

Glossary of Useful Microbiological Terms for the Metalworking Industry

Aerobe: A microorganism that can only grow when adequate oxygen is present. Oxygen serves as the terminal electron acceptor

Anaerobe: A microorganism that can only grow in the absence of oxygen. Nitrate, sulfate or organic compounds serve as terminal electron acceptors in different species.

Bacterium: A single-cell organism. Bacteria are the smallest living units capable of carrying out, independently, all of the basic functions that characterize living beings (respiration, growth, assimilation, metabolism, excretion and reproduction). Bacteria may be as small as 0.1 μm (4×10^{-6} in.) in diameter and may appear as spheres, rods, commas or spirals under a microscope. As a kingdom, the bacteria represent a vast diversity of nutritional and survival capabilities.

Biocide: A chemical that kills living organisms.

Biofilm: Complex layer comprised of microorganisms and their secretions as well as detritus trapped within the biofilm matrix. Biofilm thickness may range from a few microns to several centimeters. Physical and chemical conditions within biofilms are controlled by the microorganisms growing there, and may be very different from conditions in the bulk fluid. Many species of microorganisms form the biofilm community.

Biomass: The total amount of living organisms in a given volume of material. Difficult to measure directly, biomass is generally extrapolated from the measurement of a chemical component of the living cells within the mass. Optimally, the average concentration (per cell) of the chemical being measured is

either known or a standard conversion factor has been established.

Biostat: A chemical substance that prevents the growth or proliferation of living organisms, but does not necessarily prevent metabolism.

Colony: The mass formed on the surface or within the matrix of microbial growth media as a result of the reproduction of ostensibly one cell. A bacterium with a generation time of 1 hour (population doubles each hour), will form a colony containing over 2 billion cells in about 30 hours. The colony, visible to the naked eye, is easier to count than individual microbes. Problems arise because not all microorganisms grow on the same nutrients or under the same conditions. Bacteria and fungi grow in a coolant often fail to form colonies on solid growth media.

Corrosion-enhancing microbial activities: Some bacteria, like the sulfate-reducing bacteria, contain the enzyme "hydrogenase," which scavenges hydrogen ions and creates a galvanic cell. Many microbes manufacture organic acids which attack metal surfaces directly. The very presence of nonuniform biofilms causes electropotential gradients to develop. All of these activities tend to accelerate corrosion rates.

Detritus: Unwanted particles floating on the surface, suspended in the bulk mass or precipitated out to the bottom of metalworking fluid. Swarf, flocs of biomass, detached rust deposit fragments all make up typical detritus in coolant systems.

Dip stick/dip slide: One of a number of paddle-like devices either coated or saturated with a growth medium. They are dipped into the coolant to be tested, incubated for 1-2 days and observed for the development of colonies. They provide a simple means of getting very approximate plate count data.

Disinfect: To destroy or inactivate harmful bacteria. *Not* equivalent to sterilization.

Electron-acceptor molecule: A molecule like oxygen that captures electrons and becomes reduced to water. All cells derive their energy from a sequence of reactions involving the transfer of electrons along a “cascade” of molecules. The last molecule in this sequence is the *terminal electron acceptor*. For aerobic organisms, oxygen is the terminal electron acceptor. Sulfate serves this function for sulfate-reducing bacteria.

Enzyme: A molecule or cluster of molecules composed of long chains of amino acids. The enzymes are the cell’s metabolic factories. They act as catalysts for the metabolic reactions of all biochemical pathways. Active enzymes can cause fluids to become rancid even though the cells may be judged “dead” by some other criterion, such as plate counts.

Essential elements: Carbon, hydrogen, oxygen, phosphorus and sulfur are the elements without which life, as we know it cannot exist. All of these elements are present in abundance in metalworking fluids.

Facultative anaerobe: A bacterium that lives like an aerobe when oxygen is present, and like an anaerobe when oxygen is absent. Facultative anaerobes play a key role in creating and maintaining environments in which anaerobes can grow.

Fungicide: A chemical that preferentially or selectively kills fungi.

Fungus: The simplest microorganisms having a true cell wall. They appear as single-cell yeasts (approximately 10,000 times the volume of most bacteria) or as filamentous “molds.” These filaments are long strands (hyphae) of cells which form the fibrous network of growth one sees when looking at moldy food. The colored bodies found in a filamentous mat contain spores. One of these bodies may contain several hundred spores, each of which can give rise to a fungal colony.

Growth: Growth is the measurable increase of an individual’s or population’s biomass. See definition of

“biomass.”

Growth rate: The amount by which the biomass increases per unit period of time (usually hours). Often growth rate is reported as the amount of time it takes for the population to double, assuming that biomass per organism is constant.

Inhibition: The prevention of any particular activity. Corrosion inhibition, microbial growth inhibition and foam inhibition are examples of inhibiting functions required of metalworking fluids. Inhibition is rarely absolute, so cost-benefit ratios should be computed to determine the merits of various inhibitor products.

Metabolism: The enzymatic reactions by which cells break down food sources (anabolism) and create new cell material (catabolism), giving off heat and waste “metabolites” in the process.

Microbially-mediated process: Processes such as corrosion and pH drop which are the direct or indirect result of microbial activity. For example, bacteria secrete organic acids which react with pH buffers, leading to a loss of pH control. The consequent drop in pH is microbially-mediated.

Microbicide: (Often written “microbiocide”) is an agent which is designed to kill microorganisms, ie., both bacteria and fungi.

Mold: See “Fungus.”

Nutrient: Any substance that an organism needs in order to grow and proliferate. In order for a chemical to function as a nutrient, the organism must be able to assimilate it (bring it into contact with the appropriate enzymatic machinery). Nutrients are “essential” if an organism cannot survive without them. “Non-essential” nutrients are important for healthy growth, but not for survival.

Pasteurize: To heat-treat a fluid (usually with

steam) in order to kill-off potentially pathogenic microorganisms. Pasteurization requires exposure to 61-63 C (142-145 F) for 30 minutes. *Note: many nonpathogenic microorganisms generally survive pasteurization.*

Plate counts: A standard method for enumerating bacteria and fungi. A small sample portion is spread onto the surface of a suitable nutrient-containing gel. After incubation, colonies develop. (see “Dipsticks”) This traditional technique is called the “plate count” because the nutrient gel is generally contained in a standard 100 mm “petri dish” or “plate.” Like dipstick methods, microbes must grow on the nutrients provided to form visible colonies. Consequently, these methods are often referred to as “viable counts.”

Proliferation: The increase in the number of individuals in a population. It may or may not be proportional to growth: for example, if cells are dividing, but there is no net biomass increase, the population is proliferating but not growing. Often, in metalworking systems, biomass increases are not accompanied by increased cell numbers. If viable counts are the only measurements of microbial contamination being used, the data may be dangerously misleading.

Sterilize: The complete destruction of biological activity.

Yeast: See “Fungus.”