



Keeping Water Safe: Chlorination and Disinfection By-Products



The most important responsibility of water suppliers is to provide water that is safe to drink. In most cases this means that water must be disinfected before distribution to consumers.

WHAT IS DISINFECTION?

Most tap water in Australia undergoes a range of treatment processes before it is distributed to consumers, to make sure that it is safe to drink. Disinfection is one of the most important of these processes.

Disinfection kills the bacteria, viruses, and other microorganisms that are often found in water. Having some disinfectant present throughout the water distribution system prevents potentially harmful microorganisms growing in the water pipes.

THE POWER OF DISINFECTION

In the nineteenth century, before the widespread acceptance of the idea that germs cause disease, water supplies were not disinfected and thousands of Australians died each year from water-borne diseases caused by microorganisms. Typhoid fever and cholera were common causes of illness and death.

In 1896, scientists began experimenting with chlorine as a disinfectant in water supplies and in 1897, chlorine was used to disinfect water mains following a typhoid outbreak in England.

The disinfection of public water supplies spread rapidly in technologically advanced countries after liquid chlorine became commercially available in 1909.

Thousands of lives were saved, as the rates of waterborne diseases dropped dramatically, increasing life expectancy and reducing infant mortality.

The disinfection of drinking water is now recognised as the basis for one of humanity's greatest public health advances.

CHOOSING A DISINFECTANT

Water authorities have a few options when deciding on how to disinfect their water.

The most frequently used disinfectant is chlorine, but other types of disinfectant are becoming more common, such as chloramine (chlorine in another form), ozone, and ultraviolet light.

A number of key factors are considered when selecting a disinfection system. These include its:

- effectiveness in killing a range of microorganisms
- potential to form possibly harmful disinfection by-products
- ability to remain effective in the water throughout the distribution system
- safety and ease of handling
- cost.

ABOUT CHLORINATION

Chlorine is the most widely used disinfectant for drinking water in Australia. It is used in most Australian capital cities and many smaller water supplies. The process of using chlorine to disinfect water is called chlorination.

Chlorine passes through microorganism cell walls and attacks vital enzymes, causing cell death.

Chlorine is cheap, easy to use, effective at low dose levels against a wide range of infectious microorganisms, can protect water within the pipe system, and has a long history of safe use around the world.

However, there is a downside to chlorine disinfection.

DISINFECTION BY-PRODUCTS

When chlorine is added to raw water supplies it can react with dissolved substances in the water, such as natural organic matter, to produce unwanted chemicals, called "disinfection by-products". The natural organic matter comes from decaying plants and animals in the water catchment that break down into smaller components, which dissolve in the water.

The by-products formed are generally organic compounds, with the most common being a group of chemicals called trihalomethanes (THM). The presence of these compounds was first detected in 1974, and they have been studied ever since. Around 250 disinfection by-products have been found in drinking water, with some scientists predicting that there may be hundreds more yet to be discovered.

To keep the level of disinfection by-products low in drinking water, suppliers treat the water to remove as much natural organic matter as possible before it undergoes disinfection.

Removing this organic matter also decreases the total amount of chlorine needed for disinfection, because organic matter reacts with chlorine and so its presence reduces the amount of disinfectant available to kill microorganisms.

WHAT ARE THE RISKS?

Some people are concerned about the possible health risks of disinfection by-products. Several scientific studies have shown that there is a possible link between disinfection by-products and an increased risk from a variety of cancers, but this has not been confirmed. Recent studies have suggested possible links with bladder cancer in men and effects on pregnancy, but again this has not been clearly established. Research teams in a number of countries are still investigating whether drinking water could be involved and if so, how significant the effects could be.

As a precaution, many countries limit the allowable level of chlorinated disinfection by-products in the water. Some countries also limit the level of non-chlorinated disinfection by-products.

The Australian Drinking Water Guidelines suggest maximum values for a range of disinfection by-products (for example, 0.25 parts per million for trihalomethanes). Although the focus to date has been



Photo courtesy Water Corporation

on chlorine-containing disinfection by-products, this has been mainly because they are easier to detect in a laboratory.

Alternative disinfectants - chloramines, chlorine dioxide and ozone - can also react with organic matter in water to produce disinfection by-products.

These by-products are different from those formed by chlorine, but some may also present health risks.

Each method of disinfection will have advantages and disadvantages that must be considered when choosing the best disinfectant to use in a particular water supply.

HOW SIGNIFICANT ARE THE RISKS?

Although disinfection by-products may increase the risk of some forms of cancer, risks from water that is not disinfected are significantly greater.

The World Health Organisation advises that:

- the risk of death from pathogens is at least 100 to 1000 times greater than the risk of cancer from disinfection by-products
- the risk of illness from pathogens is at least 10,000 to one million times greater than the risk of cancer from disinfection by-products.

The *Australian Drinking Water Guidelines* encourage water authorities to reduce disinfection by-products in water supplies, but emphasise that this should not in any way compromise the proper disinfection of the water.

FOR MORE INFORMATION

visit the Web site:
www.waterquality.crc.org.au