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Flushing and Disinfection of Hot and Cold Water Systems

BS 6700* requires that every new water service, cistern, distributing pipe, hot water cylinder, or similar appliances and modifications to these services, be thoroughly flushed with drinking water before being used.

Where the piping system is not used immediately after commissioning, and has not been flushed at regular intervals (of up to 30 days depending on the characteristics of the water), it must be disinfected before use. Furthermore, BS 6700 requires that water-piping systems be disinfected in the following situations:

- In new installations (except for private dwellings occupied by a single family)
- Where major extensions or alterations have been carried out
- Where underground pipework has been installed (except where localised repairs have been carried out or a junction inserted after the fittings have been disinfected by immersion in a solution of sodium hypochlorite that has 200 parts per million of available chlorine) Note: 1ppm is equivalent to 1mg/l
- Where it is suspected that contamination may have occurred, for example: fouling by sewage, drainage, animals or physical entry by site personnel for interior inspection, painting or repairs
- Where a system has not been in regular use and not regularly flushed

Furthermore, cleaning and disinfection of water systems on a scheduled routine basis is good engineering practice. It is a statutory requirement to disinfect water systems in premises where water is stored and used in a way that could create the foreseeable risk of legionellosis (Legionnaires' Disease).

*Specification for "Design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages".

Disinfection process

The disinfection is normally carried out by thorough flushing and then filling the system with chlorinated water at an initial concentration of 50ppm for a contact period of 1 hour. The process has been successful if the free residual chlorine level is not less than 30ppm at the end of this period.

Safety

The piping system must not be used during the disinfection process and all outlets should have a temporary sign stating "DISINFECTION IN PROGRESS, DO NOT USE". To avoid generating toxic fumes, caused by adverse chemical fumes, no other chemicals - such as toilet cleansers for example - should be added to the water until the disinfection process is complete. All building users (including people not usually present during working hours such as cleaners and security guards) should be informed of the disinfection before it is carried out. Operatives should refer to the COSHH data provided by the chemical suppliers and wear appropriate PPE (goggles or face shield, plastic apron and sleeves/ gloves) when handling and mixing the disinfectant.

Disinfectants

The chemicals used to disinfect the system must be approved by the Drinking Water Inspectorate for use with the supply of water for drinking, washing, cooking or food production purposes. They must therefore conform to the specifications of either EN 900 for Calcium Hypochlorite or EN 901 for Sodium Hypochlorite.

Sodium hypochlorite concentration

Sodium hypochlorite solution (household strength bleach) contains 5% available chlorine (equivalent to 50,000ppm). If we wish to create an initial concentration of 50ppm chlorinated water then we need to add 50 ÷1,000,000 x 100 ÷ 5 = 0.001 parts of sodium hypochlorite solution to 1 part water.

This equates to a ratio of 1 litre (of 5% sodium hypochlorite solution) to every 1000 litres of water system volume.

Commercial strength products often contain 10% available chlorine, so where these more concentrated products are used we would need to add 50 ÷ 1,000,000 x 100 ÷ 10 = 0.0005 parts of sodium hypochlorite solution to 1 part water.

This equates to a ratio of 1 litre (of 10% sodium hypochlorite solution) to every 2000 litres of water system volume.

Assessment of system volume

In order to achieve the correct concentration of disinfectant solution for a **gravity-fed system** it is necessary to estimate the cistern water volume. The volume, in litres, can be obtained by multiplying the length, width, and height up to the water level in metres and then multiply the result by 1000.

Copper tube to EN 1057	
Tube size	Water volume (litres per metre run)
15 x 0.7	0.145
22 x 0.9	0.320
28 x 0.9	0.539
35 x 1.2	0.835
42 x 1.2	1.232
54 x 1.2	2.091
66.7 x 1.2	3.247
76 x 1.5	4.197
108 x 1.5	8.659

The volume of a **mains-fed system** can be found by totalling the lengths of the different tube sizes and multiplying these by the appropriate figure in the table, then adding the volume of any hot water storage vessel.

Procedure for gravity fed systems

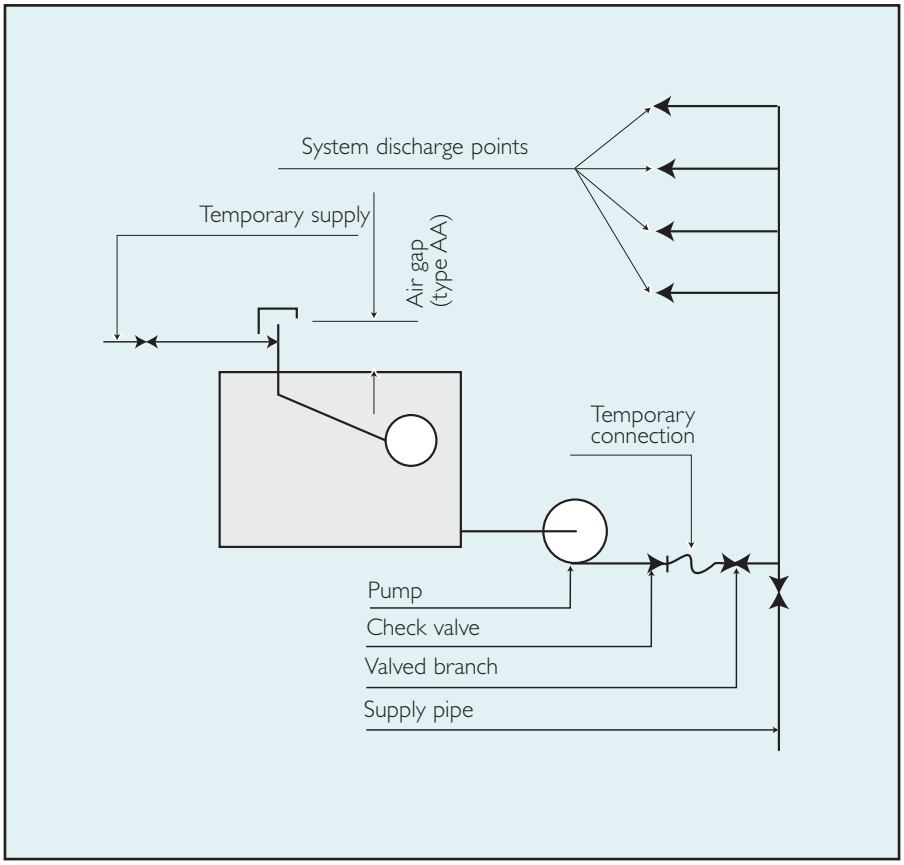
1. Thoroughly flush the system to remove any flux residue, swarf or other contaminants
2. Close all outlets, once the cistern is full close the servicing valve on the supply
3. Assess the capacity of the cistern and determine the quantity of disinfectant to use
4. Add this to the water in the cistern and mix to give the initial strength of 50 ppm required
5. Working away from the cistern, open each draw-off fitting until disinfectant solution is detected, then close the fitting to progressively draw the solution around the system
6. As chlorinated water is drawn off, it will be necessary to add further measured amounts of disinfectant to maintain the initial concentration up to the overflow level of the cistern during the filling process
7. Once the entire system is full the 1-hour contact time can commence

Procedure for supply pipes, service pipes and unvented hot water systems

A small diameter plugged and valved branch needs to be fitted at the upstream end of the supply/service pipe during installation to facilitate disinfection.

1. Thoroughly flush the system to remove any flux residue, swarf or other contaminants, then close all outlets and the servicing valve on the supply
2. Using the valved branch, connect a suitable pump, check valve and the storage cistern outlet to the installation, (see diagram)
3. Determine the capacity of the system and the quantity of disinfectant to use
4. Add this quantity of water to the cistern and add disinfectant to give the initial strength of 50 ppm required, mix then start the pump to inject the disinfectant solution into the system
5. Working away from the temporary connection, open each draw-off fitting until disinfectant solution is detected then close the fitting to progressively draw the solution around the system
6. As chlorinated water is drawn off, it will be necessary to add further measured amounts of disinfectant to maintain the initial concentration during the filling process

The 1-hour contact time will start when the entire system has been filled with water containing 50ppm chlorine.



Testing for residual chlorine

If the free residual chlorine measures less than 30ppm at the end of the 1-hour contact period, it will be necessary to repeat the process as required by BS 6700. How can we know what the residual chlorine level is?

People with a normal sense of smell might just be able to detect the smell of the normal level of chlorine present in ordinary tap water (<1ppm), and they should easily detect the smell formed by a residual chlorine level of 30ppm. This isn't very scientific however, and so a simple colorimetric chemical test has been developed. The test procedure consists of filling a clear plastic tube with a sample of the water to be checked and adding a tablet of indicator chemical. This is shaken to dissolve the tablet and the water must be examined to judge the colour change to estimate the chlorine level.

Water colour	Chlorine level (ppm or mg/l)
Clear	None
Faint pink/pink	0.2 - 1
Pink/red	1 - 5
Red/purple	5 - 10
Purple/blue	10 - 20
Blue/grey-green	20 - 30
Grey-green/ yellow	30 - 50
Muddy brown	Over 50
Colour develops and then goes clear	Excessive

Completion of the disinfection process

It is vital to thoroughly drain and then flush out all the disinfectant once the 1 hour contact period is complete. **Flushing should continue until the level of free residual chlorine is equal to the level present in the drinking water supplied.**

If the chlorinated water remains in contact with the tube, the system will be damaged because the chlorine will react with the copper to eventually form insoluble cuprous chloride, which can continue to attack the tube.

Chlorine neutralising chemical

Where it is necessary to remove chlorine before the system water is discharged into a drain or water course, a neutraliser chemical (for example Sodium Thiosulphate) can be added at the rate of: System volume (m^3) x ppm (mg/l) chlorine x 2 = No. of grams required.

Cisterns and components with internal coatings

Take care to check whether any coatings have been applied to the inside of the storage cistern. High chlorine concentrations can adversely affect new coatings and release chemicals into the water, so it is necessary to ensure that enough time has passed to allow complete curing of any internal coating before disinfection is carried out.

Disinfection Do's and Don'ts

- **Do** take care to warn people before starting, and handle chemicals with care - ***they are dangerous***
- **Do** calculate the amount of chemicals to use accurately - using too much will not produce better results
- **Do** use chlorinated water to replenish the storage cistern up to the overflow level - to keep the disinfection concentration correct
- **Don't** leave the chlorinated water in the system longer than 1 hour and NEVER overnight
- **Do** check for residual chlorine at the end of the contact period - to ensure an effective disinfection
- **Don't** discharge highly chlorinated water into a drain or into a watercourse without first notifying the Water Authority or the Environment Agency. It is highly toxic to fish and other aquatic organisms
- **Do** leave systems full and flush through regularly with fresh water as it is virtually impossible to effect a 100% drain-down of systems. It is recommended that systems which are not coming into immediate use be left full and flushed through at regular intervals (by opening-up all terminal connections) in order to periodically introduce fresh water into the system and thereby enhance protective scale formation within the pipework

Commissioning heating system pipework

It is important to thoroughly flush every heating system as soon as possible after installation. Fill and vent the system with cold water and check all connections for leaks before draining. Refill and commission the boiler and heat up the system. Leaks can be found at this stage, (sometimes due to heat melting grease based fluxes) so check again before draining the system whilst still hot. By following these key steps, you will be able to develop a system with a long and trouble free service life.