



Water and Wastewater Test Methods

Introduction

A variety of test procedures and methods are available for use by water and wastewater operators. They range from colourimetric, titrimetric, electrometric (meter & probe), turbimetric, nephelometric, and demonstrative methods. Often, more than one of these methods can be utilized to measure a single unknown parameter. For example, chlorine residual can be measured colourimetrically, titrimetrically, or electrometrically. What is the best method for your application? First, let's define these methods, give examples of each, learn the limitations of each method, and then decide what method (test kit) (procedure) is best suited for your needs.

The key issue here is to decide upon the test procedure that best meets your requirements for:

- a) accuracy
- b) cost (initial & cost per test)
- c) skill level
- d) repeatability
- e) portability
- f) decision-making information obtained
- g) safety and reagent disposal
- h) are the results reportable?

Remember, the most complete, reliable, and accurate information obtained from your testing will provide you with the decision-making tools to monitor your water or wastewater systems, make operational changes and meet permit requirements and state mandates.

Colourimetric Methods

Defined as the measurement of a parameter where its concentration is directly proportional to colour development and intensity after the addition of known volume of reagent(s) (chemicals). In cases like chlorine residual, the reaction is almost immediate, and results can be determined right away. Other tests like nitrates and phosphates may require a 5 to 10 minute waiting period before full colour development is obtained due to the chemistry involved.

Some unique colourimetric tests react in reverse. That is - the greater the colour development, the lower the concentration of a particular parameter. Examples here are Fluoride and some Ozone test methods. To determine concentration, the colour developed in the sample is either compared visually with manufacturer supplied standards (colour comparator) or inserted into a photometer, colourimeter, or spectrophotometer to give results directly on a meter scale, or digitally via a discreet readout. Results obtained are expressed as parts per million (ppm), milligrams per liter (mg/L), grains per gallon (gpg), etc.



Visual Comparator Limitations

Individual differences in ones ability to discern colour intensity Background lighting. Most manufacturers formulate their colour standards using natural daylight. Incandescent, fluorescent and direct sunlight are unacceptable and may produce errors. Colour blindness is a definite problem with visual colour comparison methods. Certain colours are extremely difficult to discern variations. Example: yellows, and some hues of blue. Even with the limitations described above, visual colour comparison methods are inexpensive, generally easy to use, conveniently packaged and designed for simplicity. Some visual test results are reportable for permit purpose. Check with your local inspector. Calorimetric methods using a photometer, colourimeter, or spectrophotometer offer a unique advantage. Many meters are battery powered and conveniently packaged for portability. To briefly describe their operation, a light beam is passed through the sample. Depending upon the amount of colour present, light is transmitted through the sample and detected by a photodiode. With aid of electronics, the results are displayed on a meter, either directly in concentration or as a percentage of light transmitted.

Advantages of instrumentation are:

- eliminates need for visual interpretation by operator
- eliminates concern for background lighting
- ultimately greater accuracy

Of course, using a meter to "read" colour development can be more expensive initially. Colourimetric test methods offer an opportunity to provide on-the-spot results and have the capability to test for a variety of common parameters. Tests for Chlorine, Iron, Manganese, Copper, Zinc, Aluminum, Fluoride, Ozone, Nitrates, Phosphates, Sulfides, and many more are available. Weigh the advantages, disadvantages and overall requirements before you make your decision.

Titrimetric Methods

A sample is taken, and reagent(s) is added to produce a colour. In this case the reagent is known as an indicator reagent. A titrant or a reacting reagent is added drop by drop until a colour change occurs. The point at which the colour changes is called the endpoint.

Titrimetric methods offer a number of titrant dispensing apparatuses:

- **Drop count**, where a calibrated dropper dispenses drops of equal size. Once the endpoint is reached, the number of drops required to reach the endpoint is counted and multiplied by a conversion factor. Example, one drop equals 5 ppm.
- **Laboratory burets, Automatic burets** - which are generally not portable. This dispensing apparatus has a calibrated scale on the barrel. Titrant is dispensed until the endpoint is reached. Volume used is then read from the calibrated scale. In many cases the number of milliliters used equals the test result in ppm. Direct Reading Microburet, a syringe size calibrated microburet which dispenses the titrant until endpoint is reached. Results are usually read directly off the calibrated scale in ppm. This procedure is totally portable like drop count methods.



- **Digital Titrators**, where titrant from a cartridge is inserted into a micro dispensing device. The amount dispensed is read on a digital vernier, usually in ppm. Titration methods are generally quite inexpensive, and are the preferred method in many procedures. Typical tests for Acidity, Alkalinity, Carbon Dioxide, Hardness, Dissolved Oxygen, and Chlorine are among the most common. Here too, convenient packaging and simplicity is the key to their portability and accuracy. This method is preferred in determining corrosion in water supplies, and offers the operator an easy, inexpensive approach in meeting lead/copper requirements.

Turbidimetric Methods

Some unique test procedures do not use colour as a way to determining results. A sample is taken and a reagent is added which produces turbidity or cloudiness in the sample. The greater the turbidity, the greater the concentration. Turbidimetric, like colourimetric methods, can be "read" using a visual comparator, or by the use of a colourimeter (meter). Results here are expressed in ppms or mg/L. Typical tests using this method are Potassium and Sulfates. Again, this method can portable and conveniently packaged as a kit.

Electrometric Methods

One of the most commonly used, an electrode, is inserted into a sample. A small current or voltage is produced and electronically amplified and read on a meter scale. Typical tests here are pH and conductivity, but a variety of parameters using ion specific electrodes (ISE) can be measured including Calcium, Nitrates, Chlorine, etc.

Nearly every electrometric procedure requires meter calibration and/or sample pretreatment. Examples here are the 4, 7 & 10 pH buffers used to calibrate pH meters. Generally, electrometric methods are more costly initially and require a higher degree of care and maintenance due to the electrode systems.

Today, inexpensive pocket pH, conductivity, and ORP meters are on the market. Even though designed to be disposable after a period of time, great care must be exercised in their use and maintenance. These pocket meters rival the costs of colourimetric or titrimetric methods. They generally are not acceptable for reporting purposes, but are ideal for quick system checks.

Nephelometric Methods

This method is specific to water turbidity. Suspended matter within the sample is measured via a specially designed meter which sends a focused light beam through the water sample. Suspended solids, dirt, and silt scatter the light. The scatter is measured by a photodiode at a 90° angle incident to the light source. Results here are expressed as Nephelometric Turbidity units (NTU's), and are more qualitative than quantitative. Portable, battery powered units are available for field use. Private and municipal water treatment systems using surface water supplies such as lakes, streams, etc. are required to measure turbidity routinely as a guide to monitoring various water treatment systems like settling



basins, and sand filter performance. Continuous monitoring turbidity meters and recorders are becoming the rule rather than the exception.

Gravimetric Test Methods

These are essentially physical test procedures. They include settleable solids, settle ability tests primarily used as operational guideposts in both water and waste facilities. A sample is taken (usually one liter), mixed and allowed to settle. Imhoff cones and settlometers are common containers here. The samples are timed at various intervals to determine ratio of solids and volume of solids serried. Results can be transferable to plant operations to determine proper flocculant dose, expected sludge volumes, adjust waste and return sludge in wastewater facilities. These are relatively simple test methods that require no chemical or reagent to perform (except when determining flocculant dosage), and provide valuable current data to a water or wastewater operator.

Sampling Technique

All test methods described above require a proper sample. Accurate sample volumes required by the test are important.

Here are some important points to remember:

- Choose the proper point in the water system for your sample. Let the spigot run a short period of time to obtain a representative sample. (Note if this is a first draw sample. For lead or copper disregard this step.) Pour the correct volume of sample into the test tube or jar. Accurate results require accurate sample volumes.
- Once test is complete dispose of waste reagent/sample properly, and clean all test tube thoroughly.
- Follow the test kit manufacturers' directions specifically. Do not alter the procedure to suit your needs or to take shortcuts risking skewed results.
- Do not intermix different manufacturers' reagents, particularly colourimetric ones, unless they are the exact concentration.

Summary

Briefly, we have looked at six water test methods for use by the water and wastewater operator. So what's right for you?

- A careful review of tests is needed.
- Choose the test method that suits your testing skill level.
- What accuracy do you need? Know the test's limitations.
- Review test kit (method) cost versus expected results. - Look to the marketplace for manufacturers of test equipment and kits. Review their products.
- Safety and reagent disposal requirements. - Are the results reportable, does the procedure follow standard methods or EPA manual? Provincial or Federal approved?

Safety & Environmental Factors



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Many test kits and instruments contain hazardous reagents. Read all safety related instructions. Thoroughly review test procedures before running the test. Use manufacturer supplied Material Safety Data Sheets (MSDS) to learn about specific hazards and waste reagent disposal. Know shelf-life of specific reagents and replace when required.

Some heavy metal test kit reagents have been banned for water testing in the home. Tests for Lead, Cadmium, Mercury, etc. may contain extremely hazardous materials like Carbon Tetrachloride and Sodium Cyanide. Leave those tests for the outside certified laboratory to perform. Nearly all test methods defined and described here are common inorganic tests. Tests for pesticides, aromatic hydrocarbons (gasoline's), PCB's and the like should also be left to a qualified certified laboratory with the proper equipment.

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