Deaeration | Why & How in Industrial Water Conditioning

For more than a century COCHRANE® by newterra has been associated with the art of conditioning water to prevent corrosion, including heating, deaeration and all phases of water treatment.

Why Industrial Water Conditioning?

Corrosion of iron or steel is influenced by three fundamental factors:

1. Temperature
2. pH value
3. Oxygen content

Temperature and pH value control the activity or aggressiveness or corrosion (high temperatures and low pH values increase aggressiveness). The oxygen content is a large factor in determining the extent or amount of corrosion.
Figure 1 illustrates the expected oxygen content of raw water at various temperatures.

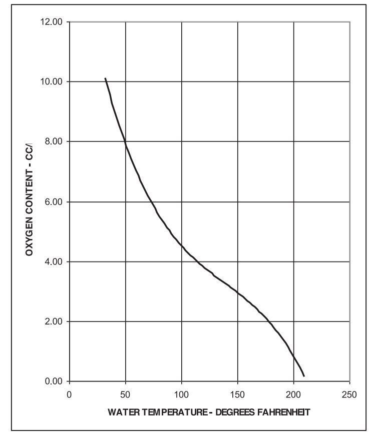

Figure 1

Iron goes into solution in pure water to a slight extent, according to the formula $Fe+2H_2O \rightarrow Fe(OH)_2+H_2$ but the ferrous hydrate $Fe(OH)_2$ formed is alkaline and raises the pH value. At a definite pH value further dissolving of iron is stopped. However, if oxygen is present it immediately oxidizes the ferrous hydrate forming ferric hydrate $Fe(OH)_3$, which is insoluble and precipitates, permitting more iron to go into solution and thus the reaction continues until all oxygen is dissipated.

It is evident, therefore, that the removal of oxygen and carbon dioxide from solution is important and essential when conditioning water for industrial use. This is particularly true when boilerfeed water and process water are used at elevated temperatures.

How Does Industrial Water Conditioning Takes Place?

Deaeration is the mechanical removal of dissolved gases from a fluid. The process of deaeration is most frequently applied in boiler feed water heaters to protect piping, boilers and condensate equipment from corrosion. In other applications deaeration of cold water is necessary to protect pipe lines and equipment from corrosion, as well as to provide oxygen-free water required in some processes. Deaeration of service water for buildings and institutions is desirable in order to protect distribution systems.

Since 1885 when COCHRANE Feed Water Heaters were first installed, continual improvements of higher steam pressures and more advanced boiler design and practice.

The three cardinal principals that must be satisfied in any mechanical deaerator are:

Heating: Water must be heated to full saturation temperature (boiling point), corresponding to the steam pressure in the unit. Since, theoretically, the solubility of any gas is zero at the boiling point of the liquid, complete gas removal is not possible unless the liquid is kept at boiling temperature.

For operation at sub-atmospheric pressures, as is the case with cold water deaerators, evacuation or heating or both, must be applied to create this boiling condition.

Mechanical Agitation: The heated water must be mechanically agitated, by spraying, cascading over trays, or by atomization, to expose maximum surface contact to the scrubbing atmosphere, thus permitting complete release and removal of gases. When water is broken down into fine droplets for thin films, the distance that the gas bubble must travel for release is greatly decreased. Thorough agitation also overcomes tendencies of surface tension and viscosity to retain the gas bubbles and increases the rate of gas diffusion from the liquid to the surrounding atmosphere. The deaerating equipment, therefore, must provide the most efficient mechanical agitation possible to permit meeting modern requirements of gas removal. Since a normal warranty of *"less than 0.005 cc per litre of oxygen"* means less than 7 pounds in a billion pounds of water, the importance of effective agitation cannot be overstressed.

Complete Gas Removal: Adequate steam must be passed through the water to scrub out and carry away the gases after release. Extremely low partial gas pressure must be maintained since Henry's Law states that the amount of gas which will dissolve in a

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liquid is proportional to the partial gas pressure in the atmosphere contacting the liquid. It is mandatory that the volume of scrubbing steam be high to produce the low partial gas pressure, and it is equally mandatory that these conditions prevail throughout the deaerating section. The effect of partial gas pressure and heating is illustrated in **Figure 2**.

Deaerator Types

COCHRANE by newterra provides five types of deaerators:

Parallel Flow Tray (Jet Tray), counterflow tray, atomizing, spray scrubber, and cold water type. All designs employ the cardinal principles of deaeration outlined above.

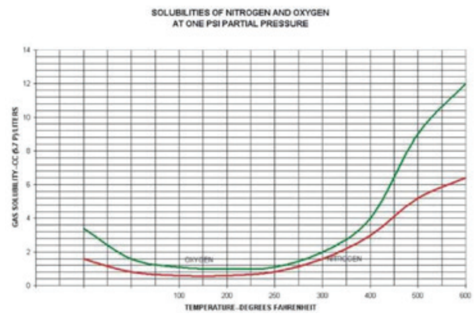

Figure 2

Tray and Jet Tray Deaerators

Tray type units are most widely used for deaerating boiler feedwater in industrial plants and central generating stations. Water is heated to full saturation temperature with minimum pressure drop and minimum vent, thereby assuring best thermal efficiency. Deaeration is accomplished by spreading the water over multiple layers of trays designed to break the water into thin films and drops to promote intimate contact with the scrubbing steam. Jet tray (parallel downflow) designs provide maximum flexibility for application, and will handle any combination of condensate and make-up. Counterflow designs provide best economy for plants having low make-up requirements (higher condensate return percentage).

Atomizing Deaerators

This is widely used in marine applications since it is unaffected by normal roll and pitch of the vessel. Widespread use in industrial plants occurs particularly where operating pressures are stable. The Atomizing type employs a high velocity steam jet to atomize and scrub the preheated water. The breakup of water into fog-like particles assures maximum surface exposure and intimacy of contact necessary for complete deaeration.

The atomizing device features a variable orifice that is self adjusting to changes in load or feedwater conditions, maintaining high steam jet velocity and permitting operation over a range from 5% to 100% of rating.

Cold Water Deaerators

Cold Water deaerators are used primarily to eliminate corrosive gases from cooling water, demineralization systems and industrial water supplies without the addition of heat.

The boiling condition is accomplished by pressure reduction with vacuum-producing equipment. Surface contact with scrubbing vapor is provided by a packing or Raschig rings.

Spray Scrubber Type

This type of spray deaerator may be applied in those plants where operating loads are maintained at a steady high level (>50% of rating) and operating pressure is steady.

Like atomizing type, the scrubber uses steam energy to break up the water flow and create a turbulent mixture of steam and water for attaining final deaeration. Unlike the atomizing type, scrubber types have a fixed steam orifice area which prevents efficient deaeration at loads less than 50% of rating.

Conclusion

The necessity for deaeration of boiler feed and process water has become so recognized that even small plants now assure longer equipment life and reduced maintenance by employing some type of deaeration.

Deaeration today is an important factor in the successful and economical operation of any modern boiler plant, regardless of its size.