ALTAIR EQUIPMENT CO.,INC.
Water Treatment Technologies
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DEAERATORS

Why Deaeration

Corrosion of iron or steel in boilers or boilers feed water piping is caused by three fundamental factors:

1. Feedwater temperature
2. Feed water ph value
3. Feedwater oxygen content

Temperature and ph value influence the aggressiveness of corrosion. The higher the temperature, and the lower the pH value the increased aggressiveness of the feedwater. The dissolved oxygen content of the feedwater is a large factor in determining the amount of corrosion that will take place. The presence of oxygen, and other non-condensable gases, in the feedwater is a major cause of corrosion in the feedwater piping, boiler, and condensate handling equipment.

Deaerator Principles

Deaeration is the mechanical removal of dissolved gases from the boiler feedwater. There are three principles that must be met in the design of any deaerator.

1. The incoming feedwater must be heated to the full saturation temperature, corresponding to the steam pressure maintained inside the deaerator . This will lower the solubility of the dissolved gases to zero.

2. The heated feedwater must be mechanically agitated. This is accomplished in a tray deaerator by first spraying the water in a thin film into a steam atmosphere. Creating a thin film reduces the distance the gas bubble has to travel to be released from the water. Next, the water is cascaded over a bank of slotted trays, further reducing the surface tension of the water. This allows for the removal of any gases not liberated by the initial spraying.

3. Adequate steam supply must be passed through the water, in both the spray section and the tray section to sweep out the gases from the water.

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Deaerator Designs

Over the years, various types of deaerators have been developed. They are the counter-flow tray type, the atomizer type, the packed tower type, and the parallel downflow type, to name a few. Altair offers two types of deaerators that it feels meets the requirements of most installations. These two types are the packed tower, and the parallel downflow.

- Counterflow deaerators

  Disadvantages

  1. Inability to deliver 0.007 ppb outlet quality in applications with a low inlet water temperature, or when 100% make-up is required.
  2. Low tray loading. This reduces the flow rating for a given diameter deaerator vs. a parallel downflow unit.
  3. High vent rate. This reduces operating efficiency

  Advantages

  1. The counter flow deaerator is cheaper to manufacture.

  Conclusion

  Altair feels the higher capacity, and the ability to perform under varying steam and water conditions makes the parallel downflow (and packed tower for smaller applications) design competitive, and the only logical choice.

- Atomizer deaerators

  Disadvantages

  1. Inability to deliver 7 ppb outlet quality when plant conditions vary from design specifications. Requires constant plant conditions.
  2. Failure rate of the atomizer valve, and maintenance required to keep it operating properly.

  Advantages

  1. Low cost
  2. Low overall height

  Conclusion

  Altair experience indicates that the atomizer type deaerator is only effective when applied to an application with no plant or process swings. Along with the maintenance required, this type deaerator, while inexpensive, has only limited applications.

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- Parallel downflow

  Disadvantages

  1. More complicated design, resulting in slightly higher cost

  Advantages

  1. Time proven design
  2. Thousands of installations worldwide
  3. Design suitable for small to medium size plants
  4. Can meet outlet guarantees at varying plant conditions.
  5. High tray loading, resulting in higher outlet capacity for any given diameter.
  6. Large tray spilling edge, resulting in high deaerating efficiency
  7. Low vent rate, resulting in increased operating efficiency.

Conclusion

Altair has standardized on the parallel downflow design, due to the obvious design and operational advantages. Altair is one of only two manufactures that can produce this type deaerator. Altair's low overheads allow it to offer this type unit at a very competitive selling price.

- Packed tower

  Disadvantages

  1. Height requirement
  2. Typically considered for small size plants.

  Advantages

  1. Low cost
  2. Low maintenance
  3. Ability to handle varying plant conditions

Conclusion

Altair has developed this design to meet the requirements for a reliable deaerator capable of producing completely deaerated water for small plants. Altair's proprietary packed tower design includes multi-stage deaeration, to deliver top performance.

Description of Altair Deaerator Operation

- *Parallel downflow*

  In this design, the inlet water is sprayed into a steam atmosphere through variable orifice, spring loaded spray nozzle(s). This action heats the water to within 2 to 3 degrees of the steam temperature, while liberating 90% to 95% of the dissolved gases.

  This pre-heated, partially departed water then flows down through a water seal(s) for distribution over the tray bank. The water seal(s) serve two functions. First they prevent gases liberated in the initiate heating, from entering the tray bank. Second they direct the steam to flow down through the trays, before entering the upper heating section.

  The main function of the tray bank is to remove the remaining amounts of dissolved gases, not liberated in the initial heating. Since very little, or no heating takes place in the trays, the entire volume of steam is used to scrub out the remaining gases. The trays are slotted, and provide a great amount of spilling edge. This allows for a great amount of water surface area to be exposed to the steam. Water flows downward through the trays. Steam flows downward through the trays. Thus the name parallel downflow.

  The steam, after exiting the tray bank, then flows upward into the top of the deaerator where it is used to heat the incoming water being discharged by the spray nozzles. The steam is condensed by the colder inlet water, and a small amount is vented to atmosphere, along with the dissolved gases.

  The deaerated water flows from the deaerator down into the storage tank. The stored water is covered by a steam blanket, to maintain heat, pressure, and prevent recontamination of the deaerated water.

- *Packed tower*

  In this proprietary Altair design, the inlet water is sprayed into a steam atmosphere through a variable orifice, spring loaded spray nozzle. This action heats the water to within 2 to 3 degrees of the steam temperature, while liberating 90% to 95% of the dissolved gases.

  The heated water flows down onto a distribution plate. This plate evenly distributes the water over the entire cross-sectional area of the tower packing.

  As the water flows down through the distribution plate it enters a steam chest area, where the water is further heated by upflowing steam, and more of the dissolved gases are liberated.

  Any remaining dissolved gases are removed when the water flows down from the steam chest and then down through the packing tower. The packing tower function is to expose a greater surface area of the water, while upflowing steam completes the deaeration process.

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The water leaving the bottom of the packing tower, is given a final scrubbing of steam. The steam, entering the deaerator from below the packing tower, is introduced through a fixed orifice steam distributor. This steam distributor directs high velocity steam through the downflowing water leaving the bottom of the packing tower.

The departed water flows from the deaerator down into the storage tank. The stored water is covered by a steam blanket, to maintain heat, pressure, and prevent recontamination of the deaerated water.