AquaAnalytics Engineering Notes

Dissolved Oxygen Studies and Deaerator Efficiency

Introduction

Boiler feedwater is comprised of cold make-up and condensate returns, both of which naturally contain varying levels of dissolved oxygen. At high temperatures, the presence of dissolved oxygen can cause corrosive damage to steam systems. Deaerators are often used to enhance mechanical oxygen removal and improve system efficiency.

All deaerators are designed to enhance removal of dissolved gases, including oxygen. Steam injection is used to increase temperature and pressure within the vessel, driving oxygen from the feedwater (Figure 1). Gases are then vented through a valve or machined orifice. Any remaining oxygen is removed by addition of oxygen scavenging chemicals to ensure equipment is protected.

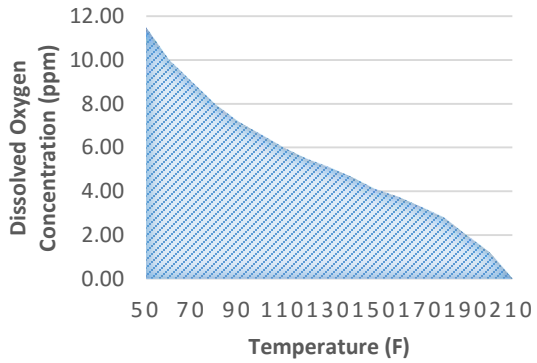

Figure 1: Dissolved oxygen vs. temperature

At optimal operating conditions, deaerators are designed to achieve a dissolved oxygen concentration of as low as 7 parts per billion (ppb). Many factors influence performance, including internal pressure, temperature and water level, incoming feedwater temperature, retention time, vent design, maintenance, etc. Variation in these parameters can alter the effectiveness of mechanical oxygen removal. Periodic dissolved oxygen studies can help to monitor changes in deaerator performance.

Measuring Deaerator Efficiency

Any oxygen escaping mechanical deaeration requires scavenging by chemical means. Ensuring peak mechanical performance of the deaeration system is critical to minimizing operating costs and chemical requirements.

To measure the current mechanical performance, a dissolved oxygen study can be performed. Prior to the test, the oxygen scavenger feed is disable for 12 – 24 hours to

ensure an accurate measurement in the absence of chemical treatment. Proper sampling of the deaerated water is crucial for accurate measurements, and the following factors should be considered:

- Samples should be collected from the main storage section of the deaerator, or directly from the boiler feedwater supply line
- Stainless tubing from the deaerator to a sample cooler is ideal to minimize travel time of the fluid
- Sustained and continuous flow of the sample is recommended to minimize noise in the data
- Discharged to an inverted funnel to reduce contamination from ambient air

There are several test methods available to measure dissolved oxygen content, including colorimetric tests (ampule comparators and spectrophotometric meters), and sensor-based analyzers (Figure 2). To best categorize deaerator performance under varying conditions, multiple samples should be analyzed over time.

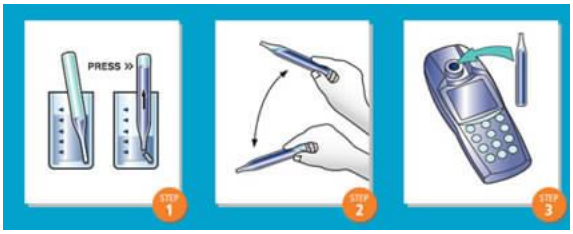

Figure 2: Methods for analyzing dissolved oxygen

Once sufficient data is gathered, treatment equipment is re-enabled to restore chemical residuals to within the recommended range. Additional dissolved oxygen content samples are obtained to benchmark normal operating conditions.

Results

Results of a dissolved oxygen study provide valuable insight into opportunities for continuous improvement in the steam system. Significant variations in the dissolved oxygen level could indicate mechanical adjustments or maintenance is required. Additional opportunities for improvement include: redesign of the chemical injection feed, adjustments to the current vent design, changes to pressure, temperature and level control settings, etc. Completion of ongoing periodic testing will help to identify trends where additional action may be required.