Dissolved Oxygen Measurement in Generator Stator Coolant

Introduction

Turbine generators used in power generation typically have a stator that is cooled down with water circulating in thin copper alloy rectangular tubing in a closed-loop system. The tubing is oxidized to form a protective layer of copper oxide. The total heat exchange surface can reach 360 square meters, and the total amount of copper 12 tons.

Techniques

Two cooling water chemistry techniques are considered:

- In **aerated cooling water**, dissolved oxygen in the cooling water circuit must be maintained between 2 – 5 ppm to ensure stable operating conditions and to prevent a reducible environment. The rotor is cooled down with hydrogen gas that can permeate through copper tubing; if the O_2 level drops to the point where the cooling water becomes reducible, the protective copper oxide layer is removed, and suspended particles cause scaling inside the tubing. Eventually, the tubing will become plugged or pierced.

  Strong chemical cleaning using nitric acid and sodium persulfate must be performed to remove these particles. The next step is to redeposit a new protective copper oxide layer. Such strong chemical cleaning can remove up to 1% of the copper and is very costly to implement.

  Due to the serious damage resulting from scaling and fouling, DO_2 must be measured continuously, providing that the measurement can be made for several months without service or maintenance.
- In **deaerated cooling water**, the coolant contains DH_2 and the copper tubing is not passivated. The difficulty with this approach is that ambient air can diffuse into the stator cooling water resulting in oxidation and eventually scaling and fouling.

  Adding to these challenges, the accumulation of gaseous O_2 in the circuit can lead to an explosion risk with hydrogen gas. When not in operation, the circuit is maintained under nitrogen but this does not prevent air ingress. For those reasons, dissolved O_2 levels in deaerated cooling water must not exceed a concentration of 100 ppb.

Installation Recommendations

The measurement of dissolved O_2 is made on-line through a flow chamber. The circulating water is re-injected into the line at a low pressure point. Thus, there is no need for a sampling pump.

The low 50 ml/minute flow rate requirement, high accuracy, hydrogen compensation feature, and low service requirement are some of the numerous advantages of the Orbisphere system for measuring dissolved O_2 in stator cooling water.

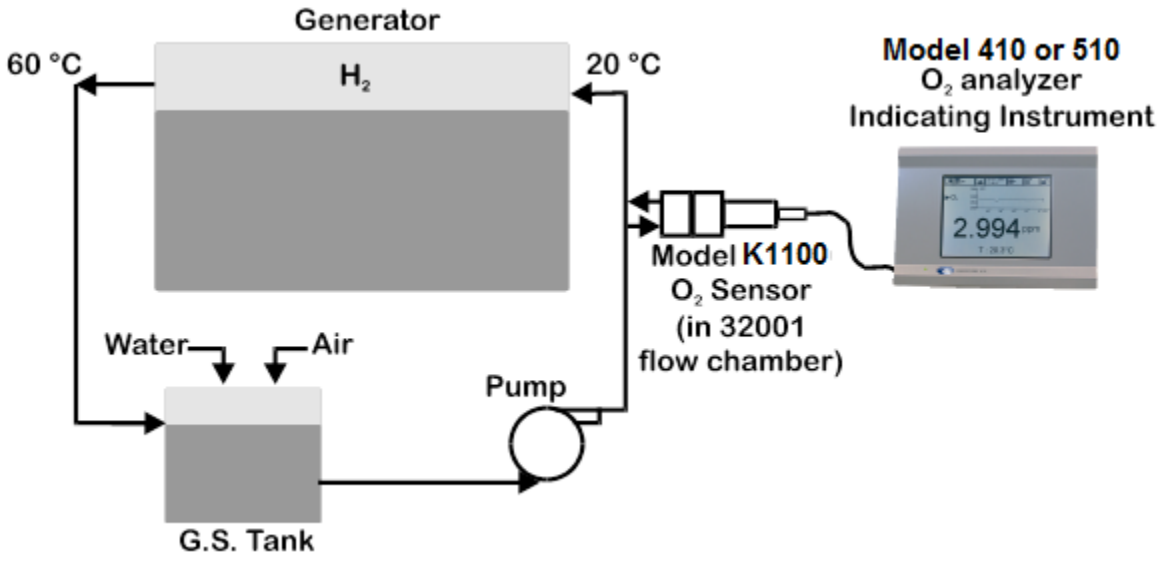

Figure 1: Installation diagram

Recommended Systems Components

Model	Description	Range of measurement
K1100-KTO-W-IMP	Kit to order, contains K1100-S00 sensor, 410/K/W1C00000 instrument, 3m cable, ¼" flow chamber	0 to 2,000 ppb (dissolved)
K110H-KTO-W-IMP	Kit to order, contains K1100-S00H sensor, 410/K/W1C00000 instrument, 3m cable, ¼" flow chamber	0 to 40 ppm (dissolved)

Additional Systems

Nuclear application can be served with model K1200.

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