically bound phosphates. Phosphates may be added in small amounts to water supplies during treatment. Larger amounts are introduced to water used for cleaning or laundering as components of commercial cleaning preparations. Phosphates are used to treat boiler water and are components of agricultural and residential fertilizers. Phosphorus is an important nutrient for aquatic plants. The amount found in natural water is generally not more than 0.1 mg/L unless the water has become polluted from wastewater sources or excessive drainage from agricultural areas.

| | |
|---|---|
| APPLICATION: | Drinking, surface and saline waters; domestic and industrial waste water. |
| RANGE: | 0.00–3.50 mg/L Total Phosphorus as phosphate |
| MDL: | 0.07 mg/L |
| METHOD: | Pretreatment of the sample with heat and acid provides conditions for the hydrolysis of condensed inorganic phosphates. Heat, acid and persulfate convert the organic phosphates to orthophosphate during the digestion. Ammonium molybdate and antimony potassium tartrate react in a filtered acid medium with dilute solutions of phosphate to form an antimony-phosphomolybdate complex. This complex is reduced to an intense blue colored complex by ascorbic acid. The color is proportional to the amount of phosphate present. |
| SAMPLE HANDLING & PRESERVATION: | Rinse sample bottle with 1:1 hydrochloric acid followed by deionized water. Do not use phosphate detergents. If the sample can not be analyzed immediately, the sample should be preserved by adjusting the pH to 2 or less with concentrated sulfuric acid and refrigerated at 4°C. Warm the sample to room temperature and neutralize with 5.0 N sodium hydroxide before analyzing. |
| INTERFERENCES: | Large amounts of turbidity may interfere. Aluminum (>200 ppm), arsenate (any level), chromium (>100 ppm), copper (>10 ppm), Iron (>100 ppm), Nickel (>300 ppm), silica (>50 ppm), silicate (>10 ppm), sulfide (>90 ppm) and zinc (>80 ppm) will interfere. |

# PROCEDURE

Use universal sample holder

1. Preheat COD reactor to 150 ±2°C. Follow safety precautions.
2. Remove cap from a *Total Phosphorus Acid Reagent Tube (4035). Use a 1.0 mL pipet (0354) to add 5.0 mL of sample.
3. Use the 0.15 g spoon (0727) and a funnel (0459) to add one level measure of *Digestion Reagent Powder (4036). Tap funnel to dispense powder completely. Cap tube tightly and shake until powder dissolves completely.
4. Place the tube in the COD reactor for 30 minutes.
5. At the end of the heating period, turn the reactor off. Carefully remove the tube from the reactor and allow it to cool to room temperature.
6. At the end of the cooling period, press **ON** button until spectrophotometer turns on.
7. Scroll to and select **PROGRAMMED TESTS** from menu.
8. Scroll to and select **ALL TESTS** (or another sequence containing **82 Phosphorus T LR** from **PROGRAMMED TESTS** menu.
9. Scroll to and select **82 Phosphorus T LR** from the menu.
10. Carefully remove the caps from the digested tube. Use another 1 mL pipet (0354) to add 1.0 mL of *Total Phosphorus LR Hydroxide Reagent (4038) to the tube. Cap and invert to mix.
11. Wipe the vial with a damp towel to remove fingerprints and smudges. Wipe with a dry towel.
12. Insert the tube into the chamber. Select **SCAN BLANK**. Remove the tube from the spectrophotometer.
13. Use another 1 mL pipet (0354) to add *1.0 mL of Phosphate Acid Reagent (V-6282). Cap and invert tube to mix.
14. Use the 0.1g spoon (0699) and a funnel (0459) to add one level spoon of Phosphate Reducing Reagent (V-6283). Tap funnel to dispense powder completely. Cap tube and shake until powder dissolves.
15. Wait 5 minutes.
16. Wipe the tubes with a damp towel to remove fingerprints and smudges. Wipe with a dry towel.
17. Insert the tube into the chamber. Select **SCAN SAMPLE**. Record the result as Total Phosphorus in mg/L $PO_4$.
18. Press **OFF** button to turn the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTE: For greater accuracy, use laboratory grade pipets.

# PHOSPHORUS-TOTAL, HIGH RANGE

## MOLYBDOVANADATE WITH ACID PERSULFATE DIGESTION METHOD • CODE 4025-01

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 25 | *Total Phosphorus Acid Reagent Tubes | *4035-G |
| 60 mL | Deionized Water | 5115PS-H |
| 5 g | *Digestion Reagent Powder | *4036- C |
| 2 X 30 mL | *Total Phosphorus HR Hydroxide Reagent | *4037-G |
| 30 mL | *Total Phosphorus HR Indicator Reagent | *4039-G |
| 1 | Spoon, 0.15 g | 0727 |
| 3 | Pipets 1.0 mL, plastic | 0354 |
| 1 | Pipet, 0.5 mL | 0353 |
| 1 | Funnel, plastic | 0459 |

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Note: for greater accuracy, use laboratory grade pipets.

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 1 | COD Reactor, 12 vial, 120V | 5-0102 |
| 1 | COD Reactor, 12 vial, 230V | 5-0102-EX2 |
| or 1 | COD Reactor, 12 vial, 230V | 5-0094 |

Optional Equipment:

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 1 | Volumetric Pipet, 2.0 mL | 2-2168 |
| 1 | Volumetric pipet, 5.0 mL | 2-2174 |
| 2 | Volumetric pipets, 0.5 mL | 30503 |
| 1 | Pipet Bulb | 30503 |
| 1 | Wipes | 2-2069 |
| 1 | Test Tube Holder | 2-2190 |

Phosphorus in natural waters and wastewaters occurs almost exclusively in the form of orthophosphates, condensed phosphates (pyro-, meta- and other polyphosphates) and organically bound phosphates. Phosphates may be added in small amounts to water supplies during treatment. Larger amounts are introduced to water used for cleaning or laundering as components of commercial cleaning preparations. Phosphates are used to treat boiler water and are components of agricultural and residential fertilizers. Phosphorus is an important nutrient for aquatic plants. The amount found in natural water is generally not more than 0.1 mg/L unless the water has become polluted from wastewater sources or excessive drainage from agricultural areas.

| | |
|---|---|
| APPLICATION: | Boiler, cooling, and industrial water. |
| RANGE: | 0.0–100.0 mg/L Total Phosphorus as phosphate |
| MDL: | 5.0 mg/L |
| METHOD: | Pretreatment of the sample with heat and acid provides conditions for the hydrolysis of condensed inorganic phosphates. Heat, acid and persulfate convert the organic phosphates to orthophosphate during the digestion. Orthophosphate reacts in acid conditions with ammonium vanadomolybdate to form vanadomolybdophosphoric acid. The resulting yellow color is proportional to the concentration of orthophosphate. |
| SAMPLE HANDLING & PRESERVATION: | Rinse sample bottle with 1:1 hydrochloric acid followed by deionized water. Do not use phosphate detergents. If the sample can not be analyzed immediately, the sample should be preserved by adjusting the pH to 2 or less with concentrated sulfuric acid and refrigerated at 4°C. Warm the sample to room temperature and neutralize with 5.0 N sodium hydroxide before analyzing. |
| INTERFERENCES: | Large amounts of turbidity may interfere. Silica and arsenate interfere only if the sample is heated. Arsenite, fluoride, thorium, bismuth, molybdate, thiosulfate, and thiocyanate cause negative interference. Ferrous iron concentrations above 100 ppm will interfere. |

NOTE: For greater accuracy, use laboratory grade pipets. To order reagent refills, order code R-4025.

# PROCEDURE

Use universal sample holder

1. Preheat COD reactor to 150 ±2°C. Follow safety precautions.
2. Remove cap from a *Total Phosphorus Acid Reagent Tube (4035). Use a 1.0 mL pipet (0354) to add 5.0 mL of Deionized Water (5115PS). This is the blank.
3. Remove cap from a *Total Phosphorus Acid Reagent Tube (4035). Use another 1.0 mL pipet (0354) to add 5.0 mL of sample water. This is the sample.
4. Use the 0.15 g spoon (0727) and a funnel (0459) to add one level measure of *Digestion Reagent Powder (4036) to each tube. Tap funnel to dispense powder completely. Cap tube tightly and shake until powder completely dissolves.
5. Place the tubes in the COD reactor for 30 minutes.
6. At the end of the heating period, turn the reactor off. Carefully remove the tubes from the reactor block and allow them to cool to room temperature.
7. Carefully remove the caps from the digested tubes. Use another 1 mL pipet (0354) to add 2.0 mL of *Total Phosphorus HR Hydroxide Reagent (4037) to each tube. Cap and invert to mix.
8. Use the 0.5 mL pipet (0353) to add 0.5 mL *Total Phosphorus HR Indicator Reagent (4039) to each tube. Cap and invert to mix. Wait 7 minutes.
9. During the waiting period, press **ON** button until spectrophotometer turns on.
10. Scroll to and select **PROGRAMMED TESTS** from menu.
11. Scroll to and select **ALL TESTS** (or another sequence containing **83 Phosphorus T HR**) from **PROGRAMMED TESTS** menu.
12. Scroll to and select **83 Phosphorus T HR** from the menu.
13. Wipe the vials with a damp towel to remove fingerprints and smudges. Wipe with a dry towel.
14. Insert the blank tube into the chamber. Select **SCAN BLANK**. Remove the blank tube from the spectrophotemeter.
15. Insert the sample tube into the chamber. Select **SCAN SAMPLE**. Record the result as Total Phosphorus in mg/L $PO_4$.
16. Press **OFF** button to turn the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

# POTASSIUM

## TETRAPHENYLBORON METHOD • CODE 3639-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 30 mL | *Sodium Hydroxide, 1.0N | *4004WT-G |
| 5 g | *Tetraphenylboron Powder | *6364-C |
| 1 | Spoon, 0.05 g, plastic | 0696 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Potassium, as the seventh most common element on the Earth, may be found in minor quantities in most water supplies. It seldom exceeds 10 ppm in drinking water and usually is less than 2 ppm. In some brine or runoff in agricultural areas the potassium concentration may reach 100 ppm.

| | |
|---|---|
| APPLICATION: | Drinking, surface, and saline waters. |
| RANGE: | 0.0–10.0 ppm Potassium |
| MDL: | 0.5 ppm |
| METHOD: | Potassium reacts with sodium tetraphenylborate to form a colloidal white precipitate in quantities proportional to the potassium concentration. |
| SAMPLE HANDLING & PRESERVATION: | Store samples in polyethylene bottles, not in soft glass where leaching of potassium from the glass may occur. Samples may be acidified to pH 2 with nitric acid, but should be neutralized before analyzing. |
| INTERFERENCES: | Calcium and magnesium interfere at very high concentrations. Check for stray light interference (see page 15). |

# PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **81 Potassium**) from **TESTING MENU**.
4. Scroll to and select **81 Potassium** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Remove tube from Spectro. Add 4 drops of *Sodium Hydroxide, 1.0N (4004WT). Cap and mix.
8. Use the 0.05 g spoon (0696) to add one measure of *Tetraphenylboron Powder (6364). Cap and shake vigorously until all of the powder has dissolved. Wait 5 minutes.
9. At end of 5 minute waiting period, mix tube again to suspend any settled precipitate. Immediately insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
10. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTES: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

For the most accurate results, the sample and reagents should be at 25±4°C.

# SILICA–LOW RANGE

## HETEROPOLY BLUE METHOD • CODE 3664-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 30 mL | *Silica Reagent #1 | *V-4466-G |
| 30 mL | *Silica Reagent #2 | *V-4467-G |
| 30 mL | *Silica Reagent #3 | *V-4468-G |
| 10 g | *Silica Reagent #4 | *V-6284-D |
| 1 | Spoon, 0.1 g, plastic | 0699 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Silicon dioxide, $SiO_2$, commonly known as silica, occurs in all natural water. Silica may be present as suspended, insoluble particles in a colloidal or polymeric state. It may also be present in a reactive form as silicic acid or silicate ions. Silica is a major nutrient for diatoms. A silica cycle occurs in many bodies of water containing organisms, such as diatoms, that use silica in their skeletal structure. The silica removed from the water may be slowly returned to solution by the decomposition of the dead organisms. The major source of silica in natural water is from the decomposition of silicate minerals in the drainage basin from which the waters flow.

The presence of silica is particularly objectionable in water used for boiler feed water purposes, as it may cause the formation of a hard, dense scale which has unusually high resistance to heat transfer. Serious loss of turbine efficiency results from insoluble silica turbine blade deposits caused by vaporization of silica from boiler water.

| | |
|---|---|
| APPLICATION: | Drinking, surface, and saline waters; domestic and industrial wastes. |
| RANGE: | 0.00–2.50 ppm Silica |
| MDL: | 0.03 ppm |
| METHOD: | Reactive silica forms a complex with ammonium molybdate in an acidic solution to produce a yellow-green color in proportion to the amount of silica present. Phosphate also reacts with molybdate but the addition of oxalic acid eliminates the molybdophosphoric acid complex. This silica molybdate complex is then reduced by ascorbic acid to produce an intense blue color. |
| SAMPLE HANDLING & PRESERVATION: | Silica samples may be preserved by refrigeration at 4°C in plastic containers up to one week without any change in silica concentration. |
| INTERFERENCES: | Sulfides and large amounts of iron interfere. Color and turbidity may be removed by standardizing the instrument with the original water sample. Since silica is a component of glass waste and a common contaminant, it is suggested to run a reagent blank using silica-free water. The blank value is subtracted from the sample concentrations. |

# PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **85 Silica Lo**) from **TESTING MENU**.
4. Scroll to and select **85 Silica Lo** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**. (See Note)
7. Remove tube from Spectro. Add 6 drops *Silica Reagent #1 (V-4466). Cap and invert to mix.
8. Add 12 drops of *Silica Reagent #2 (V-4467). Cap and mix. Wait 5 minutes.
9. Add 8 drops of *Silica Reagent #3 (V-4468). Cap and mix. Wait 2 minutes.
10. Use the 0.1 g spoon (0699) to add one measure of *Silica Reagent #4 (V-6284). Cap and mix gently until powder has dissolved. Wait 5 minutes for full color development.
11. At end of 5 minute waiting period, mix, insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
12. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTE: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

# SILICA–HIGH RANGE

## SILICOMOLYBDATE METHOD • CODE 3687-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 30 mL | *Silica Reagent #1 | *V-4466-G |
| 30 mL | *Silica Reagent #2 | *V-4467-G |
| 15 mL | *Silica Reagent #3 | *V-4468-G |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Silicon dioxide, $SiO_2$, commonly known as silica, occurs in all natural water. Silica may be present as suspended, insoluble particles in a colloidal or polymeric state. It may also be present in a reactive form as silicic acid or silicate ions. Silica is a major nutrient for diatoms. A silica cycle occurs in many bodies of water containing organisms, such as diatoms, that use silica in their skeletal structure. The silica removed from the water may be slowly returned to solution by the decomposition of the dead organisms. The major source of silica in natural water is from the decomposition of silicate minerals in the drainage basin from which the waters flow.

The presence of silica is particularly objectionable in water used for boiler feed water purposes, as it may cause the formation of a hard, dense scale which has unusually high resistance to heat transfer. Serious loss of turbine efficiency results from insoluble silica turbine blade deposits caused by vaporization of silica from boiler water.

| | |
|---|---|
| APPLICATION: | Boiler and cooling waters; domestic and industrial wastes. |
| RANGE: | 0–50 ppm Silica |
| MDL: | 1 ppm |
| METHOD: | Silica forms a complex with ammonium molybdate in an acidic solution to produce a yellow color in proportion to the amount of silica present. Phosphate also reacts with molybdate but the addition of oxalic acid eliminates the molybdophosphoric acid complex. |
| SAMPLE HANDLING & PRESERVATION: | Silica samples may be preserved by refrigeration at 4°C in plastic containers up to one week without any change in silica concentration. |
| INTERFERENCES: | Sulfides and large amounts of iron interfere. Color and turbidity may be removed by standardizing the instrument with the original water sample. |

# PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **86 Silica Hi**) from **TESTING MENU**.
4. Scroll to and select **86 Silica Hi** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Remove tube from Spectro. Add 6 drops *Silica Reagent #1 (V-4466). Cap and invert to mix.
8. Add 12 drops of *Silica Reagent #2 (V-4467). Cap and mix. Wait 5 minutes.
9. At end of 5 minute waiting period, add 8 drops of *Silica Reagent #3 (V-4468). Cap and mix.
10. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
11. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTE: To extend the range to 100 ppm, perform a 2:1 dilution of water sample, with silica-free water. Perform test and multiply result by 2.

# SULFATE

## BARIUM CHLORIDE METHOD • CODE 3665-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 10 g | *Sulfate Reagent | *V-6277-D |
| 1 | Spoon, 0.1 g, plastic | 0699 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

The most common mineral forms of sulfur are iron sulfide, lead sulfide, zinc sulfide and as calcium sulfate and magnesium sulfate. In most fresh waters the sulfate ion is the second or third most abundant anion, being exceeded only by bicarbonate and, in some cases, silicate. Sulfur, in the form of sulfate, is considered an important nutrient element. Mineral springs are rich in sulfate and feed appreciable quantities of this compound to the watershed. Acid mine water drainage is a form of pollution which may contribute extremely large amounts of sulfate content to natural waters. Other sources of sulfate include waste material from pulp mills, steel mills, food processing operations and municipal wastes. Many bacteria obtain sulfur from sulfate for the synthesis of amino acids. In lakes and streams low in oxygen, this process of sulfate reduction causes the production of hydrogen sulfide, with its characteristic offensive odor. Calcium sulfate and magnesium sulfate contribute significantly to the hardness of water. Under natural conditions, the quantities ordinarily to be expected in lakes are between 3 and 30 parts per million.

| | |
|---|---|
| APPLICATION: | Drinking and surface waters; domestic and industrial wastes. |
| RANGE: | 6–100 ppm Sulfate |
| MDL: | 5 ppm |
| METHOD: | Sulfate ion is precipitated in an acid medium with barium chloride to form a barium sulfate suspension in proportion to the amount of sulfate present. |
| SAMPLE HANDLING & PRESERVATION: | Sulfate samples may be preserved by refrigeration at 4°C up to 7 days in glass or plastic containers without any change in concentration. |
| INTERFERENCES: | Suspended matter and color interference may be removed by a filtration step. Silica in excess of 500 mg/L will interfere. Check for stray light interference (see page 15). |

# PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **89 SULFATE-HR**) from **TESTING MENU**.
4. Scroll to and select **89 SULFATE-HR** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Remove tube from Spectro. Use the 0.1 g spoon (0699) to add one measure of *Sulfate Reagent (V-6277). Cap and shake until powder dissolves. A white precipitate will develop if sulfates are present. Wait 5 minutes.
8. Mix tube again. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
9. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTES: If the sulfate concentration of the test sample is greater than 100 ppm, it is recommended that a dilution be made with deionized water and the results multiplied by the dilution factor.

A white film is deposited on the inside of test tubes as a result of the sulfate test. Thoroughly clean and rinse test tubes after each test.

For the most accurate results, samples and reactions should be at 25±4°C.

# SULFIDE

## METHYLENE BLUE METHOD • CODE 3654-02-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 2 X 30 mL | *Sulfide Reagent A | *V-4458-G |
| 15 mL | *Sulfide Reagent B | *V-4459-E |
| 2 x 60 mL | Sulfide Reagent C | 4460-H |
| 2 | Pipets, 1.0 mL, plastic | 0354 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Sulfide occurs in many well water supplies and sometimes is formed in lakes or surface waters. In distribution systems, it may be formed as a result of bacterial action on organic matter under anaerobic conditions. It may also be found in waters receiving sewage or industrial wastes. Lake muds rich in sulfates produce hydrogen sulfide during periods of very low oxygen levels that result from stagnation. Concentrations of a few hundredths of a part per million (or milligram per liter) cause a noticeable odor. At low concentrations, this odor is described as “musty”; at high concentration, as “rotten eggs.” Removal of sulfide odor is accomplished by aeration or chlorination. Hydrogen sulfide, a toxic substance, acts as a respiratory depressant in both humans and fish.

| | |
|---|---|
| APPLICATION: | Drinking, surface, and saline waters; domestic and industrial wastes. |
| RANGE: | 0.00–1.00 ppm Sulfide |
| MDL: | 0.02 ppm |
| METHOD: | Under suitable conditions the sulfide ion reacts with p-aminodimethylaniline and ferric chloride to produce methylene blue in proportion to the sulfide concentration. Ammonium phosphate is added to remove the color due to the ferric iron. |
| SAMPLE HANDLING & PRESERVATION: | Samples must be taken with a minimum of aeration since sulfide is volatilized by aeration and any oxygen which is taken up will destroy sulfides by chemical action. Samples that are used for total sulfide concentrations may be preserved by adding 2M zinc acetate solution at a dosage of 2 mL per liter of sample. This precipitates sulfide as inert zinc sulfide. Determination of dissolved sulfides in samples not preserved with zinc acetate must be started within 3 minutes of sampling. |
| INTERFERENCES: | Strong reducing agents such as sulfite, thiosulfate, and hydrosulfite prevent the formation of the color or diminish its intensity. High concentrations of sulfide will inhibit the reaction, but dilution of the sample prior to analysis eliminates this problem. |

# PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **90 Sulfide-LR**) from **TESTING MENU**.
4. Scroll to and select **90 Sulfide-LR** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Remove tube from Spectro. Use the 1.0 mL pipet (0354) to add 1.0 mL of *Sulfide Reagent A (V-4458). Cap and mix.
8. Add 6 drops of Sulfide Reagent B (V-4459). Cap and mix. Wait 1 minute. Solution will turn blue if sulfides are present.
9. Use the 1.0 mL pipet (0354) to add 2.0 mL of Sulfide Reagent C (4460). Cap and mix. Color development is immediate and stable.
10. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
11. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

# SURFACTANTS

## ION PAIR EXTRACTION–BROMPHENOL BLUE INDICATOR METHOD • CODE 4876-01

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 50 g | pH Adjustment Powder | 4509- H |
| 10 g | Sodium Chloride Reagent | 4877-D |
| 2 X 60 mL | *DS Indicator Reagent | *4508-H |
| 1 | Spoon, 0.5 g, plastic | 0698 |
| 1 | Spoon, 0.1 g, plastic | 0699 |
| 1 | Pipet, 1.0 mL, plastic | 0354 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Aqueous waste from households and industrial laundering operations is the main source of surfactants in waters. Surfactants are found in low concentrations in natural water except in areas of an outfall or other point source.

| | |
|---|---|
| APPLICATION: | Surface water, wastewater. |
| RANGE: | 0.00–8.0 ppm as Linear Alkyl Sulfonates (LAS). |
| MDL: | 1.0 ppm |
| METHOD: | The presence of LAS in the water sample causes the transfer of bromphenol blue dye from the organic reagent layer to the aqueous layer. The amount of color in the aqueous layer is proportional to the concentration of the LAS in the sample. LAS are Methylene Blue Active Substances (MBAS). This calibration is based on sodium lauryl sulfate (dodecyl sodium sulfate). Some linear alkyl sulfonates may have a slightly different response. Prepare standards of a known concentration and follow the test procedure below to determine a conversion factor. |
| SAMPLE HANDLING & PRESERVATION: | Analyze samples as soon as possible. May be stored at 4°C for 24 hours. Warm to room temperature before testing. |
| INTERFERENCES: | Cationic and non-ionic surfactants. |

# PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **94 Surfactants**) from **TESTING MENU**.
4. Scroll to and select **94 Surfactants** from menu.
5. Rinse a tube (0290) with sample water. Fill to 10 mL line with sample.
6. Insert the tube into chamber, close lid and select **SCAN BLANK**.
7. Remove the tube from Spectro.
8. Use the 0.5 g spoon (0698) to add 0.5 g pH Adjustment Powder (4509). Cap and mix until powder dissolves.
9. Use the 0.1 g spoon (0699) to add two measures of Sodium Chloride Reagent (4877). Cap and mix until powder disintegrates.
10. Use the 1.0 pipet (0354) to add 2.0 mL of *DS Indicator (4508).
11. Cap and shake for 1 minute.
    NOTE: Bubbles on the sides of the tube will interfere with the results. Swirl the tube to remove bubbles if they are present.
12. Wait 5 minutes. DO NOT MIX.
13. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result in ppm LAS.
14. Press **OFF** button to turn the spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTE: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

# TANNIN

## TUNGSTO-MOLYBDOPHOSPHORIC ACID METHOD
## CODE 3666-01-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 30 mL | *Tannin Reagent #1 | *7833-G |
| 2 x 60 mL | *Tannin Reagent #2 | *7834-H |
| | Pipet, plain, plastic | 0352 |
| | Pipet, 1.0 mL, plastic | 0354 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Tannin and lignin are examples of hydroxylated aromatic compounds found in discharge wastewater from paper mills, in some boiler water treatment, in natural brackish water, and in wastewater from leather tanning plants. The taste and odor of these compounds is generally offensive so that their control is important in many areas.

| | |
|---|---|
| APPLICATION: | Industrial wastewaters; boiler and cooling waters; natural waters. |
| RANGE: | 0.00–10.00 ppm Tannic Acid |
| MDL: | 0.2 ppm |
| METHOD: | The hydroxylated aromatic compounds will reduce a mixture of tungstophosphoric and molybdophosphoric acids to form a blue color in proportion to the concentration of aromatic hydroxyl groups. |
| SAMPLE HANDLING & PRESERVATION: | Sample should be analyzed as soon as possible after collection. |
| INTERFERENCES: | Other reducing compounds such as ferrous iron and sulfites. Results may be expressed as tannin like compounds, or aromatic hydroxy compounds. |

# PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **96 TANNIN**) from **TESTING MENU**.
4. Scroll to and select **96 TANNIN** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Remove tube from Spectro. Use the plain pipet (0352) to add 4 drops of *Tannin Reagent #1 (7833). Cap and mix.
8. Use the 1.0 mL pipet (0354) to add 2.0 mL of *Tannin Reagent #2 (7834). Cap and mix. Wait 30 minutes for full color development.
9. At end of 30 minute waiting period, mix, insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
10. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTES: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to determine the reagent blank only when a new lot number of reagents is obtained.

For the most accurate results, the sample and reagents should be at 20±2°C.

# TURBIDITY

## ABSORPTION METHOD • NO REAGENTS REQUIRED

Turbidity is a measure of water clarity and is independent of color. Turbidity is caused by undissolved and suspended solids. Mud, silt, algae, and microorganisms can all cause turbidity. Turbidity is a gross measurement of water quality.

| | |
|---|---|
| APPLICATION: | Surface and industrial waters for non-compliance monitoring. (For compliance monitoring at low turbidity levels, use a commercial .) |
| RANGE: | 0–400 FTU |
| MDL: | 2 FTU |
| METHOD: | Absorptimetric |
| SAMPLE HANDLING & PRESERVATION: | Measure sample as soon as possible after collection. |
| INTERFERENCES: | Check for stray light interference |

## PROCEDURE

Use universal sample holder.

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **98 Turbidity**) from **TESTING MENU**.
4. Scroll to and select **98 Turbidity** from menu.
5. Rinse a clean tube (0290) with deionized water (turbidity free). Fill to the 10 mL line with deionized water.
6. Insert tube into chamber, close lid and select **SCAN BLANK**.
7. Rinse a second clean tube (0290) with sample water. Fill to the 10 mL line with sample. Cap tube. Wipe off excess water and fingerprints. Shake to resuspend particulate matter. Remove all bubbles before measurement.
8. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result. Turbidity measurements should be taken as soon as possible after sample has been collected.
9. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTE: For the most accurate results, the sample should be at 25±4°C.

## FORMAZIN STOCK SOLUTION

The turbidity calibration curve for this instrument was prepared by using formazin solutions as a reference. A 4000 FTU standard solution is available (Order Code 6195-H, 60 mL) that can be diluted with low turbidity water to prepare solutions within the test range.Dilutions from this stock solution should be prepared fresh daily with low turbidity water.

Alternatively, a stock turbidity solution of 400 NTU can be prepared by observing safety precautions and carefully following the procedure below.

Preparation of Formazin Stock Solution

1. Dissolve 1.000 g of Hydrazine Sulfate in deionized water and dilute to the mark in a 100 mL volumetric flask.
2. Dissolve 10.00 g of hexamethylenetetramine in deionized water and dilute to the mark in a 100 mL volumetric flask.
3. Mix 5 mL of each solution in a 100 mL volumetric flask and allow to sit undisturbed for 24 hours at 25 +/- 3 °C.
4. At the end of the waiting period, dilute to the mark with deionized water and mix. Store in amber glass.
5. The concentration of this stock solution is 400 FTU. This stock solution is stable for one month. Dilutions from this stock solution should be prepared fresh daily with low turbidity water.

# ZINC

## ZINCON METHOD • CODE 3667-SC

| QUANTITY | CONTENTS | CODE |
|---|---|---|
| 30 mL | *Zinc Indicator Solution | *6314-G |
| 120 mL | *Methyl Alcohol | *6319-J |
| 10 g | Sodium Ascorbate Powder | 6316-D |
| 25 g | *Zinc Buffer Powder | *6315-G |
| 15 mL | *Sodium Cyanide, 10% | *6565-E |
| 30 mL | *Formaldehyde Solution, 37% | *5128-G |
| 1 | "Dilute Zinc Indicator Solution" Bottle, with 1 mL pipet assembly | 0128-MT |
| 1 | Graduated Cylinder, 10 mL, glass | 0416 |
| 1 | Spoon, 0.5 g, plastic | 0698 |
| 2 | Pipets, plain, plastic | 0352 |
| 1 | Spoon, 0.1 g, plastic | 0699 |

***WARNING:** Reagents marked with an * are considered to be potential health hazards. To view or print a Material Safety Data Sheet (MSDS) for these reagents go to www.lamotte.com. To obtain a printed copy, contact LaMotte by e-mail, phone or fax.

Zinc enters the domestic water supply from the deterioration of galvanized iron and brass pipes, and from industrial wastes. Zinc is an essential element for body growth and development and is an important plant nutrient. Concentrations of zinc above 5.0 mg/L in drinking water can cause a bitter astringent taste. In the U.S., zinc concentrations may vary between 0.06 to 7.0 mg/L, with an average value of 1.33 mg/L.

APPLICATION: Drinking and surface waters; domestic and industrial wastewaters.

RANGE: 0.00–3.00 ppm Zinc

MDL: 0.025 ppm

METHOD: Zinc forms a blue colored complex with Zincon in a solution buffered at pH 9.0. Other heavy metals are complexed by cyanide and the zinc cyanide complex is released by the addition of formaldehyde before the other metal cyanide complexes are destroyed. Sodium ascorbate is added to reduce the interference of manganese.

SAMPLE HANDLING & PRESERVATION: Sample should be analyzed within 6 hours after collection. The addition of hydrochloric acid will help preserve the metal ion content, however the acid should be neutralized before analysis.

INTERFERENCES: The following ions interfere in concentrations greater than those listed.

| ION | MG/L | ION | MG/L |
|---|---|---|---|
| Cd(II) | 1 | Cr(III) | 10 |
| Al (III) | 5 | Ni(II) | 20 |
| Mn (II) | 5 | Co (II) | 30 |
| Fe (III) | 7 | $CrO_4$(II) | 50 |
| Fe (II) | 9 | | |

# PROCEDURE

Use universal sample holder.

## A. PREPARATION OF DILUTE ZINC INDICATOR SOLUTION

1. Use a pipet (0352) to measure exactly 5.0 mL of *Zinc Indicator Solution (6314) into 10 mL graduated cylinder (0416). The bottom of the curved surface (the meniscus) of liquid should be at 5.0 mL mark. Pour this into the bottle labeled "Dilute Zinc Indicator Solution".
2. Use unrinsed graduated cylinder to add 10.0 mL and then 7.8 mL (total of 17.8 mL) of *Methyl Alcohol (6319) to bottle labeled "Dilute Zinc Indicator Solution". Cap and mix ingredients in this bottle. Do not leave this bottle uncapped.

## B. DETERMINATION OF ZINC

1. Press and hold **ON** button until spectrophotometer turns on.
2. Scroll to and select **PROGRAMMED TESTS**.
3. Scroll to and select **ALL TESTS** (or another sequence containing **99 Zinc-LR**) from **TESTING MENU**.
4. Scroll to and select **99 Zinc-LR** from menu.
5. Rinse a clean tube (0290) with sample water. Fill to the 10 mL line with sample.
6. Insert tube into chamber, close lid and select **SCAN BLANK**. (See Note)
7. Remove tube from Spectro. Use 0.1 g spoon (0699) to add one measure of Sodium Ascorbate Powder (6316). Use 0.5 g spoon (0698) to add one measure of *Zinc Buffer Powder (6315). Cap and shake vigorously for 1 minute. Some undissolved buffer may remain in the bottom of the tube.
8. Add 3 drops of *Sodium Cyanide, 10% (6565). Cap and mix.
9. Use the 1 mL pipet assembly to add 1 mL of "Dilute Zinc Indicator Solution". Cap and mix.
10. Use a second plain pipet (0352) to add 4 drops of *Formaldehyde Solution, 37% (5128). Cap and mix by inverting 15 times.
11. Insert tube into chamber, close lid and select **SCAN SAMPLE**. Record result.
12. Press **OFF** button to turn spectrophotometer off or press **EXIT** button to exit to a previous menu or make another menu selection.

NOTE: For best possible results, a reagent blank should be determined to account for any contribution to the test result by the reagent system. To determine the reagent blank, follow the above test procedure to scan a distilled or deionized water blank. Then follow the above procedure to perform the test on a distilled or deionized water sample. This test result is the reagent blank. Subtract the reagent blank from all subsequent test results of unknown samples. It is necessary to

determine the reagent blank only when a new lot number of reagents is obtained.

# APPENDIX

Ammonia in water occurs in two forms: toxic unionized ammonia ($NH_3$) and the relatively non-toxic ionized form, ammonium ion ($NH^{4+}$). This test method measures both forms as ammonia-nitrogen ($NH_3$–N) to give the total ammonia-nitrogen concentration in water. The actual proportion of each compound depends on temperature, salinity, and pH. A greater concentration of unionized ammonia is present when the pH value and salinity increase.

1. Consult the table below to find the percentage that corresponds to the temperature, pH, and salinity of the sample.
2. To express the test result as ppm Unionized Ammonia-Nitrogen ($NH_3$–N), multiply the total ammonia-nitrogen test result by the percentage from the table.
3. To express the test result as Ionized Ammonia-Nitrogen ($NH^{4+}$–N), subtract the unionized ammonia-nitrogen determined in Step 2 from the total ammonia-nitrogen.

| | 10°C | | 15°C | | 20°C | | 25°C | |
|---|---|---|---|---|---|---|---|---|
| pH | FW1 | SW2 | FW | SW | FW | SW | FW | SW |
| 7.0 | 0.19 | ---- | 0.27 | ---- | 0.40 | ---- | 0.55 | ---- |
| 7.1 | 0.23 | ---- | 0.34 | ---- | 0.50 | ---- | 0.70 | ---- |
| 7.2 | 0.29 | ---- | 0.43 | ---- | 0.63 | ---- | 0.88 | ---- |
| 7.3 | 0.37 | ---- | 0.54 | ---- | 0.79 | ---- | 1.10 | ---- |
| 7.4 | 0.47 | ---- | 0.68 | ---- | 0.99 | ---- | 1.38 | ---- |
| 7.5 | 0.59 | 0.459 | 0.85 | 0.665 | 1.24 | 0.963 | 1.73 | 1.39 |
| 7.6 | 0.74 | 0.577 | 1.07 | 0.836 | 1.56 | 1.21 | 2.17 | 1.75 |
| 7.7 | 0.92 | 0.726 | 1.35 | 1.05 | 1.96 | 1.52 | 2.72 | 2.19 |
| 7.8 | 1.16 | 0.912 | 1.69 | 1.32 | 2.45 | 1.90 | 3.39 | 2.74 |
| 7.9 | 1.46 | 1.15 | 2.12 | 1.66 | 3.06 | 2.39 | 4.24 | 3.43 |
| 8.0 | 1.83 | 1.44 | 2.65 | 2.07 | 3.83 | 2.98 | 5.28 | 4.28 |
| 8.1 | 2.29 | 1.80 | 3.32 | 2.60 | 4.77 | 3.73 | 6.55 | 5.32 |
| 8.2 | 2.86 | 2.26 | 4.14 | 3.25 | 5.94 | 4.65 | 8.11 | 6.61 |
| 8.3 | 3.58 | 2.83 | 5.16 | 4.06 | 7.36 | 5.78 | 10.00 | 8.18 |
| 8.4 | 4.46 | 3.54 | 6.41 | 5.05 | 9.09 | 7.17 | 12.27 | 10.10 |
| 8.5 | 5.55 | 4.41 | 7.98 | 6.28 | 11.18 | 8.87 | 14.96 | 12.40 |

[1]Freshwater data from Trussel (1972).

[2]Seawater values from Bower and Bidwell (1978). Salinity for Seawater values = 34% at an ionic strength of 0.701m.

**FOR EXAMPLE:**

If a fresh water sample at 20°C has a pH of 8.5 and the test result is 1.0 ppm as Total Ammonia-Nitrogen:

1. The percentage from the table is 11.18% (or 0.1118).
2. 1 ppm Total Ammonia-Nitrogen x 0.1118 = 0.1118 ppm Unionized Ammonia-Nitrogen.
3. Total Ammonia-Nitrogen 1.0000 ppm

| | | |
|---|---|---|
| Unionized Ammonia-Nitrogen | – | 0.1118 ppm |
| Ionized Ammonia-Nitrogen | = | 0.8882 ppm |