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Audit your deaerator performance

Deaerators remove dissolved oxygen from boiler feedwater to prevent corrosion of downstream components such as feedwater heaters, economizers and boilers. Dissolved oxygen has retrograde solubility, i.e., the saturation concentration of dissolved oxygen is inversely proportional to water temperature. As water temperature increases in the feedwater circuit, it releases oxygen, which is available to react with steel piping—**Result:** corrosion.

Oxygen-related corrosion is highly localized and forms a pit whose depth increases rapidly under high-temperature conditions. Depending on the dissolved oxygen concentration and water temperature, penetration of the pipe wall and subsequent failure can occur in hours or days. Most refineries and chemical/petrochemical plants have pressure deaerators that use steam to mechanically remove dissolved oxygen. Deaerators also remove carbon dioxide and ammonia.

System configuration. Fig. 1 shows a typical configuration of a pressure deaerator. Some plants return condensate to the storage section. The scrubbing section uses either sprays, or sprays and trays to ensure complete mixing of the stream with the feedwater.

Dissolved oxygen removal is a mass transfer process governed by Henry's Law. The scrubbing steam contacts the boiler feedwater and discharges to atmosphere enriched with oxygen. The ideal height of the steam plume at the vent is approximately three feet (one meter).

During optimal, steady-state operation, deaerators produce water with a dissolved oxygen concentration less than 7 ppb, an operating condition consistent with ASME guidelines.[1] Operating conditions such as changing makeup and/or condensate flowrates, scrubbing steam flowrate, proportion of makeup and condensate flows and mechanical integrity of the scrubbing section can compromise the efficiency for dissolved oxygen removal. To compensate for the dynamic plant operation, plant personnel feed a chemical oxygen scavenger. The ideal feedpoint for oxygen scavenger is the drop leg from the mechanical scrubbing section to the storage section (Fig. 1).

Monitoring. Plant personnel should establish a routine monitoring program and a periodic deaerator performance audit. Routine monitoring consists of dissolved oxygen measurements on a daily or weekly basis. Often, plant personnel monitor operating pressure and temperature of the steam-water mixture to ensure adequate mechanical deaeration. The two most common methods to monitor dissolved oxygen are a grab-sample method using an evacuated CHEMets ampoules and the Rhodazine D method, and an online analyzer.[2] Soluble iron concentration measurements are not appropriate to track deaerator performance, because the localized pit-type characteristics of dissolved-oxygen corrosion generate a small mass of corrosion products.

Plant personnel or the incumbent water treatment supplier should conduct a performance audit on an annual or semi-annual frequency. Audits should measure the dissolved oxygen concentration of the deaerator effluent with/without the chemical oxygen scavenger, during typical steam load changes, and unit start-ups and shutdowns. To minimize risk, plant personnel should use an online dissolved oxygen analyzer during an audit and restore the chemical feed if the dissolved oxygen concentration starts to exceed the maximum specification limit of 7 ppb.

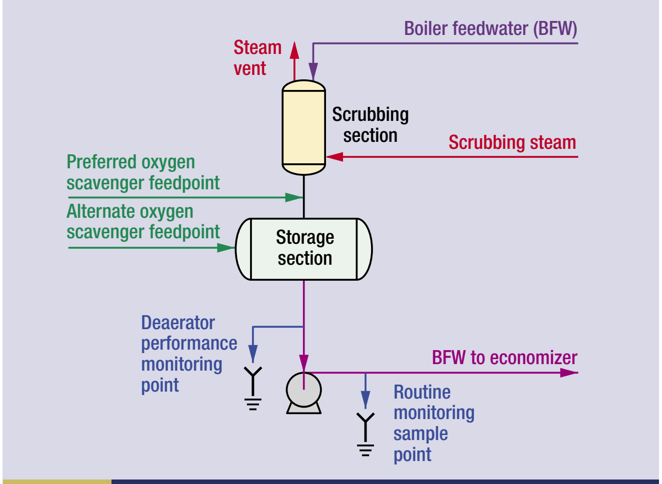

FIG. 1 Flow diagram of the pressure deaerator unit.

To identify the root cause for the deaerator problems, plant personnel should measure the dissolved oxygen concentration during steam-load changes and identify other transient operational issues. A comparison of current operating specifications to the original design can provide important information. Critical operating parameters include makeup flowrate, condensate flowrate, inlet boiler feedwater temperature, scrubbing section temperature and pressure, storage section temperature and pressure and scrubbing steam plume height.

Actions. Proper deaerator operation is critical when maintaining system reliability. High dissolved oxygen concentrations in the boiler feedwater can cause rapid failure of equipment, lost opportunity costs and risk of injury or fatalities of operating personnel. Plant personnel should develop practices to routinely monitor and periodically audit deaerator performance to reduce the risk of catastrophic failure. **HP**

LITERATURE CITED

1 *Consensus on Operating Practices for the Control of Feedwater and Boiler Water Chemistry in Modern Industrial Boilers,* CRTD-Vol. 34, American Society of Mechanical Engineers, New York, NY, 1994.

2 CHEMets are a registered trademark of Chemetrics, Inc., www.chemetrics.com.

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