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DEAERATOR HISTORY

Today's modern deaerator is the result of many years of development. The principal of heating water by direct and intimate contact with steam was known long before it could be applied on a practical basis. For many years most plants operated boilers at low pressures and exhaust steam supplies from reciprocating engines were contaminated with oil.

In the late 1800's the first practical oil separator was developed. This permitted the commercial use of open heaters. The initial use of these open heaters was for the thermal advantages afforded, although it was recognized as early as 1890 that dissolved gases were liberated to a large degree by this device. But the main attraction was BTU recovery from exhaust steam, since about a 1% fuel saving was realized for each 11°F that the feed water temperature was raised. At this time, feed water treatments were relatively crude, and it was common for boilers to contain enough scale to protect metal surfaces from attack by oxygen.

As the years passed, more efficient feed water treatments developed, boiler metal surfaces were maintained free from scale, and the problem of oxygen corrosion became more pronounced. This corrosion along with a trend to higher boiler pressures and the resultant increase in the temperature of the boiler water, highlighted the need .for more efficient deaeration equipment. Oxygen attack on boiler metal is accelerated with increased temperatures.

In the early 1920's the first open feed water heater was designed to specifically to remove dissolved gases. This initial design was a counter-flow tray deaerator with a re-boiler coil arranged in the storage section, and an internal vent condenser water box.

Operating experience with this counter-flow design, highlighted it's limitations. In theory, idea of steam flowing in opposite direction to water seemed proper, but at high loads steam would tend, to hold water up in the tray bank with resultant noise, water hammer and poor distribution. In an attempt to permit free passage of water and steam in opposite flow directions, the tray openings had to be unnecessarily large, with the result that valuable "spilling edge" was held to low limits.

In the mid 1920's the counter-flow design was abandoned in favor of a cross-flow design, that incorporated "air separating" trays. But the cross-flow principle also had serious design limitations. As loads went up. so did steam velocity, which tended to blow water to one side of the tray-stack. causing short-circuiting of steam and poor distribution of water.

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Consequently, by the late 1920's the cross-flow was abandoned, and the parallel down-flow deaerator was developed. This deaerator not only gave more efficient gas removal, but also overcame the inherent problems of the earlier counter-flow and cross-flow designs. Water sprayed into a steam space above the trays, then and cascaded downward through the tray bank. Steam was directed through a perforated baffle above the trays and also flowed down through the tray bank.

The down-flow design provides the following advantages:

1. The co-flow, down flow path of the steam, assists water distribution and flow through trays at all loads. .

2. Tray openings are narrower, and for a given diameter shell, permit a greater number of slots, and substantially greater spilling edge. In the current down-flow designs, the lineal feet of tray spilling edge is tremendous. For example. in one down-flow design of 500,000 #/hr hour outlet capacity, there is more than 13.000 lineal feet of spilling edge. This is a critical factor in determining guarantees of 7 parts per billion of oxygen in the deaerator effluent.

3. The down-flow design permits enclosing or sealing of the entire tray bank, thus liberated gases are kept from contacting the main heater shell.

Further refinements of the parallel down-flow deaerator resulted in the mid 1930's design that allowed operation under the most severe conditions of operation, such as handling 100% makeup water at very low inlet temperatures, and an effluent oxygen content of less than 0.005 cc/litre or 7 ppb (commonly accepted as zero O_2). This design has also won wide acceptance in Central Station power plants, where typically the inlet water is usually 100% condensate at relatively high temperature. Under this condition, the terminal temperature difference (steam temperature minus inlet water temperature) is low, so the quantity of steam passing through the deaerator is relatively small.

Typically, these deaerators operate on the extraction line of the turbine, with the result that steam pressures on the deaerator will vary over a wide range. At higher pressures the specific volume of steam is low, so obviously it becomes essential to make the most efficient use of this steam, if deaeration is to be complete. Since most plants of this type utilize very high boiler pressures, the performance of the deaerator becomes a major factor in the operation of the plant.

In the parallel down-flow design, the inlet water is sprayed into an upper preheating/vent condensing area where it is heated to within a few degrees of steam temperature.

The combination of spraying and heating action, liberates the bulk of dissolved gases, usually in the order of 90% or more.

The preheated, almost completely deaerated water flows downward through a water seal, then downward through the tray stacks. The purpose of the water seal is important, since it prevents the gases liberated in the preheating/vent condensing compartment from entering the tray bank. It also prevents short-circuiting of incoming steam into the preheating section.

Since the water leaving the preheating compartment is within a few degrees of steam temperature before entering trays, the principal function of the tray bank is in scrubbing out the remaining small amounts of oxygen. Practically no condensation of steam occurs in the tray bank, allowing the entire volume of pure steam to be used for scrubbing action alone.

Steam after flowing downward through the tray bank in parallel with the flow of the water, leaves the bottom of the tray bank, and is directed to the preheating/vent condenser section where it is condensed in heating incoming water. The inlet spray arrangement is, in itself, a direct contact vent condenser. The steam must pass directly through sprays of incoming water before reaching the vent opening.

The passing years have seen the re-emergence of the counter-flow design, and the development of many other types of deaerating feed water heaters, such as the atomizing, fixed orifice, packed tower, and re-boiler type designs. All have evolved, and found success, when used in applications that have limited ranges of operation, and plant conditions.

The same basic parallel down-flow design deaerator, developed in the 1930's, remains the choice when zero O_2 is required, over a broad spectrum of inlet water flow rates, temperatures, and plant operating conditions.

The parallel down-flow design units are the most widely used type of deaerating heater, with 1000's of successful installations world-wide.

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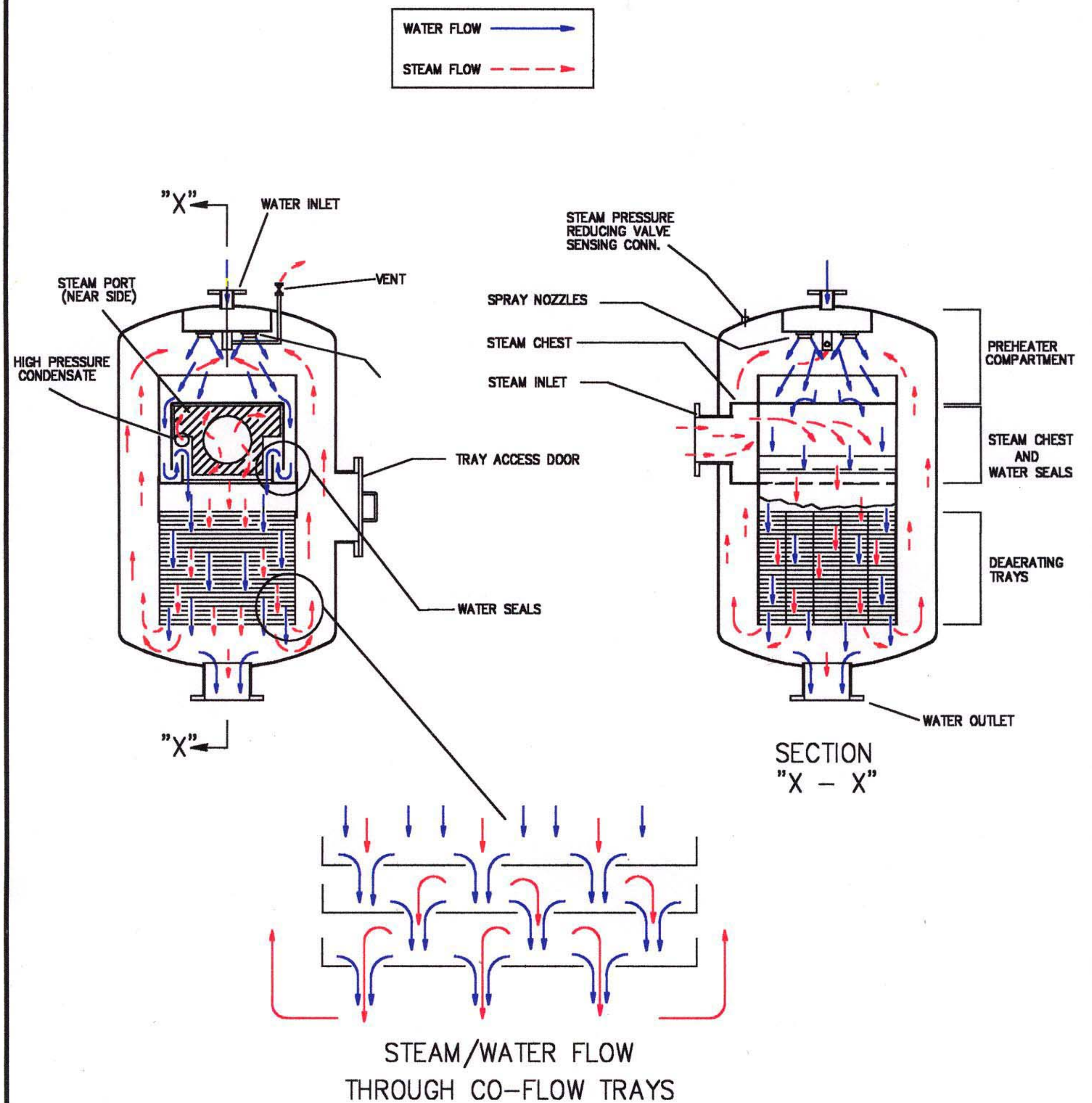

DOWN–FLOW DEAERATOR