Behind the scenes of closed-system HVAC

Reviewing the problems real-time monitoring has prevented

HEVASURE
INTELLIGENT CORROSION CONTROL

Introduction:

Hevasure is the premier real-time water monitoring company in the UK, dedicated to improving the quality of closed water systems, preventing corrosion and the damage it can cause by identifying deleterious changes in conditions.

Introduced in 2014 to monitor both Low Temperature Hot Water (LTHW) and Chilled Hot Water (CHW) systems, Hevasure's award-winning technology has been installed in over 80 buildings nationwide, including some of London's most iconic commercial spaces, such as the Leadenhall Building and Scalpel. Other installations include hospitals, data centres and residential blocks connected to district heating schemes.

From data collected over the last eight years, we can see that more than 50% of closed systems have developed problems at some stage, the majority of which relate to high levels of dissolved oxygen - something that would not have been identified without real-time condition monitoring.

As the precursor to virtually all types of corrosion, oxygen ingress is a very serious issue that went largely unchecked before Hevasure's invention.

In this white paper, we will use the data from Hevasure's systems to demonstrate the potential issues in our closed systems, showcasing the problems that are being prevented by a 'real-time' 24/7 approach.

What does Hevasure track and why?

Hevasure tracks a range of parameters that can be indicative of corrosive conditions as well as their causes. Readings are taken every 15 minutes, providing a 'live' picture of a closed-system, allowing changes in condition to be dealt with immediately or in a timely fashion before damage occurs.

Parameters monitored:

Table 1: Engineering aspects monitored	
System parameter	Reasons for monitoring
Dissolved Oxygen	Closed heating / chilled water systems need to be air-tight to prevent the ingress of dissolved oxygen. For a typical closed system, dissolved oxygen levels should be around 0.1 to 0.2 mg/L. Oxygen is the precursor of most types of corrosion.
Pressure	Positive, but not excessive, pressures must be maintained throughout the system at all times to prevent air being drawn-in.
Make-up water	The intake of fresh make-up water into a system indicates a planned maintenance activity (e.g. flushing operation) or an unplanned event such as a leak. Either way it contributes to increasing dissolved oxygen levels and dilution of inhibitors.
Temperature	This is a key parameter of any HVAC system and needs to be constantly checked to ensure it is operating at the intended level.

Table 2: Water characteristics monitored	
System Parameter	Reasons for monitoring
Conductivity	For systems dosed with chemicals, conductivity is directly related to concentration. Measuring this parameter is essential to ensure that minimum thresholds are maintained, otherwise inhibitors are ineffective, and glycols offer insufficient freeze protection. Conversely, over-dosing is an environmentally unacceptable and an expensive waste.
pH	This needs to be maintained within the limits set by the chemical supplier in order to ensure metals are immune from corrosion or adequately passivated.

Table 3: Corrosion aspects monitored	
System Parameter	Reasons for monitoring
Galvanic currents	The galvanic current is the current that flows between different metals within a system (e.g. steel and copper). Maintaining low galvanic currents is indicative of low oxygen levels and/or good inhibition of metallic surfaces The Hevasure Galvanic Current sensor is used to determine general corrosion rates of anodic surfaces such as steel.
Crevice corrosion	Crevice corrosion can occur even if general corrosion rates are low. It occurs in localised regions (weld seems, crimpled joints or under debris) due to differential aeration effects and is a frequent cause of pitting attack and pin-holing.

Analysis of alarms generated from Hevasure systems (since 2014)

The Hevasure monitoring system generates an alarm when there is an excessive deviation from specified parameters. We have tracked these alarms across the 86 systems installed with our cloud-based, Aquila system, providing an insight into the problems of closed systems in commercial buildings over an eight-year period.

Total number of (cloud-based) systems installed	86
Number of systems generating alarms	70
Total number of alarms generated	1444
Average	20.6
Maximum	128
Percentage from LTHW systems	58%
Percentage from CHW system	42%

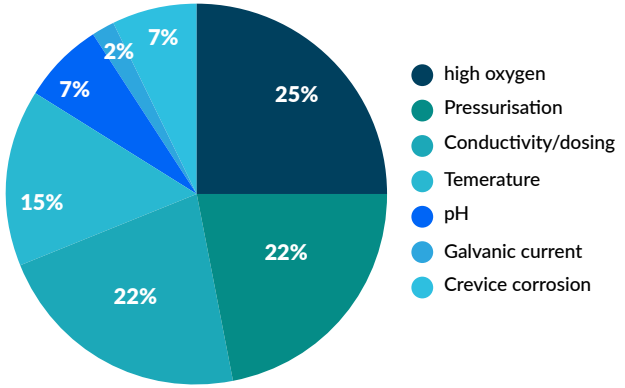
The above data reveals that the majority of LTHW and CHW systems suffer from deviations in water quality or system performance at some stage, with virtually all displaying multiple issues over their lifetimes.

We can break down this data further, identifying the specific parameters that sounded the alarm:

Issue	Number or times alarm triggered
High oxygen	443
Pressurisation	402
Conductivity / dosing	403
Temperature	271
pH	130
Galvanic current	34
Crevice corrosion	129
Total issues	1812

Note that most of these issues would have been missed by intermittent water sampling leading to potentially serious corrosion damage.

Analysis of alarms by type (issue)



The alarm's been sounded, what next?

In these examples, the generation of an alarm is an early warning sign, which means in most cases the problem was identified before corrosion took hold.

By monitoring a plethora of parameters, the Hevasure Aquila systems help identify the root-cause of a problem enabling early intervention and preventing costly downtime and repairs. For instance, oxygen ingress can be caused by pressurisation issues or the demand for fresh make-up water as a result of a leak or planned drain-down. The latter would also explain why conductivity (related to dosing level) was decreasing, indicating a need for remediation and chemical top-up.

Following an informed service intervention, Hevasure technology would then be used to confirm resolution. Once confirmed, no further action is required. Monitoring continues.

Where sampling is the main source of checking condition, true problem solving and certainty of resolution is hard to achieve. A sample represents a snap-shot in time, which is sent for laboratory analysis, taking days, if not weeks to return, by which time conditions may have changed.

Flushing, a water wasting, expensive and in itself damaging process, is often overused in systems reliant on sampling as a safety precaution.

Industry backing

The benefits of real-time monitoring have had a huge impact on water system management best practice, so much so that this approach is now recommended in BSRIA guides BG50/2021 – Water Treatment for Closed Heating & Cooling Systems and BG29/2021 – Precommission Cleaning of Pipework.

Demonstrating the benefits of condition monitoring at all stages of a water system's life, both guides identify DO as the main cause of corrosion in closed systems, specifying real-time monitoring technology as a recommended mitigating factor.

BG50/2021 – section 2.10: "Analysis of system water quality provides useful information about the concentration and performance of corrosion inhibitors and biocides but only gives a partial picture of the overall condition of the system and the extent to which corrosion is taking place. Furthermore, corrosion coupons without electric monitoring do not show sudden changes in corrosion conditions that can be linked to specific events and actions."

The guide then goes on to recommend monitoring and interpreting selected system parameters in real-time to provide advance warning and diagnosis of problems, with information sent electronically to the maintenance team, thereby facilitating remedial investigation and action.

BG29/2021 - section 2.3.8: "Specialist corrosion monitoring equipment is available to measure and record specific corrosion influencing parameters. As a permanent feature of the system, the data recorded can give the maintenance team early warning of conditions likely to promote internal corrosion. This technology allows remote diagnostics so that site visits are minimised."

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Conclusion

It's clear to see from our findings that closed LTHW and CHW systems in commercial buildings are under threat from the hidden menace of corrosion. Prior to the introduction of real-time monitoring, this threat and the issues it causes was not being successfully identified or dealt with, leaving extremely expensive and important infrastructure building services at risk from repairs and breakdown.

The knock-on effect of this vulnerability is potentially disastrous, with responsible parties (often facilities managers) open to litigation.

Since we first started installing Hevasure units in 2014, the industry has moved on apace, and our approach is now recommended at all stages of a water system's life.

Apart from saving money and safeguarding reputations, real-time monitoring offers a host of other benefits, including leaner maintenance practices, reduced need for site visits and improved sustainability, thanks to the potential to cut flushing requirements, optimise chemical use and increase component longevity.

What's key is that building owners, maintenance teams and FMs understand the value of prevention.

Without real-time monitoring technology over the past eight years, where would the water systems in these buildings be? How many small issues would have slipped through the sampling net? Would any of these 'small' issues turned into serious disasters? And if so, at what cost?

Real-time Aquila-2 monitoring range from Hevasure

The newly launched Hevasure Aquila-2 range protects closed water-based HVAC systems from damage and degradation by continuously and remotely monitoring conditions that can be indicative of corrosion.

The fully integrated system incorporates a wide range of high-quality sensors connected to a sophisticated data acquisition system, as well as an interactive display, enabling users to view real-time information and change configurations either remotely or onsite.

Parameters monitored include:

- Dissolved oxygen
- Make-up water flow
- Pressure
- Temperature
- Conductivity/chemical dosing level
- pH
- Galvanic currents (related to corrosion rate of steel)
- Crevice corrosion

Any event, whether planned or unplanned (such as leaks or loss of pressure), can be flagged on the inbuilt charts, allowing maintenance teams to keep electronic records all in one place.

Hevasure Aquila-2 can be used throughout a water system's life – during precommission cleaning, at the point of handover and beyond. It can also be used to provide a one-off health check to identify the cause of a specific issue.

The early detection of adverse conditions will ensure system health, prevent repairs and breakdown, and allow prompt and targeted intervention before any significant damage occurs to the system.

Hevasure Aquila-2c

Hevasure Aquila-2c uses cloud-based data storage together with a sophisticated browser-based dashboard and reporting tool to provide real-time information about a system, easily accessible via any internet enabled device. Alerts are sent to responsible parties if conditions change, allowing problems to be quickly identified.

The fully integrated monitoring station is simple to install requiring only mains power and connection into the flow and return pipework. It can be fitted to new systems or retrofitted to existing ones.

Hevasure Aquila-2s

Hevasure Aquila-2s has been specifically developed for secure environments where 'cloud' and internet communication is forbidden. Instead, all data processing is done locally and data, alarms and messaging is made available to a BMS via a BACnet interface.

An ethernet link to the building LAN and configuration to the BMS display is required as part of the installation.

Hevasure Aquila-2+

Hevasure Aquila-2+ incorporates the benefits of both 2c and 2s, allowing remote access to data as well as connection to a BMS.

All data, alarms, and messaging is made available remotely to the interactive dashboard and BMS via a BACnet interface. The local interactive touch-screen display enables users to view real-time data and change configurations.

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