Fluid thinking: two ways to encourage failure

There are two ways to encourage your cooling system to fail – using a fluid that contains no or limited corrosion inhibitors, and not preparing the system correctly to allow the fluid to work to its full potential. *Jerry Lewis*, chief technical officer at Kilfrost elaborates.

Water is commonly used in cooling as a thermal conductor. The molecules are small, but bond strongly in all direction to give a dense and compact structure. This density and strong bonding means that water can carry a lot of energy without boiling at low temperatures. In addition, as the molecules are small, water has a low viscosity and is easy to pump.

The potential failures with water are its problems of metallic corrosion and freezing. Almost all industrial systems contain components in piping or heat exchangers that can corrode in the presence of water, particularly if oxygen is also available. You could add glycol to the water to offer some freeze protection and some corrosion inhibition will clearly help. On the other hand, to discourage corrosion-based failure and to improve the longevity of cooling system hardware, fluid evaluation and selection is crucial.

Expert fluid manufacturers are committed to providing, research and development intelligent fluids that provide accredited corrosion protection. This is achieved using a combination of ASTM international standards, usually the testing method ASTM D1384 and the standards specification ASTM D3306. This accreditation can offer reassurance that hardware is adequately protected by the fluid used.

ASTM D1384

This standard defines the protocol for setting up glass laboratory equipment for the corrosion testing of six specific metal coupons in a mixture of 33% of the heat transfer fluid to be tested, diluted with standard corrosive water, 67%.

The metal coupons are immersed in the solution, the mixture aerated at 100ml/min air, and the entire test carried out at 88°C for 336 hours (two weeks). This is clearly a tough test versus the conditions to which most heat transfer fluids (HTF) would be subjected, however, it is the standard of testing that HTF customers expect. The ASTM D1384 methodology describes the way in which the coupons are arranged in the test fluid to allow some interaction to take place. The test pieces are separated by one insulator in the centre of the spindle holding the six coupons together, although the three soft metal coupons and the three iron-based coupons are in galvanic contact through metal spacers. The testing should be done in triplicate and the average of the three test coupon corrosion results should be reported.

ASTM D3306

The measurement of coupon corrosion allowed in the ASTM D1384 test depends upon the method used as further described in ASTM D3306. The simulated service test is used primarily for automotive applications. For heat transfer fluids, the glassware limits described in this standard are used, and any test run that gives weight loss

for each metal coupon less than the appropriate tolerance is deemed a pass. Upon passing this testing protocol, the fluid is accredited to the ASTM D1384 / D3306 standards.

The correct deployment of the fluid

The second way to encourage your cooling system to fail is to not clean or sanitise the system when changing or introducing a new fluid. It is critical that the system undergoes a thorough pre-commission cleaning process. Whether it is a new or a refit system there will be contaminants present. New equipment will contain debris, welding slag, and potentially chemicals and residues from the manufacturing process.

Lubricants and oils are also used to protect hardware during storage and transport. These contaminants need to be removed from the coolant system before it is put to use. Refit systems will also need contaminants removed due to the fact these systems have been previously deployed. These contaminants would include degraded antifreeze, rust, scale and sludge.

The Building Service Research and Information Association (BSRIA) have developed independent guidance for everyone involved in the commissioning of closed-loop pipework since 1991. This tried and tested guidance was updated earlier this year in the form of BG 29/2021, and Kilfrost recommend its use to all of their customers.

Once put in place, the coolant system should be thoroughly cleaned using a pH neutral solution which is compatible with all construction materials. This should be followed by descaling if required. The system then needs to be sanitised using a disinfectant and biocide solution. The biocide needs to be effective against a wide range of microorganisms including Legionella.

Inadequate removal of the debris, welding slag, and potentially chemicals and residues from new equipment may have a detrimental effect on the effectiveness of the corrosion protection designed for the fluid. These contaminations work to degrade the corrosion inhibition, intended to protect the system components.

Refit systems will also need contaminants removed, if microbiological contaminations and hard water ions are present, than this may lead to scaling, biofouling and fluid degradation.

The effects of fluid degradation can also reduce the heat transfer efficiency due to obstruction of the piping, a possible reduction of pump service life and unscheduled forced system shutdowns all impacting the efficiency of the cooling system.

To encourage fluid thinking and to discourage failures, select the correct fluid with accredited corrosion test standards.

Furthermore, ensure the system has had an entire pre-commission cleaning process to remove contaminants will degrade the effectiveness of the fluid you are using. In short, use the right fluid, and use it in the right way for best system protection.