CIWEM Chartered Institution of Water and Environmental Management

Policy Position Statement

Disinfection of drinking water supplies - Information sheet

Purpose

This information sheet sets out the general principles for the disinfection of drinking water supplies. Disinfection is a regulatory requirement for all drinking water entering supply and is essential for the protection of public health from waterborne infectious diseases.

Introduction

The Water Supply (Water Quality) Regulations for England and Wales (2000, as amended) define disinfection as "a process of water treatment to remove or render harmless to human health every pathogenic micro-organism and pathogenic parasite that would otherwise be present in the water and 'disinfected' shall be construed accordingly".

In the UK disinfection is always carried out on public water supplies by applying one or more processes, to remove or inactivate waterborne pathogens, including viruses, bacteria and parasitic protozoa, which may be present in sources of drinking water. Worldwide, many thousands of people continue to die each year from waterborne diseases. Infectious diseases including cholera and typhoid are spread by inadequate treatment of sources of water which are contaminated with human excrement and abstracted for the production of drinking water

Disinfection of surface water is typically carried out by a combination of two or more processes, including physical removal (e.g. by sand filtration or membrane filtration), inactivation with an oxidising agent and/or irradiation by ultraviolet light. For water stored in underground aquifers the physical removal is carried out by filtering through the ground. There are several ways of disinfecting water supplies, and the most common methods include:

1. Physical removal of viruses, bacteria and protozoa in conjunction with:
2. Chlorine
3. Ultraviolet light
4. Ozone

Chlorination is commonly used in the UK because it is very effective at inactivating many harmful viruses and bacteria, it is harmless to humans at the concentrations used, and it is relatively cheap. It also provides protection for the water after it leaves the treatment works as it travels through the network of pipes and reservoirs into people's homes. Sometimes, chlorine is combined with ammonia to produce monochloramine as the preferred residual for drinking water leaving a treatment works. Chlorine gas or liquid sodium hypochlorite is injected into the water at the final stage of water treatment and allowed contact time for the disinfection process to work.

Other disinfection methods have different advantages, and can be used in conjunction with chlorine or as a substitute, depending on the specific circumstances. Ultraviolet light is an effective disinfectant for protozoa, such as *Cryptosporidium*, and is now a commonly used disinfection method for both private and public water supplies.

Key considerations

1) Water sources vary greatly in the amount of faecal contamination. For example, deep, well protected groundwater can be substantially free of waterborne pathogens, whereas a surface water may be subject to significant faecal and sewage contamination. A risk assessment must be carried out to determine the type of treatment and disinfection required depending on the type and numbers of waterborne pathogens expected to be present, both under normal conditions and in the event of deterioration in quality due to events such as extreme weather or pollution.

2) The risk assessment should consider the potential for pathogens in the source water. In practice, it will usually involve identifying sources of faecal contamination within the catchment and determining the numbers of coliform and *Escherichia coli* bacteria. These can provide an indication of the extent of faecal contamination. Disinfection strategies should be a key section in the Water Safety Plans of water companies.

3) The treatment conditions and their operation and control are set out in a site-specific disinfection policy developed by every water company. It is essential that all processes are validated to make sure they can achieve the required level of disinfection and that appropriate measures are in place to verify disinfection performance.

4) Surface water (rivers and reservoirs) must be adequately prepared for disinfection. This can require a number of stages including coagulation, flocculation and sedimentation and filtration prior to addition of a disinfectant. These processes must be closely controlled to ensure that they are removing the required quantity of microorganisms and other impurities.

5) Turbidity is the cloudiness of the water caused by the quantity of small particles present. Clear water is very important for the pleasing appearance of drinking water, but turbidity monitoring also fulfils another important function. Turbidity is used in water treatment to monitor the performance of removal processes, because it can give an instant measurement of the amount of particles being removed by the water treatment. Turbidity can also indicate the presence of particulates which might interfere with disinfection processes by shielding microorganisms. The turbidity is measured through the treatment process and water to be chlorinated must have a turbidity below 1 NTU before the final stage of chlorination. In practice most water treatment plants in the UK achieve much lower turbidity values, with <0.1 NTU being commonly targeted and achieved.

6) Chlorination needs to be monitored continuously. This involves checking that the correct dose is being applied to achieve the required level of pathogen inactivation after allowing for the effects of flow rate, water temperature and pH.

7) There is no requirement for a water supply to have a disinfectant residual in distribution. It is common practice, however, for all water supplies in the UK to carry a residual. The residual is applied at the treatment works although sometimes it may be necessary to provide additional dosing during distribution by installing booster chlorination. Ideally, there should be persistence of the disinfectant residual throughout a network. A number of factors, however, will combine to cause a decline in its concentration, including the concentration of dissolved organic matter, type of pipe material, water temperature, and residence time.

In practice there is a balance between maintaining a chlorine residual effective enough to protect the water and providing water which is aesthetically acceptable in terms of taste and odour. People may notice a slight taste or smell of chlorine, though the ability of people to detect chlorine is variable and personal tastes are subjective. Water can be kept in a jug in the fridge for a few hours to remove the chlorine taste.

8) *Cryptosporidium* is not killed by chlorine at the concentrations at which chlorine is used in the water industry. Physical removal by filtration plus the use of ultraviolet disinfection, where required, can provide effective *Cryptosporidium* control.

9) Disinfectants can react with dissolved organic matter and other constituents (e.g. bromide) to form disinfection by-products. By-product formation can be an important consideration in the choice of disinfection method. Organic matter can also affect the UV transmittance and hence the efficacy of UV disinfection. Many private supplies have coloured water, and effective removal of organic matter prior to disinfection is important.

10) It may be necessary to issue public health advice if there is a problem with the disinfection process, or any other indication that the water supply may be contaminated or unfit to drink. Such decisions are usually taken after discussion with local health authorities. This may result in the customers being advised to boil water before drinking or brushing teeth. Boiling is an effective way of killing harmful microorganisms including bacteria, viruses and *Cryptosporidium*.

Further Information

More specific guidance is given in the CIWEM Policy Position Papers: 'Chlorine Disinfection of Water Supplies in the UK' and 'Ultraviolet Disinfection of Drinking Water Supplies'.

A good reference for all aspects of drinking water quality is the World Health Organisation 'Guidelines for Drinking Water Quality' 4th Edition.

The following references produced by UK Water Industry Research (UKWIR) also provide useful information:

UKWIR, 2005. UK Water Industry Research Report 05-DW02-37 'A review of Ct in water disinfection.'

UKWIR, 2010. UK Water Industry Research Report 10-DW-02-59 'Removal of micro-organisms during water treatment'.

References

Water Supply (Water Quality) (England and Wales) Regulations 2000. SI 3184.

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