

Oxygen Attack in Steam and Condensate Systems

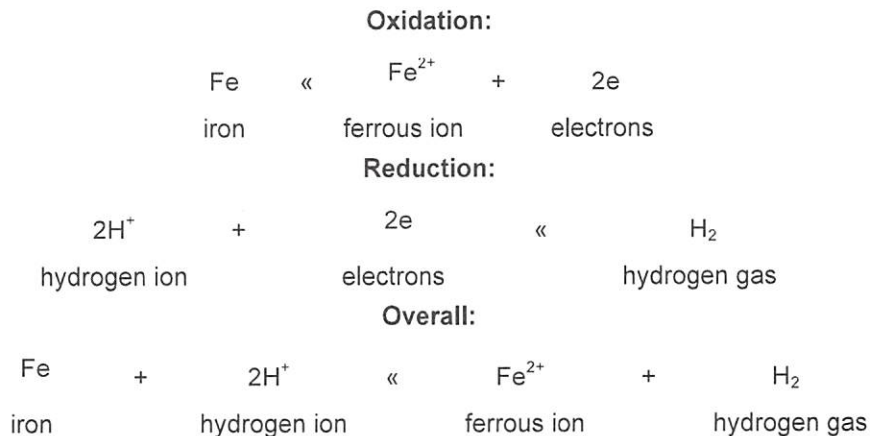
Many STEAM Users find that their Condensate System Piping is under Corrosion Attack And Don't really know why! The Main TWO Culprits are AIR and Lower Return Temperatures!
[Read Here and See Why this is Happening:](#)

Chapter 19 - Condensate System Corrosion (Reprinted Courtesy GE)

Problems caused by iron and copper corrosion in condensate systems are not restricted to piping and equipment damage or to the loss of high-quality water and heat energy when condensate is lost. If returned to the boiler, corrosion products and process chemicals from corrosion-caused leaks contribute to the formation of damaging boiler deposits, boiler carryover, and steam-driven equipment deposits. Their presence reduces system reliability and increases operation and maintenance costs.

CORROSION OF IRON

Iron corrodes in water even in the absence of oxygen. An iron oxide surface acts like a car battery, with the surface divided into microscopic anodes (+) and cathodes (-). In condensate systems, iron acts as an anode so that it is oxidized (i.e., gives its electrons to the cathode). The cathode in pure water is a proton or hydrogen ion (H^+). When iron metal is oxidized, electrons are passed from the iron surface to hydrogen ions as shown in the reactions below.



The fate of the ferrous ion (Fe^{2+}) depends on condensate temperature, pH, and flow conditions. At low temperatures, Fe^{2+} reacts with water to form insoluble ferrous hydroxide, $Fe(OH)_2$. If the condensate stream velocity is high enough, colloidal $Fe(OH)_2$ is swept into the water and carried downstream to deposit elsewhere. In low-flow areas of the condensate system, $Fe(OH)_2$ deposits near the oxidation site, forming a porous oxide layer.

At temperatures above 120°F the deposited ferrous hydroxide reacts further to form surface-bound magnetite (Fe_3O_4) crystals.

In a good steam system design, the air-condensate contact is minimized or eliminated to prevent oxygen absorption. The condensate receiving tank can be designed with a cover to reduce air contact and a steam heating coil within the tank to elevate condensate temperature and thereby reduce oxygen solubility.

Under certain conditions, gross oxygen contamination of the condensate may be unavoidable. For example, condensate from warm-up steam for equipment used only intermittently should not be saved. Its dissolved oxygen attacks systems between the point of condensation and the deaerating heater. This contaminated condensate can return large amounts of corrosion products to the boiler.

In most cases, proper feedwater deaeration and elimination of air infiltration into the condensate substantially reduce oxygen corrosion