Vapor Recompression process for recovery of fresh water from salt water

Back ground:

Fresh water is probably the most important resource in the world since it is required for: Sustenance of human life, Agricultural activities, Industrial needs.

Among various processes available for separation of fresh water from salt water, VAPOR RECOMPRESSION is one. In this method, the preheated brine solution is fed to the body of conventional evaporator where steam is formed and then compressed before returning to the tubes of evaporator. The steam condensed give up latent heat to the boiling salt solution. Pure condensate water is passed through feed preheater before being collected as product. Here, compression energy is a major cost item so compression ratio must be kept as low as possible. Pressure differences across the compressor are directly related to temperature differences at the heat transfer surface.

Advantages of vapor recompression:

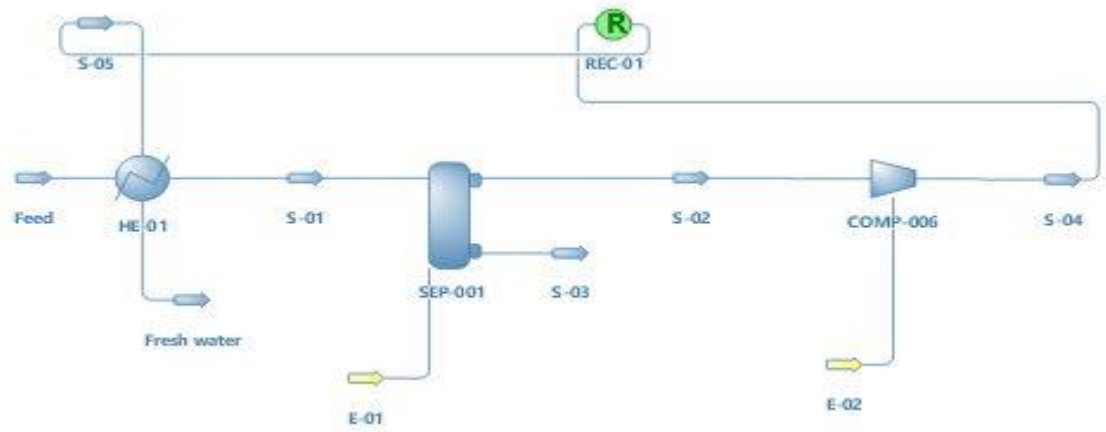
- Requires only one evaporator instead of multiple effect evaporators.
- Has lower energy requirements

Disadvantages of vapor recompression:

- High priced energy in form of electricity or high-pressure steam is needed for operating compressor.

Flowsheet Description:

For the given process suitable property packages are selected and the simulation is carried out.



Consider feed flow of salt water contains 0.8 mole fraction of water and 0.2 mole fraction of salt

- Feed at room temperature is sent into heat exchanger where the latent heat from condensed stream is used to heat up salt solution.

- It is then sent to evaporator(flash-drum) where the steam is removed as it exceeds the boiling temperature of water (i.e. 373.15K)
- The vapor is sent to compressor and with the additional energy given to compressor the condensate is formed.
- For optimization, the compression energy must be low and the pressure ratio should be in range of 1.15-1.25 (In this flowsheet pressure ratio of 1.25 is used)
- This condensate is the fresh water obtained from salt water and sent to feed preheater before removing as product.

Results:

Master property table							
Object	Feed	Fresh water	S-01	S-02	S-04	S-05	
Temperature	298.15	379.116	317.488	373.15	398.165	398.165	K
Pressure	101325	125000	101325	101325	125000	125000	Pa
Mass Flow	1	1.08705	1	1.08705	1.08705	1.08705	kg/s
Molar Flow	33.6663	60.3404	33.6663	60.3404	60.3404	60.3404	mol/s
Volumetric Flow	0.00100296	1.47131	0.00100959	1.81909	1.57589	1.57589	m3/s
Mixture Molar Enthalpy	3116.74	47738.9	55174.3	48201.4	49078.4	49078.4	kJ/kmol
Mixture Molar Entropy	10.908	129.561	18.7096	132.494	133.048	133.048	kJ/[kmol.K]
Vapor Phase Molar Fraction	0	0.984391	0	1	1	1	
Phases	Liquid Only	Mixed	Liquid Only	Vapor Only	Vapor Only	Vapor Only	
Energy Flow	104.929	2880.59	185.752	2908.49	2961.41	2961.41	kW

Conclusions:

- The heat transfer area depends on the compression ratio and should be kept optimum as low compression ratios again require a high heat transfer area
- Vapor recompression has advantage as it uses a single evaporator instead of multiple evaporators.
- Increasing pressure here decreases spontaneity of process

Results:

Results table here