Why it pays to have the right water treatment regime

The right feed water quality is crucial to optimise the operation of steam systems, says Mike Griffin Steam Systems Conditioning Manager at Spirax Sarco.

Most people think of water as plain old H_2O and life for steam users would be far easier if things were really that simple. But the raw water supply that steam users rely on can often have more to it, with a wide range of potential impurities that can cause a variety of problems if left unchecked in a boiler or steam distribution system.

Common impurities include dissolved solids and gases, suspended solids and scum-forming substances, all of which may be problematic.

Dissolved solids such as calcium and magnesium bicarbonates form an alkaline solution and salts that precipitate to create deposits. The alkalinity must be controlled to prevent such deposits damaging the performance of the boiler, for instance, by obstructing heat transfer or fluid flow. Silica and iron in the water supply can also result in unwanted deposits, although these are not as common.

Gases such as oxygen and carbon dioxide dissolve easily in water. Oxygen is harmful in even small amounts because it causes pitting in metal surfaces, while carbon dioxide dissolved to form corrosive carbonic acid. In addition, deposits of carbonates and bicarbonates inside the boiler can release carbon dioxide when heated, which can then form more carbonic acid.

Suspended solids are usually mineral or organic in origin and are not generally a big problem because they can be filtered out. However, they can cause real trouble in some equipment if they're not dealt with. For instance, they will cause severe blockages if they get through to the membranes of a reverse osmosis system.

What's the problem?

There are three main consequences of water impurities on a steam system – corrosion, deposits and foaming.

Corrosion can damage the boiler surfaces, piping and other steam system equipment and it's likely to happen if there's dissolved oxygen or carbonic acid in the water. Carbonic acid can cause thinning of metal surfaces in contact with water, for example the bottom of pipework, while oxygen causes pitting of metal surfaces above the water, for example the top of pipework.

If carbonic acid and oxygen are both present then the rate of corrosion rises by about 10%.

The biggest problem with deposits is the disruption to heat transfer and reduced energy efficiency. A layer of deposits is a barrier against effective heat transfer and can reduce the overall energy efficiency of boilers dramatically. Essentially it forces the boiler to burn more fuel to raise the same amount of steam.

A deposit layer just one millimetre thick can reduce boiler efficiency by 10%. In extreme cases, deposits can create local hot spots that can cause mechanical damage or even boiler failure.

Once a problem with deposits is identified, the resulting clean-up can also be problematic. The "quick fix" involves stripping down the system and cleaning it with acid, but this puts the boiler out of action and the aggressive acid can exacerbate any weaknesses in the equipment.

Online cleaning is a more gradual process that dissolves the deposits over several months, or softens and loosens them so that they drop to the bottom of the boiler. Online cleaning involves running the boiler at a higher alkalinity, with extra-low levels of dissolved solids and higher levels of chemical dispersants. The boiler can carry on generating steam throughout the process, but the extra boiler blowdown needed to keep dissolved solids at bay and to remove the extra sludge from the bottom of the boiler means losing energy, in addition to the extra money spent on treatment chemicals. This approach is also ineffective on silica deposits.

Foaming happens when the alkalinity of the water is too high, the boiler's levels of dissolved solids are too high, there is excessive contamination in the condensate return or the dosage of certain polymers is too great in an inappropriate water treatment regime

It can cause a variety of problems, from interfering with the readings on level instruments and pressure meters to the carryover of boiler water into the steam system. Carryover is especially troublesome elsewhere in the steam system, where it can contaminate control valve surfaces, impair heat transfer and block steam traps.

Which water treatment?

Looking at all that, it's easy to see why the wrong water quality can add up to a real headache for boiler and steam system operators. None of these problems are insurmountable however, it just takes the right water treatment regime.

Deciding on the optimum water treatment system is not always straightforward. Raw water quality can be variable and getting the wrong systems in place can mean paying more than necessary for treatment chemicals or perhaps even failing to prevent the potential problems. Expert input can be the best approach for many steam system users, perhaps even outsourcing the water treatment entirely to a third party.

Whether the treatment regime is devised in-house or outsourced, raw water needs to be treated before being fed to the boiler. Water softening supplemented by chemical treatment is the most common approach, in which various chemicals are added to the boiler feedwater. Chemicals should generally only be added to the boiler feedwater in accordance with accepted standards, such as BS 2486: 1997 or BS EN 12953 –10 2003. Following the guidance in the standards should help prevent excessive dosing and provide an effective programme of trouble-prevention.

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Reverse osmosis is also becoming increasingly popular. This forces the water through a semi-permeable membrane to strip out nearly all the contaminants. The pure water, or "permeate", will have had 98-99% of its salts removed.

In addition, carbon filtration may be needed if the water is heavily chlorinated.

There are also important aspects of the day-to-day operation of the boiler itself that can have a big impact on water quality. For instance, heating the water in the boiler feedtank will reduce the concentration of dissolved oxygen and other gases. This minimises the oxygen-scavenging chemicals required and fewer chemicals means that less bottom blowdown is needed, which saves energy.

Implementing an effective water treatment regime may seem like a complex and daunting prospect. But in these days of rising energy bills and austerity, steam users simply cannot afford to have suboptimal systems eating into their utility bills and maintenance budgets. There is plenty of help out there from responsible suppliers and any initial outlay with soon deliver healthy cost and performance improvements.