Comprehending the technical terms for water treatment can be challenging to understand outside of the industry. A Chem-Aqua expert helps readers decipher the language.

By Jerry Angelilli

Familiarity breeds misunderstanding as well as contempt. Sometimes water treatment specialists can forget that not all our business contacts understand the technical terms that are common language in our industry. The language of microbiological control becomes like one spoken in a foreign country. It helps, therefore, to have some simple definitions to facilitate meaningful communication.

First, there are general terms that need to be defined. Other terms are used to further classify chemistry to more descriptive levels. Some terms deal with the types of organisms commonly found in cooling water systems. Two specific terms, biofilm and MIC, describe the effects of uncontrolled microbiological growth. The general categories of biofilm applications follow, such as sterilization, disinfection and sanitization. Last, some common terms used in the application of chemicals are provided.

A biocide is a chemical substance capable of killing living organisms, usually in a selective way. When these chemicals are applied in adequate concentration and with sufficient contact time, they become lethal to those life forms. If these chemicals are applied to simply maintain control of the population of organisms by interrupting reproduction and activity, they are called biostats. The difference is related to mode of attack on the organism, contact time and concentration of that particular chemical in the water system. The same type of logic applies to algaecide and algaestat chemistry. When used in the control mode, biostats and algaestats are kept in the system in a certain concentration to prevent excessive growth of colonies. Biocides and algaecides are applied usually in shock concentrations of a lethal quantity over a set contact time period to kill existing colonies.

Oxidizing biocides are chemicals that react with other materials by oxidation. In the chemical process of oxidation, active agents physically destroy cell structures of living organisms. Chemical compounds that fall into this category are:

1. Halogen compounds of chlorine, bromine or iodine
2. Hydrogen peroxide
3. Chlorine dioxide
4. Peracetic acid
5. Potassium monopersulfate
6. Ozone

Non-oxidizing biocides are poisons rather than reactive chemicals. The method of kill is usually through cell assimilation. Some of these chemicals are surface active agents that disturb the permeability of cell membranes. Others are energy poisons that disrupt energy production or transfer within the organism once ingested. Some common non-oxidizing biocides are:

1. Isothiazolin or “Iso”
2. Glutaraldehyde or “Glut”
3. Methylene bis (thiocyanate) or MBT
4. Dodecyl guanidine hydrochloride or DGH
5. Quaternary ammonia compounds or “Quats,” such as Lysol or “alkyl-dimethylbenzylammonium chloride” (ADBAC)
6. 2,2-Dibromo-3-Nitrilopropionamide or DBNPA
7. Terbuthylazine
8. Tetra-kis-hydroxymethyl phosphonium (chloride or sulfate) also known as “TetraKis” (TKHP)
9. Carbamate

When referring to microorganisms in cooling water systems, we classify them using some very general descriptions and we quantify them in cfu/ml or colony forming units per milliliter. In microbiology, colony-forming unit (CFU or cfu) is a measure of viable bacterial or fungal numbers. Unlike direct microscopic counts, where all cells (dead and living) are counted, CFU measures viable cells. For convenience the results are given as CFU/mL (colony-forming units per milliliter) for liquids and CFU/g (colony-forming units per gram) for solids.

Microorganisms in the animal kingdom are referred to as one celled bacteria. Bacteria can be mobile in the water or free swimming. We use the term planktonic to describe this population. Those that are part of a stationary colony, usually beneath a biofilm formation, are called sessile. In cooling water, organisms of concern from the plant kingdom are algae, fungi and molds.

Specific terms referring to microorganisms common to cooling water are:

Total Heterotrophic Plate Count (THPC) test—refers to total heterotrophic bacteria present in the water, defined as: “Heterotrophic
bacteria—Heterotrophic cells must ingest biomass to obtain their energy and nutrition. In direct contrast, autotrophs are capable of assimilating diffuse, inorganic energy and materials, and using these to synthesize biochemicals.1

Aerobic bacteria—those species that are dependent upon oxygen in the water to sustain life. Anaerobic bacteria—those species which proliferate in a water environment lacking oxygen. These typically form under deposits of scale, debris and/or biofilm.

Iron related bacteria (IRB)—those bacterial species that utilize iron and manganese. Sulfate reducing bacteria (SRB)—those anaerobic species that reduce sulfate and sulfide to sulfide.

Nitriﬁying / denitriﬁying bacteria—a group of species that reduce nitrates or nitrites to nitrogen containing gases.

Two general terms describe the cooling system environment and effects:

Biofilm, mentioned previously regarding sessile colonies, is composed of polyaccharide mucous like secretions that form a protective slime to keep biocidal agents and other harmful elements from contacting the organisms.

The term used to deﬁne the corrosion of system metal surfaces due to the activity of microorganisms in a cooling water system is MIC. This acronym is short for Microbiologically-Induced Corrosion or Microbiially-Induced Corrosion.

In the Health Care Industry, the terms sanitization, disinfection, and sterilization are deﬁned as:

Sanitization is suitable for easily killed microorganisms and can reduce the number of microbial contaminants on an inanimate surface to a relatively safe level. … Disinfection provides a higher level of safety and can be used on work surfaces, medical devices and equipment that have come in contact with highly contaminated substances, body ﬂuids and blood. … Sterilization is the highest standard which means it ‘is a process capable of destroying all forms of microbial life on inanimate surfaces and is employed when the highest level of assurance that an item will be safe to handle is desired.’” 2

We can use these same terms in a relative fashion to the cooling water system as three distinct levels of decontamination with increasing levels of magnitude for effectiveness in eradicating harmful microorganisms:

Sanitization—chemical and physical cleaning followed by washing and rinsing, using moderate methods for killing microorganisms.

Disinfection is second involving application of disinfection chemicals in the low-level, intermediate level or high-level strategies.

Sterilization is the highest standard of chemical biocide or physical destruction technique applications to a system.

Feed methods of biocides are also described using speciﬁc terminology. Continuous feed of solid tablets or liquid is the term used to describe an ongoing application of material so there is a speciﬁc concentration in the system at all times. Shock or shot feed of a granular or liquid product are the terms associated with a batch feed of a biocide. This method allows a slow reduction of level over a pre-calculated time period so the concentration does not drop below a minimum effective level in the system before the next feed time. Both of these feed methods can be automated.

The last set of terms deals with basic calculations needed to treat a cooling system with biocides. System volume refers to the total volumetric liquid capacity of the system. It includes sumps, equipment volume and all piping associated with the system. One method of measurement involves adding a known quantity of a testable chemical, then calculating the volume using the rise in residual concentration relative to the active ingredient strength. Concentration refers to the amount of a chemical substance in the water. The terms used for this purpose are mg/L or ppm. The term mg/L is milligrams of pure chemical per liter (1,000,000 mg) of water. As stated, ppm or parts per million is the same, when referring to fresh water systems. Retention time and half life are terms used to describe the time it takes for an addition of biocide to fall to half of its original concentration in the system, either through chemical degradation, bleed off or other water loss.

With a common working vocabulary regarding microbiological control in water treatment, we can engage in meaningful dialogue without a communication gap. Understanding the language is always the first step in proper problem solving. Everyone working together on a problem must have the same basic knowledge of terms used in describing the conditions and the appropriate corrective tools. We will then be in a better position to achieve our common goal of maintaining clean cooling water systems that are free from uncontrolled microbiological growth.

Jerry Angelilli, manager of Oxidative Technology for Chem-Aqua, has 32 years of experience in industrial, commercial and institutional water treatment. After starting his career in sales, he has dedicated 14 years of his tenure in the industry to application engineering, technical assistance to field personnel and product management.

Bibliography: