MAKING BUILDINGS WORK

Guidance Note GN4

Bacteria Within Closed Circuit Pipework Systems

Introduction

Most engineers are well aware of problems encountered with bacteria in open circuit pipework systems, but there is much less understanding of closed system bacteria.

This note gives brief guidance on the types of bacteria commonly encountered in closed heating and chilled water systems, means of identification and control.

Effects

Bacteria can cause several problems within closed pipework systems including:-

1. **Unrepeatable commissioning readings due to the generation of gases.**
2. **Corrosion due to the formation of organic acids, ammonia, hydrogen sulphide etc.**
3. **Blocking of strainers, valves and pipework, due to residual dirt becoming slimy.**
4. **Fouling of heat exchanger surfaces thus reducing efficiency.**

Methods for Detection

To ascertain whether a system contains heavy bacterial contamination there are some simple tests that can be carried out on a water sample.

1. **Colour – a distinct green or brown colour frequently indicates algae or other bacterial contamination.**
2. **Visual – cloudy turbid water is often due to organic substances produced by the bacteria micro-organism.**
3. **Odour – a strong smell of stagnant water due to marsh gas, hydrogen sulphide etc, will indicate contamination.**
4. **A basic dip slide test will frequently be sufficient to determine the level of contamination.**

If it is required for the actual bacteria to be identified then more detailed laboratory tests can be used.

Incoming Water

The incoming mains or the site water supply used to fill the system can often be the source of bacterial contamination and therefore the condition of these waters should be checked prior to first filling and treated as necessary.

Tests should be carried out to assess the need for remedial action in relation to TVC (37°C), TVC (22°C), Pseudomonas, nitrite reducers, nitrite oxidising bacteria and sulphate reducing bacteria.

It is recommended that the incoming site water supply used for filling the system should be treated to control any bacteria identified during the initial water quality checks. Various methods have been used including chlorine dioxide and biocide dosing; brief descriptions of these methods are included below.

Filling & Testing

Water should be introduced from a predosed tank, the tank having been dosed with calculated and measured quantities of biocide.

If it is not possible to fill from a tank and the samples from the incoming mains indicate the need for biocide treatment, it should be injected into the system during filling for pressure tests.

An inhibitor should then be added to protect the system from corrosion until pre-commissioning takes place.

Wherever possible, sections filled with treated and inhibited water should not be drained to minimise fresh corrosion.

Dynamic Flush and Chemical Clean

The dynamic flush and chemical clean should be carried out in accordance with BSRIA 8/91.

If the incoming water is in need of biocide treatment it may be necessary to remedy the flushing water:-

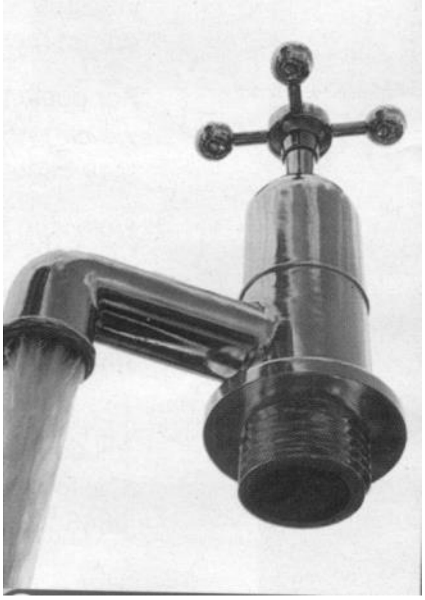
1. **Treat any make up water with biocide, or**
2. **Treat the system with biocide each night during flushing, or**
3. **Re-chlorinate the incoming mains.**

NOTE: The Local Water Authority must be made aware of the introduction of biocide treated water into their waste water system.

After flushing final treatment should be selected to deal with the microbiological condition of the water.

Example. Nitrite based inhibitors are widely used to protect the pipework surfaces but these are food for nitrite reducing and nitrite oxidising bacteria which may have entered from the incoming main. If there is a constant presence of these a different inhibitor must be used.

It is important that pressurisation units are treated as part of the system for cleaning and dosing as they can, if left untreated, become a breeding ground.



Methods of Control

As discussed above, it is important to check and control the levels of bacteria contamination from an early stage and by regular water quality sampling and analysis.

It must be noted that if early control is not carried out and microbiological contamination is allowed to become well advanced, it will be extremely difficult to eradicate the problem.

Water treatment specialists will normally specify and use a broad spectrum biocide which has generally proved to be effective in controlling the Pseudomonas bacteria. Recent experiences have indicated that this general biocide can be totally ineffective on some strains of Pseudomonas.

If the initial checks on the incoming water mains, or subsequent checks on water quality within the pipework systems, identify microbiological contamination it is recommended that Bio-Screening is carried out by the water treatment specialist. Bio-Screening will help to identify the most appropriate biocide that has the best "kill rate" against the particular strain of Pseudomonas present in the system.

Slime forming bacteria is almost impossible to remove when well established as it can be removed by filtration and a biocide dosing heavy enough to remove it can initiate pipework corrosion and thus start the whole cycle again.

Inhibitor levels, TDS, pH and iron readings should be taken weekly following completion until final handover. The results of these tests will allow quick identification of water loss and thus biocides and inhibitors can be introduced to compensate for the water loss.

If there is found to be a loss of nitrite inhibitor but no loss of TDS, it may indicate microbiological activity and therefore careful examination should be carried out.

Bacteria in water systems is widespread, they occur more frequently than other micro-organisms and are more difficult to keep under control. The table below shows some typical examples of bacteria which, under favourable growth conditions, will cause problems. Whilst the table shows favourable growth conditions this does not mean that the bacteria concerned cannot survive outside these conditions. Bacteria are particularly good at adapting themselves to unfavourable conditions enabling them to remain dormant. As soon as conditions become more favourable they awaken to form complete cells and then multiply by binary division.

TYPICAL FORMS OF BACTERIA

Bacteria	Example Characteristics	Favourable Growth Conditions	
		Temperature	pH Value
Pseudomonas	Aeruginosa Aerobic, slime forming	20 - 40 °C	4 – 8
Sulphur bacteria	Thiobaciullus Aerobic, forms sulphuric acid	20 – 40 °C	1 – 6
Sulphate reducers	Desulfovibrio Anaerobic, forms hydrogen sulphide	20 – 40 °C	4 – 8
Iron bacteria	Leptothrix Aerobic, slime forming	20 – 40 °C	7.4 – 9.5

NOTE: THE KNOWLEDGE BASE REGARDING PSEUDOMONAS CONTAMINATION IS AT PRESENT "VERY LIMITED AND THE SITUATION EXTREMELY FLUID". AS AND WHEN DEFINITIVE ADVICE IS AVAILABLE THIS GUIDANCE NOTE WILL BE UPDATED.

This Guidance Note was compiled for the CSA Technical Committee with particular reference to:
Sulzer Infra (UK) Ltd
Arcrite Water Services Ltd

Published by the:
Commissioning Specialists Association, October 1998.

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