Disinfection for Safe Water

Water supplies can contain living organisms such as bacteria, protozoa, worms, viruses and fungi. When these organisms are the sources of diseases, they are known as pathogens.

Pathogens can lead to infectious diseases such as typhoid fever, dysentery, giardiasis, cryptosporidiosis, cholera, jaundice, hepatitis, undulant fever and tularemia, making the water supply unsafe for human consumption. Disinfection plays a key part in turning non-potable water into water that is microbiologically safe to drink.

Before any disinfection method can be used, a biological water analysis must be performed to determine which contaminants are in the water. Using this information, a proper treatment method can be chosen. The primary methods of disinfection are chlorination, chloramines, ozone, distillation and ultraviolet (UV) light.

Chlorination

Gas. Chlorine is an effective method for removing almost all microbial pathogens. During the chlorination process, chlorine gas is released from a liquid chlorine cylinder. The gas is led to an injector in the water supply pipe, where highly pressurized water draws the chlorine into the water stream. Sufficient mixing and contact time must be provided after injection to guarantee complete disinfection.

Sodium hypochlorite solution. Sodium hypochlorite (sold in stores as household bleach) is easier to handle than gaseous chlorine or calcium hypochlorite. During the disinfection process, the sodium hypochlorite solution is diluted with water in a mixing/holding tank. This diluted solution is then injected into the water supply pipe at a controlled rate by a chemical pump. Sufficient mixing and contact time must be allowed.

Solid calcium hypochlorite. One of the advantages of calcium hypochlorite is that it is stable, allowing a year's supply to be bought at one time. However, it must be kept away from organic materials such as wood, cloth and petroleum products due to reactions that create enough heat to cause a fire or explosion. Calcium hypochlorite can either be dissolved in a mixing/holding tank and injected in the same way as sodium hypochlorite, or tablets of hypochlorite can be directly dissolved in free-flowing water where the pressure can be lowered to atmospheric, such as a storage tank.

Chloramines

Chloramines are effective disinfectants for bacteria and produce fewer disinfection byproducts. However, chloramines are a weak disinfectant when it comes to viruses or protozoa. In order to create chloramines, chlorine gas is injected into the supply main, followed immediately by ammonia. Sufficient mixing and contact time must be allowed. Chlorine-to-ammonia ratios of 5 to 1 should not be exceeded. If the pH drops below five, nitrogen trichloride may form.

Chlorine Byproducts

When chlorine is added to water it can create disinfection byproducts as a result of the types and concentrations of organic materials present in the water, the dosage of chlorine, the temperature and pH of the water, and the reaction time. There are three strategies that the U.S. Environmental Protection Agency has identified to help control the development of these byproducts:

- Remove the byproducts after they are formed. This can be difficult and costly.
- Use alternative disinfectants that do not create unwanted byproducts. This is usually the most cost-effective strategy.
- Decrease the concentration of organics in the water before oxidation or chlorination to minimize the formation of byproducts. This provides the highest quality finished water.

Ozonation

Ozone requires shorter contact time and dosage than chlorine because it is about 10 times more powerful. However, ozone gas is unstable and must be generated on site. Ozone also has a short life in water, providing little or no continuing disinfectant residual downstream. When used with UV, chlorine or iodination, it offers excellent oxidation and disinfection possibilities.

UV Light

The killing action of UV light is similar to sunlight, which kills bacteria in surface waters. UV radiation is generated by a special lamp. When this radiation penetrates an organism's cell wall, it causes a cross-linking within the organism's DNA that is disruptive enough to inactivate the cell, rendering it unable to reproduce. UV radiation destroys bacteria and viruses efficiently, but it may not inactivate *Giardia lamblia* or *Cryptosporidium* cysts. UV radiation should be used on water in which there is practically no risk of protozoan cyst contamination and which does not have high levels of suspended solids, turbidity or color. These materials may react or absorb the UV radiation, reducing the effectiveness of disinfection.

Distillation

Distillation is a heat-sterilization process that is one of the easiest disinfection treatments for a homeowner to operate. In this process, heat is used instead of chemicals. The steam created by the heat disinfects and deionizes water at the same time. The process is simple, but it is limited by the extra time needed to produce 1 gal of processed water when compared to other processes.

Disinfection is an important drinking water treatment. These treatments help keep everyone safe from illness. *wqp*

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