



# Risk to GSHP Closed Circuit Systems Methodology & Analysis

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Suppliers of *Innogreen GeoPro*  
Zero Toxicity – Maximum Efficiency- Triazole Free – NSF Certified



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# Agenda

- Closed Water Systems
- Closed Loop GSHP / Simplified Difference
- Standards: Installation and Pre-comm Cleaning
- Risks to the system [any closed system]
- Bacteria implications / causes
- Corrosion implications/ causes
- System preparation: design / clean
  
- Where to Start?
- Cleaning & Maintenance Analysis
- Summary



# Closed Water Systems

Newly installed closed systems, LTHW, chilled water and condenser water circuits should all be pre-commission cleaned thoroughly prior to completion and handover to the end client or their agents to an agreed standard.

Common to most closed circuit technology:

- ✓ Main Plant Unit(s) (Chillers / HVAC / Heat Pumps [heat exchangers / energy source to load side])
- ✓ Pipe network, diversion, control and regulating valves, circulation pumps
- ✓ filters, strainers, dirt & air separators...
- ✓ Working Fluid (water / inhibitor / glycol / antifreeze / brine / heat transfer fluid)

Failure to deliver a clean, operable and performing system means

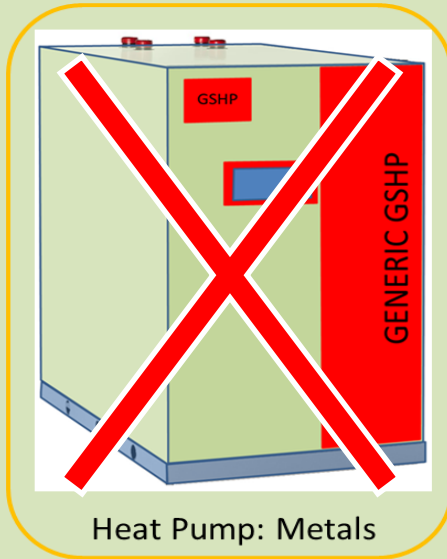
- Project delays from further investigation,
- Impact of late costs for labour, engineering and/or recleaning
- Potential additional financial penalties for project delays
- Poor Performance

Fluid networks can easily become affected or damaged as a result of poor design and engineering decisions at the earliest stages of the project.

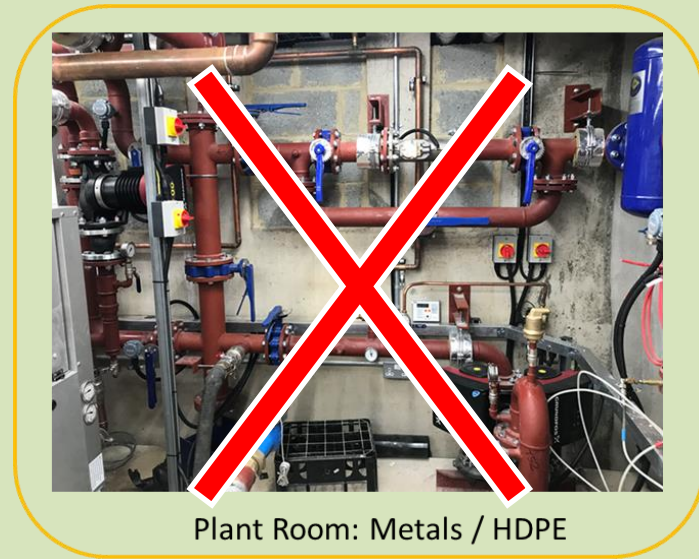


# Heat Pumps: So what's different?

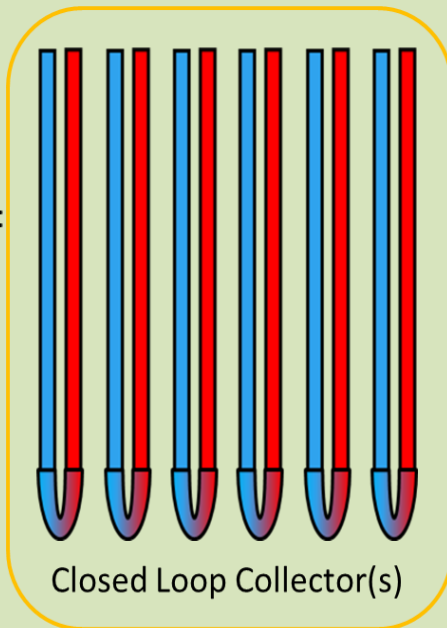
1



2



4



3



Heat Source Options:

- Horizontal (HDPE)
- Vertical (HDPE)
- Water Immersed (S/S – HDPE)

## Standards

### *Closed Circuit Water Treatment Standards for the UK*

**BSRIA GUIDE BG 29/2012** - Pre-Commission Cleaning of Pipework Systems (references to BS 8552)

**BSRIA GUIDE BG 50/2013** - Water Treatment for Closed Heating and Cooling Systems (references to BS 8552)

**BS 8552:2012** – Sampling and Monitoring of Water From Building Services Closed systems

### **OTHER STANDARDS TO REFERENCE?**

GSHPA / IGSHPA / ASHRAE / IIOR... [do they cover pre-comm and maintenance methodology?]

Whichever method or standard is agreed, the overall results should be capable of maintaining the system in a serviceable and operable condition with minimised risk of;

- a) Corrosion
- b) Scale
- c) Biofilm & bacteria
- d) Suspended and dissolved solids
- e) Detritus, sediment blockage and settling

## Risks

The plant room to HP circuit can be cleaned and drained of most/all detritus following a poor preparation and cleaning regime...

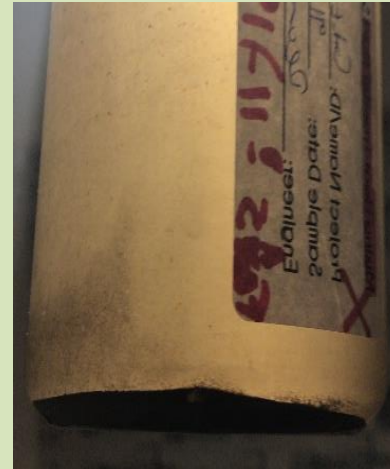
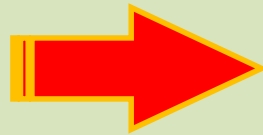
Heat Pump collectors are susceptible and do not have the benefit of a lowest drain point and all phases of installation to pre-comm clean should be maintained separately to the plant room!

**BSRIA BG29-2012** - 'Pre-commission Cleaning of Pipework Systems' outlines methods for cleaning new systems and incorporates BS 8552/2013 as the sampling and testing protocols.

- Design considerations for control
- Inspection and witnessing
- Installation Considerations
- Dynamic Flushing
- Chemical Cleaning Procedure
- Connections between new & existing systems

Plant room  
internal pipe  
corrosion...

No inhibitor or biocide  
following pressure  
test!



Collector Circuit  
initial sample  
bottle...

HDPE circuit filled with  
very high metallic  
deposits!



## Problems caused by Bacteria in Closed Systems?

The presence of unwanted bacteria in closed heating and chilled systems can cause a number of potentially serious problems including:

### **ACCELERATED CORROSION OF THE SYSTEM**

Increased maintenance costs, reduced performance and premature system failure.  
Causes: formation of organic acids, hydrogen sulphide, ammonia etc. within the closed system

### **SYSTEM BLOCKAGES**

Components become blocked from a build-up of bacteria, biofilm and corrosion particulates. Blockages of the strainers, control valves and pipework

### **REDUCED SYSTEM EFFICIENCY**

Microbial fouling of the internal network, heat exchangers and collector surfaces reduces system efficiency and leads to increased costs

### **POOR COMMISSIONING DATA**

The build-up of bacteria and generation of internal gases within the closed circuit system can affect the accuracy of commissioning data leading to poorly configured systems



## Conditions that can cause corrosion in closed systems are:

**Water quality**, without inhibitors reduces corrosion protection and introduces fresh dissolved oxygen to the surfaces of the metals. This can react swiftly with metals like iron and copper. Reacts with iron forms iron oxide (rust) which can hold bacteria and create biofilm.

**Stagnation increases with stagnation and no inhibitors/biocide.** Protect the stagnant plant circuit and boreholes between pressure testing and pre-comm cleaning. Circulate the water and chemical concentration to all sections of each closed system. [Circulation?]  
In addition to closed system deposit and corrosion inhibitors, adding biocides to control biological growth is advised.

**Corrosion deposits can cause wear and tear on seals and pumps.** Corrosion and corrosion deposits develop over time and they are difficult to remove in one cleaning process. It may take repeated cleanings to get most of the iron oxide and sludge out of the system.

**Flush and Cleaning Control:** Transfer of deposits to other zones can restrict flow in pipes, block control valves, damage pump seals, reduce heat transfer and eventually build up in heat exchangers etc. Within GSHP systems, the deposits may not be presented until the working fluid is circulated.

**No basic maintenance** and regular observations of key parameters such as pH, dilution levels, visual and smell checks.





## Where to Start

### Design Considerations:

Mechanicals & Materials: Draining, filling, filtration, flushing, operational and cleaning flow rates, pressure and flow control, bypasses, zone separation and sampling points

(Turbulent flow in excess of 110% BSRIA or design)

Agree with client which methods/standards expected?

(individual results)

Who is cleaning/responsible? To which method / standard?

[test, monitor results guidelines]

**Discharge Licence:** any waste water is trade effluent [toxic or not]

### Reduce Risks and potential costs:

Drilling & Pressure Testing -

add inhibitor/biocide/working fluid!

Plantroom Install & pressure testing

add inhibitors/biocide!

### Options for cleaning:

*Analysis\* of system sectors and supply water!*

[interpret and identify zone(s) for treatment]

Which methods & processes?

[discuss with chemical supplier or cleaning specialist]

28\* days pre analysis for make up water and representative system samples: consider demineralised / deionised water]



## Chemical Cleaning Options

(BSRIA BG29/2012)

Static Flushing [post pressure testing]

Dynamic Flush [

Degreasing

Biocide Wash\*\*

Surface oxide removal (mild Steel components)

Effluent disposal / final flushing

Neutralise of inhibited Acid cleaning

Passivation

*Corrosion Inhibitor*

*Antifreeze / Frost Protection*

*Biocide Dosing*

Observation & Treatment up to 'Practical Completion'

## Target Results & Ongoing Monitoring

### Glycol OEM Guidance / IGSHPA / IIOR

Healthy 'Working Fluid' parameters are;

pH

Dilution % (refractive Index – minimum 25%

Visual Observations

[Bacteria if requested]

## BS8552 testing:

The below table includes the full requirements as outlined in the BS 8552 and would be the testing regime recommended by most Water Treatment Companies to any customers that are not currently compliant with the British Standard.

Quarterly analysis of Closed System			
Parameter	Source Water	System Water	ALS LoR
Suspended solids	One off	Quarterly	1.0 mg/l
Conductivity	One off	Quarterly	30 uS/cm
pH	One off	Quarterly	1 pH units Dilution number
Visual appearance	One off	Quarterly	
Odour	One off	Quarterly	
Total Alkalinity	One off	Quarterly	2.8 mg/l
Total Hardness	One off	Quarterly	0.38 mg/l
Nitrite		Quarterly	0.08 mg/l
Sulphate	One off	Quarterly	4.4 mg/l
Chloride	One off	Quarterly	3.7 mg/l
Total Iron		Quarterly	230 ug/l
Dissolved Iron		Quarterly	230 ug/l
Total Copper		Quarterly	9 ug/l
Molybdate		Quarterly	0.006 mg/l
Phosphate	One off	Quarterly	0.6 mg/l
Glycol		Quarterly	2 mg/l
TVC 22-37°		Quarterly	0 cfu/ml
Pseudomonas		Quarterly	0 cfu/100ml
SRB		Quarterly	DET/ND
NRB		Quarterly	0 cfu/ml

Some additional testing, specific to certain systems, may also be required depending on the system composition or the inhibitor formulation used. Full details of sampling requirement; recommended sampling points, accuracy of test methods used etc. can be obtained from the full text of the British Standard which can be purchased on line from <http://shop.bsigroup.com/>



## Summary

- Heat Pumps are not efficient if the working fluid is compromised and/or conditions aren't maintained!
- System performance is directly linked to healthy working fluid & conditions!
- Know where you are before you commit to contractual standards
- Protect the collector and plant room circuits separately following pressure testing with suitable treatment
- Filtration during cleaning and post clean monitoring? (temporary or permanent over 2,500L advised)
- Maintain separation of HDPE / metal circuits until system conditions are suitable
- Take samples in line with BISRIA standards
- Analyse the fluid samples and makeup water prior to commencement (UKAS standards)
- Interpret the results and select the correct chemistry and/or methodology
- In-house cleaning practice or contract a specialist?
- Design affects control of flow and chemical 'contact time', contaminants dispersal, chemical volumes & time





Thank you for listening

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