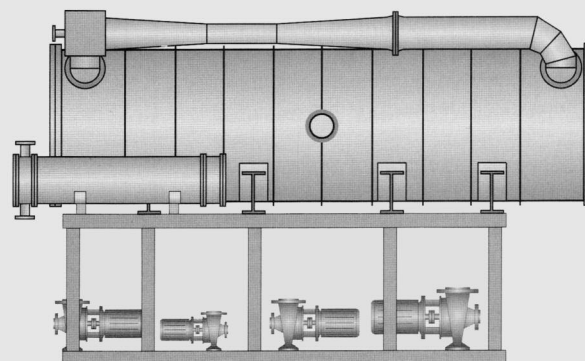




Thermal Vapour Compression (TVC) Evaporators

for sea water desalination



Advantages of TVC-HTE Evaporators:

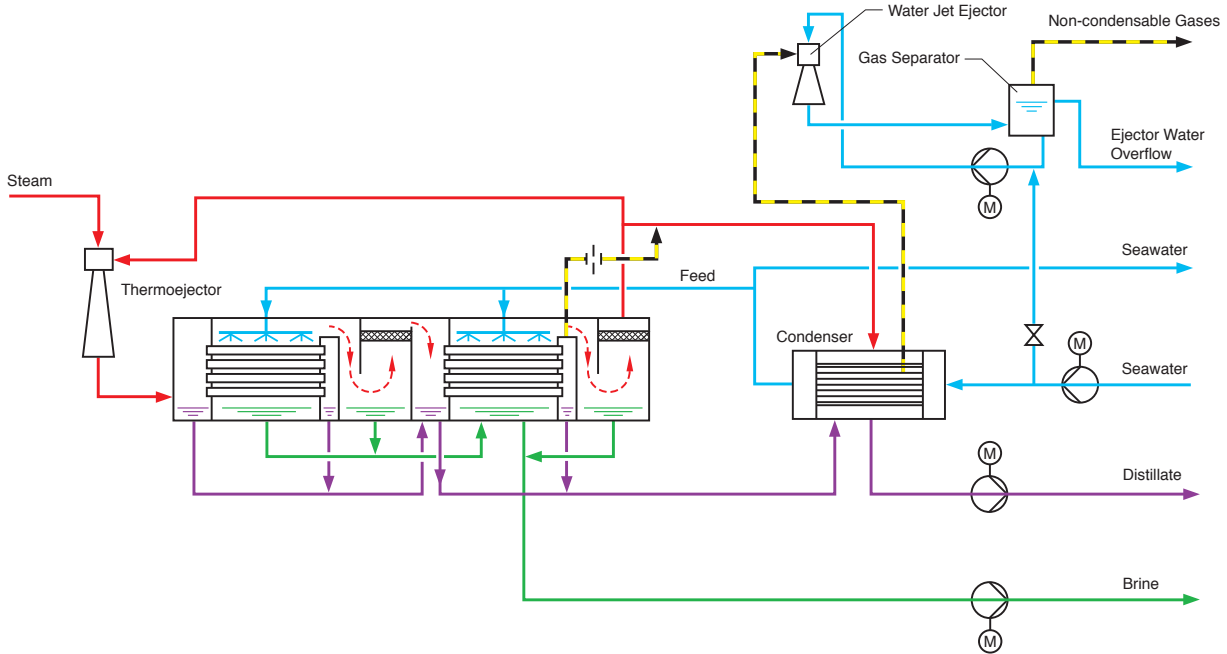
- ▶ Horizontal Tube (spray film) Evaporator (HTE) with a narrow tube bundle design for good wetting of tubes with sea water.
- ▶ Thermal Vapour Compressor (TVC) with adjustable steam nozzle for minimised steam consumption under all load conditions.
- ▶ Highly-efficient mist eliminators (demisters) guarantee optimum distillate quality.
- ▶ Efficient pre-separation of sea water droplets from vapour before entering mist eliminator.
- ▶ Fully automatic operation (start-up, shut-down and partial load).
- ▶ Full-cone, plugging free spray nozzles provide for all uniform feed water distribution.
- ▶ All parts in contact with sea water, brine or vapour are made of corrosion resistant stainless steel or copper-nickel. Titanium tubes can be supplied on request.
- ▶ Evaporators can be delivered as packaged units with all integral piping, pumps, valves, switchboard etc.
- ▶ Seasonal changes of sea water temperature are automatically compensated.
- ▶ Computerised basic and detail engineering as well as manufacture in one hand (own workshop).

Characteristics of TVC-HTE Evaporators:

- ▶ The capacity of our standard or individually designed plants ranges between 100 and 3000 t/d.
- ▶ Distillate salinity is $\leq 10\mu\text{S/cm}$ (4 ppm) or even less if requested.
- ▶ According to the number of effects and the heat transfer surface fitted, the gained output ratio (G.O.R.) ranges between 4.0 and 10.0 kg distillate/kg steam.
- ▶ The sea water flow ranges between 6 to 12 fold of the distillate production.
- ▶ Electric power consumption ranges between 1.0 and 2.0 kWh per m^3 of distillate produced only.
- ▶ Concentration factor is approximately 1.66 sea water flow is correspondingly 2.5 times the distillate production only.
- ▶ Low evaporation temperatures ($\leq 65^\circ\text{C}$) and a limited sea water concentration factor reduces the risk of scale formation on the tubes.
- ▶ The low temperature difference between the process fluids and the large evaporation surfaces result in a low heat flux which further contributes to avoiding scaling.
- ▶ On request a water treatment unit according to WHO - standards can be supplied.



Process flow diagram of 2 Effect TVC-HTE evaporator for sea water desalination



Description of process

The sea water is heated in the end condenser to a temperature of approximately 42°C - 45°C. Most of the sea water serves for cooling only and is fed back to the sea. A smaller residual part - the make-up of sea water - is distributed uniformly in parallel streams and sprayed over the horizontal tube bundles.

While flowing downwards from tube row to tube row, the sea water is partially evaporated. The vapour produced is passed through mist eliminators (demisters) in order to remove the entrained droplets of water. The vapour from the first effect is condensed inside the tubes of the second effect. The vapour produced in the last effect is divided into two streams. The major portion is re-compressed by means of a thermal vapour compressor (steam jet ejector). The smaller part is condensed in the end condenser for rejection of surplus process heat. Due to the vapour compression procedure the condensation temperature of the motive steam/suction steam mixture at the steam ejector outlet is raised.

The temperature difference produced is sufficient to transfer the heat through several heat transfer surfaces connected in series. Brine and distillate flash in parallel streams from one effect to the next are all connected at the cold end of the evaporator. A certain quantity of distillate flows back to the boiler for replacing the consumed ejector motive steam. The start-up vacuum is created and maintained during operation by means of water jet ejector operating in an open loop sea water cycle. The motive water temperature is limited by means of a certain sea water feed and overflow rate. Due to application of the Thermal Vapour Compression (TVC) - the Gained Output Ratio (G.O.R.) as kg of distillate per kg of steam is 2.0 - 2.5 times higher than the number of effects. As compared to plants not utilising TVC, the process simplicity achieved through the lower number of effects saves investment costs. In addition the brine top temperature can be kept low (<65°C) which reduces the risk of scale formation and anti-scale chemical consumption.



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