Dissolved Oxygen & Hydrazine Monitoring On Power Plant

TECHNICAL NOTE

Introduction

Extensive on-line chemical monitoring of both the water/steam cycle and water treatment plant on modern power stations is now a very well established practice. This enables careful control of the water chemistry, to achieve peak efficiency and minimise down time due to excessive boiler corrosion or scaling.

The measurement of dissolved oxygen and hydrazine on boiler plants is vital if the plant is to run efficiently, and to be cost effective, with minimum down time. Even small quantities of dissolved oxygen in boiler water are capable of causing severe pitting in boilers of all pressures, and will reduce the boiler life dramatically. In boilers where high chloride levels exist, the effect of oxygen corrosion is increased. Therefore, the need to reduce dissolved oxygen content to a very low level is even more important.

One of the properties of hydrazine is that it is an oxygen scavenger, and because of this, hydrazine is dosed into the boiler system to remove the remaining trace levels of dissolved oxygen. It is for this reason that the measurement of dissolved oxygen and hydrazine is imperative on power station plant.

This Technical Note points out typical sample points for on-line dissolved oxygen and hydrazine monitors found on power stations, and describes the information which the measurement provides.

What is Oxygen?

Oxygen is a colourless gas without smell or taste; it occurs in the free state as a gas and has the chemical formula O_2. It is present in the atmosphere to the extent of 21% by volume and 23% by weight. Oxygen becomes a liquid of pale blue colour below a temperature of -183°C, and is appreciably magnetic.

Combined oxygen occurs in: water; vegetable tissues; animal tissues; nearly all rocks; and many metals.

Oxygen is the most abundant element, occurring to a larger extent (about 50%) than any other, in the earth's crust. It is only sparingly soluble in water.

Water which is fully air saturated contains approximately 10mg kg^{-1} of dissolved oxygen. In solution, oxygen is very corrosive to most metals, including mild steel used for boiler tubes.

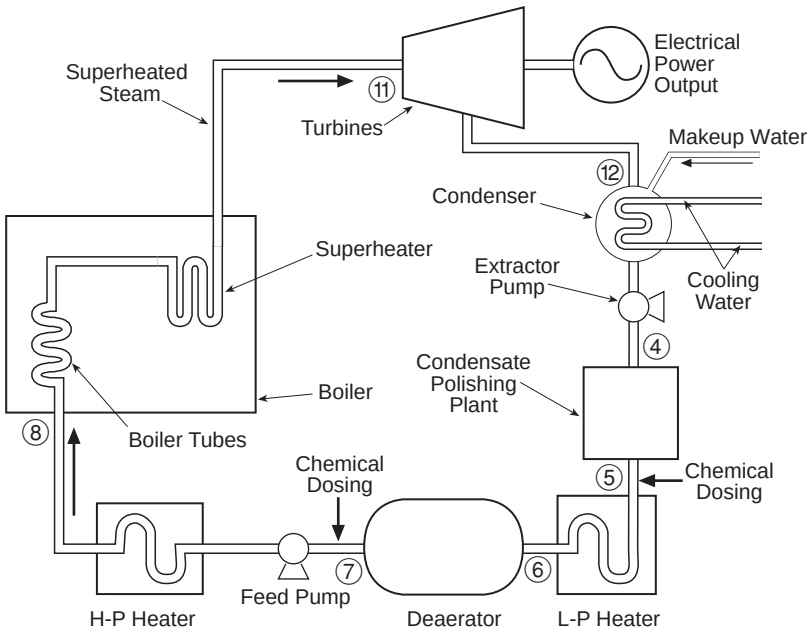

Fig. 1 Typical Generating Station Steam/Water Cycle for a Once-through Boiler

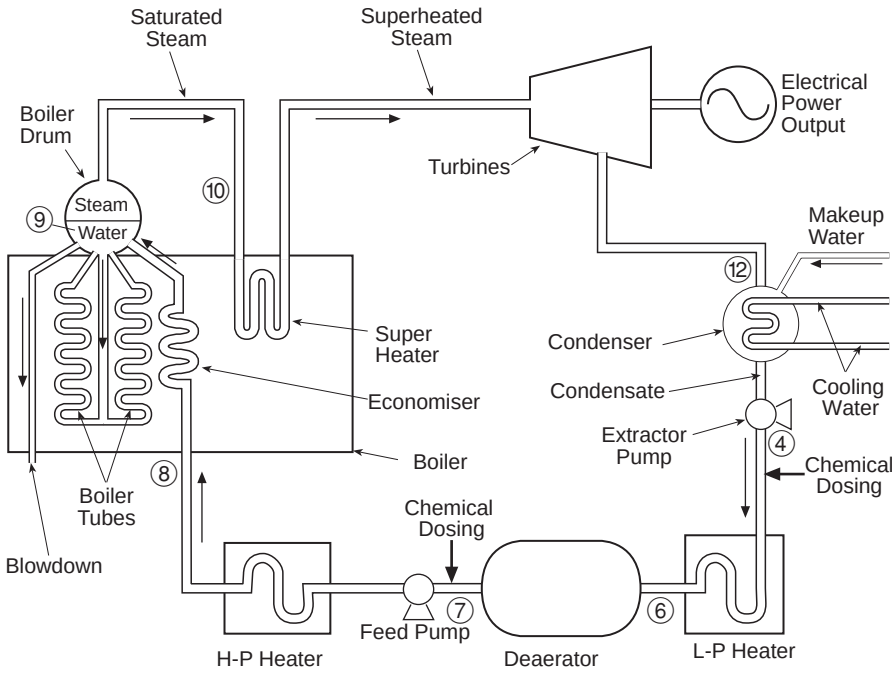

Fig. 2 Typical Generating Station Steam/Water Cycle for a Drum Boiler

What is hydrazine?

Hydrazine is a colourless liquid which boils at 113°C and is very soluble in water. It is not a naturally occurring substance, and being a compound of nitrogen and hydrogen, it has the chemical formula N_2H_4. It is a powerful reducing agent and will reduce oxygen to form nitrogen and water as follows:

$$N_2H_4 + O_2 \Rightarrow N_2 = 2H_2O$$

At high temperature and pressure, ammonia is also formed, which increases the feedwater pH level, reducing the risk of acidic corrosion. Hydrazine also reacts with soft haematite layers on the boiler tubes and forms a hard magnetite layer, which subsequently protects the boiler tubes from further corrosion. This occurs as a result of the chemical reaction:

$$N_2H_4 + 6Fe_2O_3 \Rightarrow 4Fe_3O_4 + N_{2+}2H_2O$$

Sample Points

The typical sample points for chemical monitoring are as shown in Fig. 1. Details of specific sample points where dissolved oxygen and hydrazine monitoring is carried out are as follows:

④ – Extraction Pump Discharge

The extraction pump, which operates under a vacuum, draws water out of the condenser. By monitoring the dissolved oxygen levels at the extraction pump discharge, oxygen ingress via extraction pump glands or condenser leaks can be monitored.

⑥ / ⑦ – De-aerator inlet/outlet

Dissolved oxygen levels in the condensate and in the make-up water will be higher than acceptable. The mixture of condensate and added make-up water is pumped into the aerator, which heats the water, under vacuum, and thus removes most of the dissolved oxygen. The de-aerator inlet and outlet are monitored for dissolved oxygen to check the efficiency of the de-aerator, as to whether it has developed any leaks through its casing, glands, fittings etc.

⑧ – Economiser Inlet (Boiler Feed); Boiler Inlet (Once Through Boilers)

The boiler feedwater is dosed with hydrazine as an oxygen scavenger. To monitor the effectiveness of the hydrazine dosing, a dissolved oxygen monitor is placed at the economiser inlet. This is to check that acceptable levels of dissolved oxygen have been removed (normally to below $5\mu gkg^{-1}$).

A hydrazine monitor is also placed at the economiser inlet to check that the feedwater is being dosed with the correct amount of hydrazine. Too much hydrazine is wasteful and costly; too little hydrazine will result in higher amounts of dissolved oxygen passing into the boiler, causing corrosion, and inhibiting the formation of magnetite.

Typically, the most effective dosage of hydrazine is 3:1 parts hydrazine to the expected level of dissolved oxygen.

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