FOCUS ON

By Jeff Roseman, CWS-1, Aqua Ion Plus+ Technologies

Back to the Basics

Brushing Up on Water Chemistry 101

This article is part one of a three-part series addressing water chemistry basics.

Basic water chemistry, terminology and applications can be very complicated and not seem so basic to individuals without a chemistry background. This series of articles will help shed light on the chemistry of water and the mysteries that it can contain, plus explain the technologies used to treat water so the purchaser can make an educated attempt to find the right solution for a particular application. There are no cut-and-dry formulas for water treatment and certainly no cure-all for every application or problem, but with an understanding of how water works and the technologies developed to treat water, a person can utilize his resources to come up with solutions for his particular need or application.

Water need not be obfuscated by the complexity that many treatment professionals portray about the technologies. However, the general public should not try and treat water with over-the-counter remedies, since many times without proper knowledge, education or experience these remedies will not work to their satisfaction and not achieve the desired result. The store shelves are full of water treatment products, but unless the raw water and application are understood, the problems will not be solved.

Water is a universal solvent and will dissolve everything it touches to some degree, taking with it impurities, organics and man-made chemicals. Everyone has a different use or expectation of water, whether it is a health official, industrial firm, hospital, farmer, homeowner or scientist. Each user has special requirements in terms of water quality and when these requirements are not met, trouble begins. To provide the right water for any demand depends on several factors, the analysis of the raw water, the employment of the end use and the nature and amounts of these impurities as well as the tolerances permissible. Water quality may prove unacceptable or unsatisfactory for certain requirements but may be quite favorable for other instances. To treat water economically, the raw water and end use always must be determined.

Webster defines this fascinating substance we call water, as "a liquid, which descends from clouds in rain that creates rivers, lakes, seas, etc. Pure ordinary water is (H_2O) consisting of hydrogen (11.1888 percent) by weight and oxygen (88.812 percent). It is very slightly compressible. Its maximum density at 39.2º F or 4º C is the standard for the specific gravities of solids or liquids, and its specific heat is the basis for the calorie and British thermal unit (BTU) of heat. It freezes at 32º F or 0º C."

The term pure water is ambiguous and has different connotations to individuals in various fields. A bacteriologist, for example, is apt to regard "pure water" as a sterile liquid with no living bacteria in it. A chemist would classify water as "pure" when it possesses no minerals, gaseous or organic impurities. Obviously, "pure water," as described here is likely to be found only in laboratories and even then only under ideal conditions.

The U.S. Environmental Protection Agency (EPA) provides practical standards for water of its suitability for drinking or potability in the Primary Drinking Water Regulations and for aesthetic considerations in the Secondary Drinking Water Regulations. These regulations take into consideration adequate protection of water against the effects of contamination through natural processes and through artificial treatment. The list of standards set requirements for bacterial count, plus physical and chemical characteristics. It is almost impossible to find a source of water that will meet the basic requirements for a public water supply without requiring some form of treatment. The general requirements are that it shall not contain any disease-producing organisms, be colorless and clear, good tasting and free from odors and preferably cool, be non-corrosive, free from objectionable gases or minerals which cause staining, and that it be plentiful and low in cost. Potable, or safe water is not necessarily usable or useful for many purposes and may require treatment of another sort to render it useful to home, industry or a scientist.

Water supplies vary from area to area and each are generally altered from a geographical standpoint and environmental aspects that cause these variations. The hydrological cycle causes this phenomenon as a complete sky to earth circuit is pursued by water in nature. As the largest water purification system known to man, the water cycle (See Water Definitions: hydrologic cycle) cleanses the air and picks up impurities from the Earth's crust. This vapor provides protection against extremes of heat and cold and the cleansing effects leaves water with undesirable minerals and man-made contaminants that cause problems, thus requiring treatment.

As the water falls through the air, a weak acid is formed that reacts with vegetation,

Water Definitions

- **Bacteria**—Microscopic single-cell plants that reproduce by fission or by spores; many types that may or may not be harmful to humans. Identified by their shapes: coccus spherical, bacillus rod-shaped and spirillum curve.
- **British Thermal Unit (BTU)**—The amount of heat required to raise the temperature of one pound of water one degree Fahrenheit.
- **Density**—Water is most dense at 39° F and expands, becoming less dense at both higher and lower temperatures.
- **Electron**—A negatively charged particle that revolves around the nucleus of an atom.
- **Hydrologic Cycle**—The complete circuit pursued by water in nature including precipitation as rain, hail, sleet, snow or dew. Its subsequent journey over, on and through the Earth's surfaces and its eventual evaporation and return to the atmosphere.
- **Municipal Water**—General term used to refer to source of water in urban and suburban areas that has been treated at a central plant to be of potable quality and distributed to homes and businesses via water mains.
- **Neutron**—A fundamental particle in the nucleus of an atom that has no charge and a mass equal to the proton.
- **Potable Water**—Water that does not contain objectionable pollutants, contamination, minerals or metals and is free of waterborne diseases.
- **Process Water**—Water used directly or indirectly in the manufacturing process of given products such as food processing or in cooling/boiler process waters.
- **Product Water**—Water that exits any treatment step or a series of processing steps and meets the quality standards for a given purpose (i.e., deionized, distillate, finished and softened).
- **Proton**—A positively charged particle that resides within the nucleus of an atom.
- **Protozoan**—Large, microscopic, single-cell organisms, higher on the food chain than the bacteria they consume such as *Cryptosporidium* and *Giardia*.
- **Pure Water**—A relative term no longer used alone without more specific ionic or bacterial limitations on water quality such as called for in medicine, laboratory testing and electronics.
- **Raw Water**—Water from wells or surface sources having no previous treatment, entering any water processing system or device.
- **Recycled Water**—Water that has been used once for one purpose and then is reprocessed by a water or wastewater treatment system and that water used for a secondary purpose.
- **Tap Water**—From well or plant, most often originating from rivers and lakes.

continued on page 24

Source: McGowan, Wes. All About Water: An Illustrated Dictionary of Water Terminology, *Scranton Gillette Communications, 2000. Available at www.waterinfocenter.com.*

LearnMore!
For more information related to this article, go to www.waterinfocenter.com/lm.cfm/wq050201

Water Definitions

- **Virus**—The smallest and simplest form of microbial life capable of producing disease or infection composed almost entirely of protein and nucleic acids.
- **Water Conditioning**—Virtually any water processing device or combination of equipment designed for operation to enhance and improve water quality to meet specific standards or aesthetic values by the inhibition, neutralization, reduction or removal of objectionable, undesirable and hazardous substances from water.
- **Water Processing**—A general term meaning the use of any single device or multistage treatment steps employed to modify and enhance the aesthetic parameters, biological quality or to reduce and remove both suspended and dissolved solids to render a final product water to meet either general or specific water quality standards required by the end user. (Also see water treatment.)
- **Water Treatment**—A general term including any processing step (physical, biological or chemical means) to purify, modify, improve or enhance water to meet desired water quality needs or to meet set quality standards.
- **Well Water**—Water from a hole bored, drilled or otherwise constructed in the ground that taps the water of an aquifer.

Source: McGowan, Wes. All About Water: An Illustrated Dictionary of Water Terminology, *Scranton Gillette Communications, 2000. Available at www.waterinfocenter.com.*

limestone, granite and sand. Only 30 percent of the precipitation that falls to the ground finds its way into lakes, rivers and oceans or percolates into the ground. The other 70 percent is evaporated and returns to the atmosphere almost immediately to start over in the process of cleansing the earth. The geographical areas that this acid falls on creates various degrees of impurities and the atmospheric content the water fell through causes different complications for water treatment professionals.

Sources from which water is drawn provide other complications for treatment. Each water source, whether it is a lake, river, well or municipal system, has its own unique set of contaminants that must be dealt with. Couple these with applications of various natures such as home, industry, commercial and agricultural and the water treatment professional has his work cut out for him. In the ensuing articles of subsequent nature, such technologies as ozonation, ionization, filtration, aeration, distillation, ultraviolet light and reverse osmosis will be discussed and examples of each will be presented along with the outcomes of how they faired in the application they were used to treat. Contaminants such as hardness, iron, hydrogen sulfide and manganese, will be reviewed. So, come along for an educational journey above and below the earth's surface to find out more about water and how water treatment professionals deal with this life sustaining substance. WQP

Part 2 of this article will appear in the June issue and part 3 in the July issue.

About the Author
Jeff Roseman is a CWS-I with the Water Quality Association. He has a vast knowledge of chemistry and physics from studies in electrical engineering at Purdue University and helped develop a UV light air purifier and ionization controllers for Great Lakes Control Systems, in Leamington, Ontario, Canada. He is a master distributor of Ethylene Control, Inc., and also distributes Hanna Instrument, Pura and Hydrotechnology filtration systems, and Pro-Zone International ozone products. Roseman is the owner of Aqua Ion Plus+ Technologies and can be contacted at jeff@aquaionplus.com. Visit www.aquaionplus.com for more information.

For more information on this subject, write in 1011 on the reader service card.