Aquatech

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Industrial Concentration & Desalination

Multi-Stage Flash

Brine Recirculation Seawater Distillation Plant

Overview
The Multistage Flash Evaporator produces distilled water from feedwater by heating it until it is ready to flash. The flashed vapor is drawn to the cooler tube bundle surfaces where it is condensed and collected as distillate. Flashing occurs when heated brine is turbulated in a chamber that is maintained at a lower vapor pressure than that of the entering heated brine. Heat is given up by the brine and a portion converted into vapor until the temperature of the brine reaches the saturation temperature corresponding to the chamber pressure. In other words, the heated brine is flashed off by a pressure reduction.

Entrained brine droplets are removed from the vapor by entrainment separators and the pure vapor condenses into distillate on the condenser tubes. The distillation process operates from a low vacuum in the first stage to a high vacuum in the last stage, with stage-to-stage pressure differential being the key to the repeated flashing.

Initial vacuum in the stages is created by the high-pressure steam-driven ejector/condenser vacuum system.
The brine recirculation system is designed to operate at a top temperature of 110°C (230°F). In order to achieve long run operation of the unit, it is necessary to retard the formation of scale on the heat transfer surfaces. This is accomplished through the chemical treatment systems described later.

The acid-treated brine recirculation system permits operation at higher evaporator temperatures and, at the same time, reduces the amount of feed water chemical treatment required compared with that which would be required for once-through operation at the same temperature.

Brine/Circulating Water Flow
Filtered raw seawater is pumped through the condenser tubes of the heat rejection stages and is discharged. The cool feedwater flowing through the condenser tubes dissipates the heat in these last stages. A portion of raw seawater is withdrawn as make-up water and the remainder is discharged to the sea. The make-up water is deaerated to remove the non-condensable gases and is treated with sulfuric acid for scale control purposes. The deaerated feedwater is introduced into the brine section of the last stage and mixes with the recirculating brine flow. The mixture of recirculated brine and deaerated feedwater is pumped through the condenser tubes of the heat recovery stages and the brine heater by the brine recirculating pump.

In order to maintain a material balance in the system and control the maximum brine concentration, a portion of the concentrated brine from the last stage is discharged to the ocean as blowdown. The blowdown flow rate is controlled by the brine level in the last stage. As the brine flows through the condenser tubes of the heat recovery stages, it is progressively heated in each stage by flashing brine vapor condensing on the outer tube surfaces. The brine then passes through the tubes of the brine heater for final heating to the design top temperature of 110°C. The heated recirculating brine is directed to the shell side of the first stage for flashing. The recirculating brine flows into each stage, flashes down, and is discharged from the last stage.

Condensate Flow
Low-pressure steam is used to heat the recirculating brine flowing through the tubes of the brine heater.
The low-pressure steam is piped into the shell side of the brine heater and, by transfer of its heat to the recirculating brine flow, condenses on the outer tube surfaces. Thus, the recirculating brine is heated to its design top temperature.

Aquatech International Corporation
One-Four Coins Drive; Canonsburg, PA 15317 USA t) 724 746 5300 f) 724 746 5359

Condensate formed by the condensing steam is piped to the condensate pump and is pumped to the condensate return system.

Distillate Flow
Distillate is formed on the stage condenser tubes by condensation of the flashed brine vapor. The distillate collects in a distillate trough which is common to all the stages and flows from the first stage to the last stage. From there it is pumped into the distillate storage system.

Vacuum System
High pressure steam is used to drive ejectors to create the initial vacuum in the evaporator. Once the plant is in normal operation, the vacuum is maintained by the condensing action in each stage, supported by the ejectors. The ejectors also evacuate non-condensables from the evaporators. The spent high pressure steam and the non-condensables are discharged from the ejectors into condensers where the steam is condensed and the non-condensables are vented to atmosphere.

Acid and Antifoam Injection Systems
A measured amount of sulfuric acid is continuously injected into the make-up flow to neutralize scale-forming elements in the seawater, thereby preventing formation of scale in the stage and brine heater condensing tubes. A measured amount of anti-foam can be injected into the feedwater stream to reduce the foaming characteristics in the evaporator vessel.