Analytics in Cogeneration, what to measure and why?

Many manufacturing facilities already rely on a cogeneration plant to meet power and steam needs. Cogeneration also plays an increasingly important role in energy security, sustainability and the circular economy. Whether an existing or planned plant, integrating cogeneration adds an additional dependency for production meaning that unplanned downtime can have significant knock-on effects. Managing maintenance cycles and avoiding outages will require data; but what parameters are important and where is best to put them?

Keeping cogeneration running

It is not surprising that production processes get the majority of attention, as that is where profit comes from. However, if a plant's cogeneration facility shuts down, that production stops and the major costs of not producing starts. To avoid unplanned downtime, a minimum set of required on-line water/steam analytics has been developed to ensure that this critical operational plant asset continues to run without interruption.

These recommendations specify what parameters need to be measured and where. This information was developed by the International Association of the Properties of Water and Steam (IAPWS), a non-commercial organisation made up of Industry Experts from 21 different countries.

The recommendations are based on four concepts:

1. The use and placement of the analytics should add the minimum level of instrumentation to be able to uniquely identify and pinpoint the causes of all possible major water/steam/chemistry related failure or damage mechanism.

2. There should be an adequate level of redundancy, enabling the entire boiler-steam cycle to be monitored holistically, so that in the event of a defective or out of service instrument, proper control and management can continue.

3. The minimum level of online instrumentation should provide assurance to the operator that they can trust the results, without having to double check an instrument or take a grab sample.

4. Audible alarms from these analytics should be triggered in the control room and/or fed through the DCS system so that in the case of an upset, key personnel are quickly notified and action taken before damage occurs.

Below is a list of required and optional water/steam analytics.

Make-up water

- Conductivity: Upstream of the point of mixing with the dosed condensate.
- Cation conductivity: Upstream of the point of delivery of the water into the main boiler circuit.
- Silica: If the plant's source water is high in silica and/or the treatment plant has difficulty in removing it.
- TOC: If the source/raw water has high levels of organics.

Condensate

- Cation conductivity: To detect rapid ingress of corrosive ions.
- Sodium: Required for seawater-cooled plants, especially if condensate polishing is not used. This is also because sodium measurement is much more sensitive than conductivity for quickly detecting condenser leaks.
- Dissolved oxygen: Detects air in-leakage into the high-pressure part of the cycle.
- TOC: Highly recommended at sites that have a high risk of the steam/water returning contamination from the production process.

Boiler feedwater

- pH: For continuous control of the pH set point.
- Conductivity: Gives a rapid indication of dosing levels of the chemicals being added to optimise the pH.
- Cation conductivity: Confirms that no contaminants have entered with the ammonia/phosphate/caustic dosing or via another route such as a condenser leak.
- Dissolved oxygen: If required, to check that the oxygen level is within the target range to minimise corrosion.
- ORP: Necessary if there are copper alloys in the feedwater circuit to monitor copper corrosion.

Drum boiler/HRSG evaporator

- Conductivity and cation conductivity: Essential for monitoring the boiler downcomer and in plants running an all-volatile or caustic treatment.
- If the plant adds phosphate to the boiler, then in addition to the requirements above, the on-line measurement of phosphate is necessary for an unambiguous control of the dosing and to prevent phosphate hideout.

Steam sampling (measured in the liquid phase)

- Cation conductivity, sodium, silica: Minimum requirements.
- Degassed cation conductivity: Optional if there is an elevated risk of air in-leakage or CO_2 absorption when the purified water is in storage.

By establishing, monitoring and taking action on these minimum required analytic measurement points, corrosion and the formation of deposits will be minimised in the boiler steam cycle. Water and chemical upsets are rapidly detected and can be quickly responded to, resulting in the cogeneration plant experiencing a safe, reliable and long life.

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Source: International Association for the Properties of Water and Steam, Technical Guidance Document: Instrumentation for monitoring and control of cycle chemistry for the steam-water circuits of fossil-fired and combined cycle