Desalination

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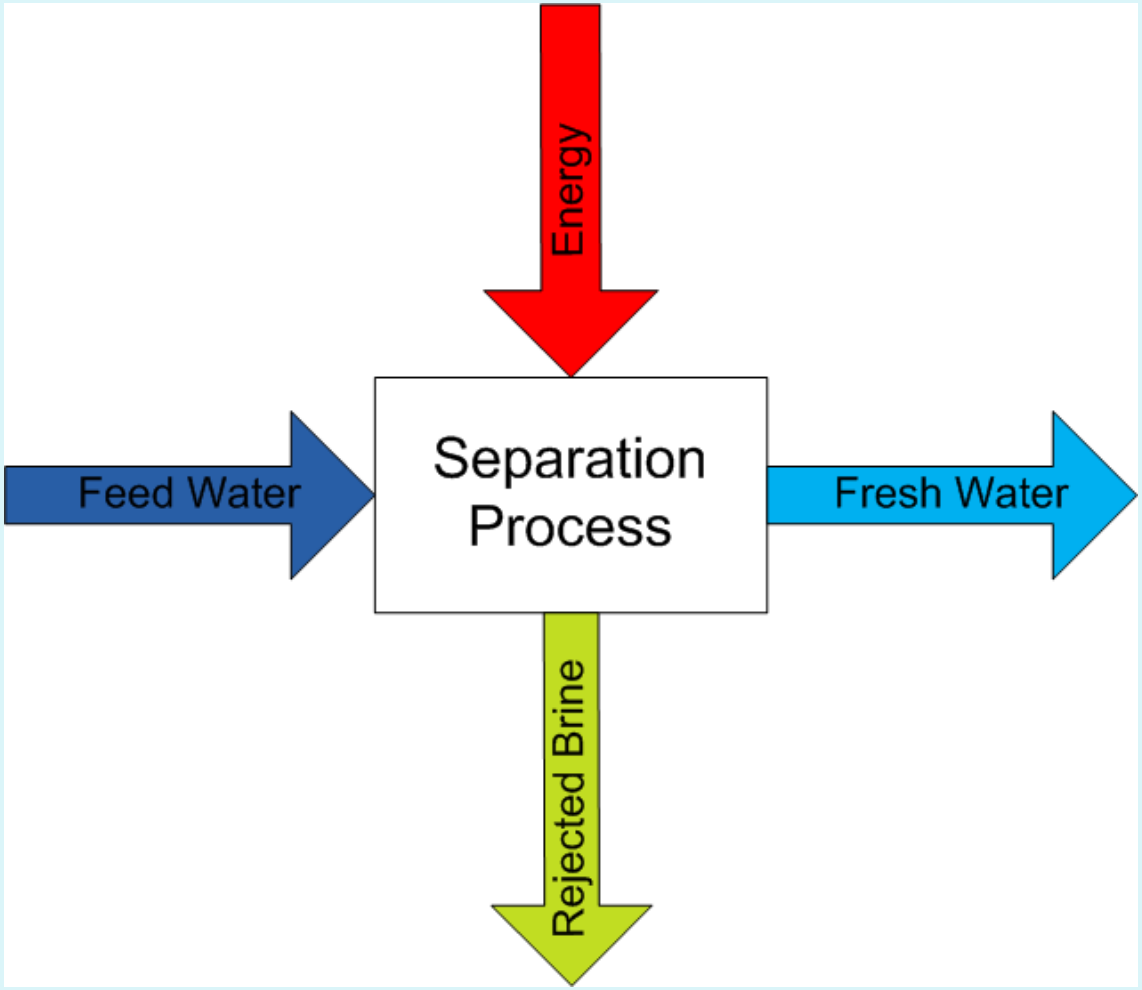
Outlines

1. Salinity
2. Desalination Processes
3. Desalination Barriers.
4. Abu Dhabi Solar Desalination Plant.
5. Useful Resources.

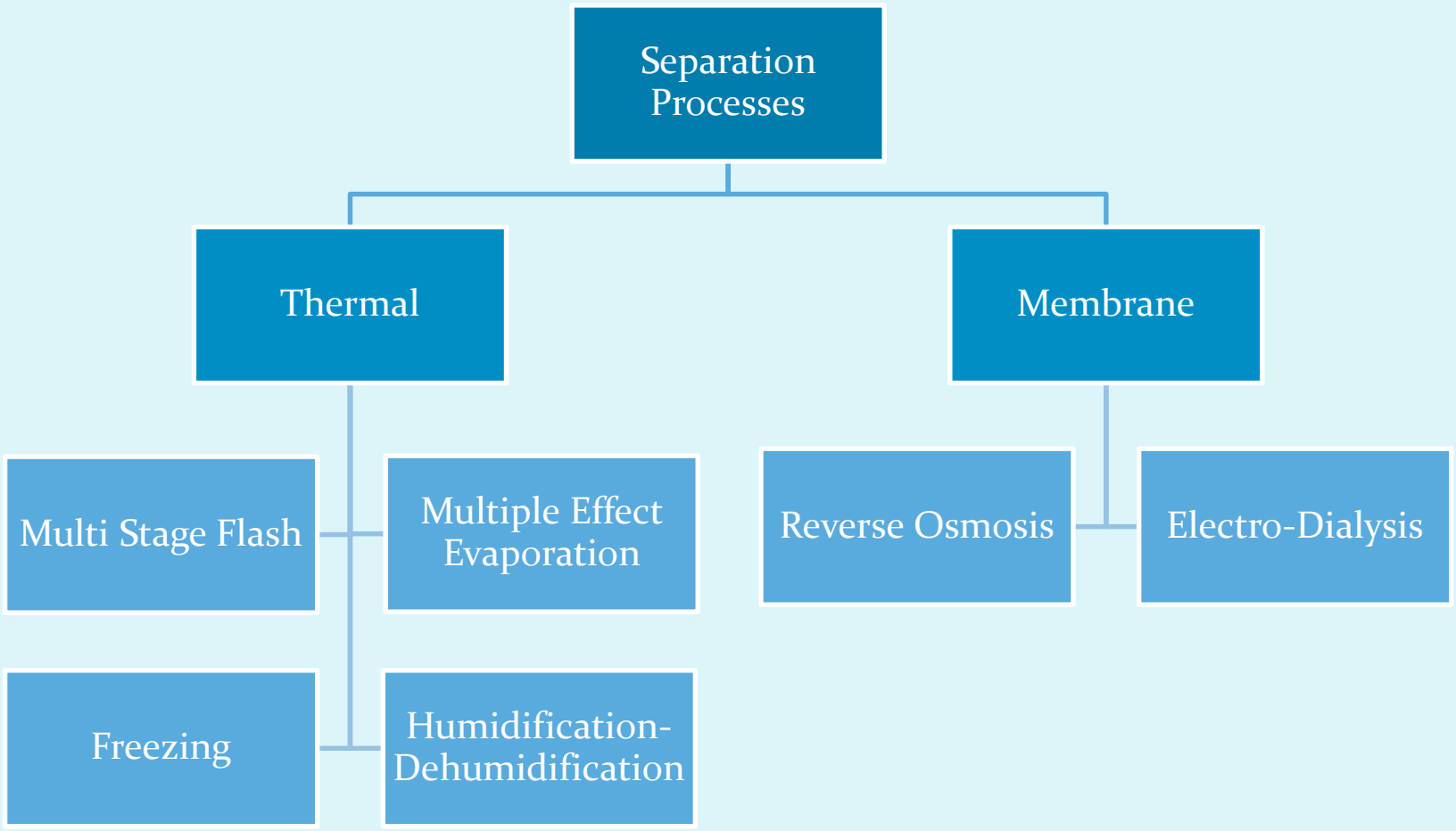
1. Salinity

Salinity			
Concentration of salt in water measured in grams per liter or parts per thousand.			
Fresh Water	**Brackish Water**	**Saline Water**	**Brine**
Less than 0.5 g/l Desalinated Water	0.5-30 g/l Underground Water	30-50 g/l Sea Water	More than 50 g/l Desalination Plants Rejection

2. Desalination Processes



2. Desalination Processes



2.1 Thermal Desalination

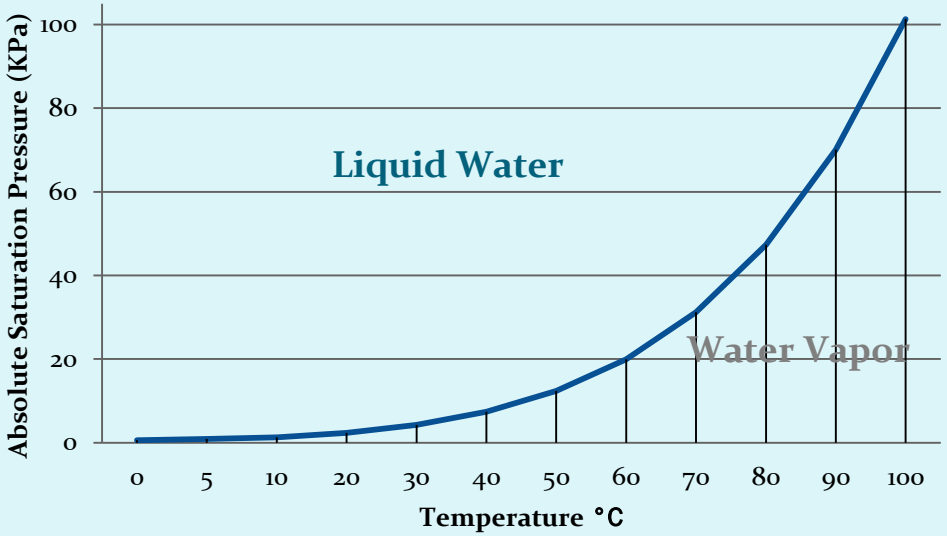
Specific Heat Capacity
Heat required to raise a unit mass by a unit temperature at constant volume or pressure (J/kg.°C).

Sensible Heat	Latent Heat
Heat added or removed and causes change in temperature.	Heat added or removed and causes change in phase.

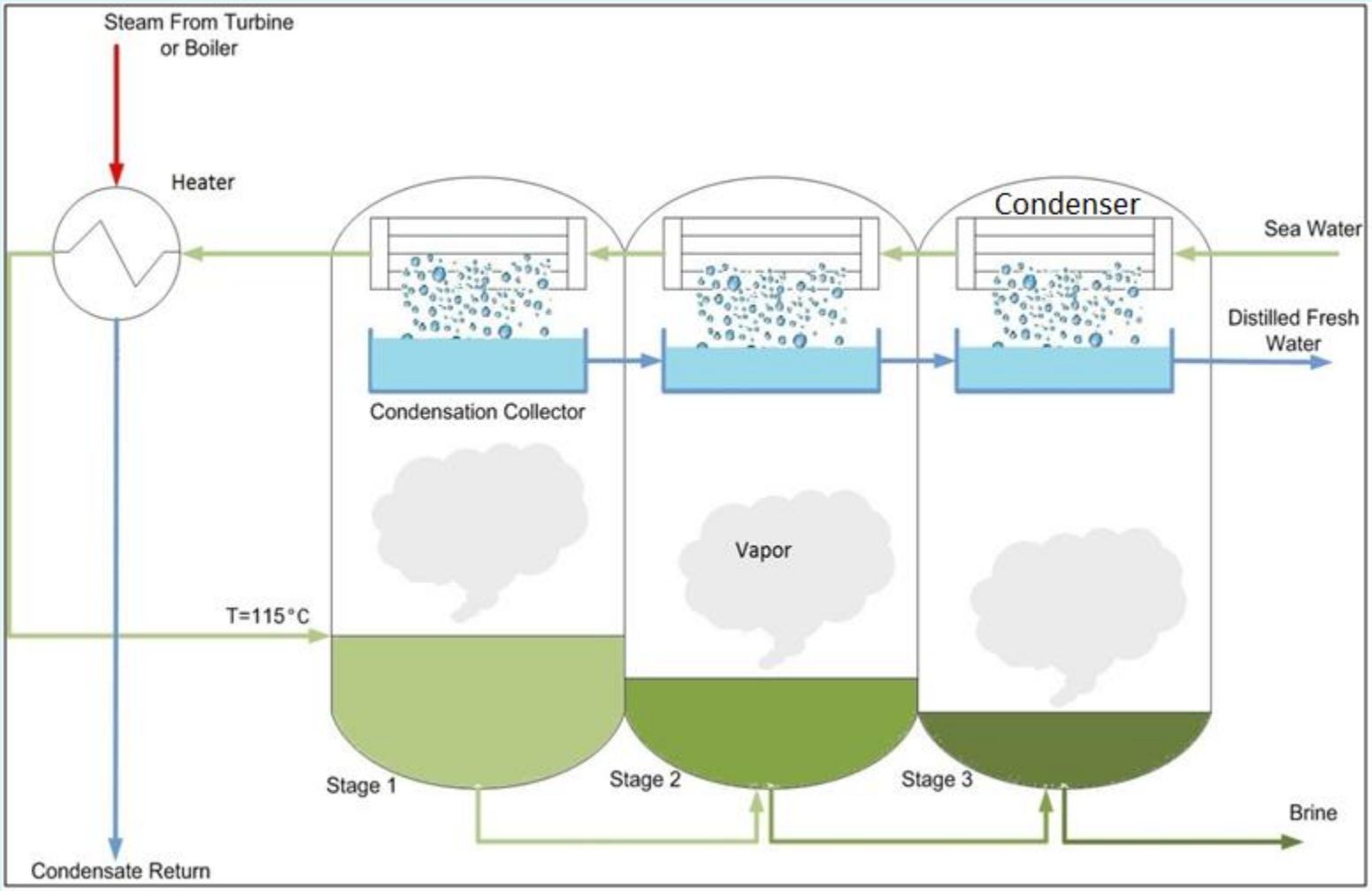
Water Vapor	Water Steam
Gas phase of water.	Water vapor at high pressure and temperature.

2.1 Thermal Desalination

Water Saturation Pressure
Pressure at which water changes its phase at certain temperature.



2.1.1 Multi Stage Flash



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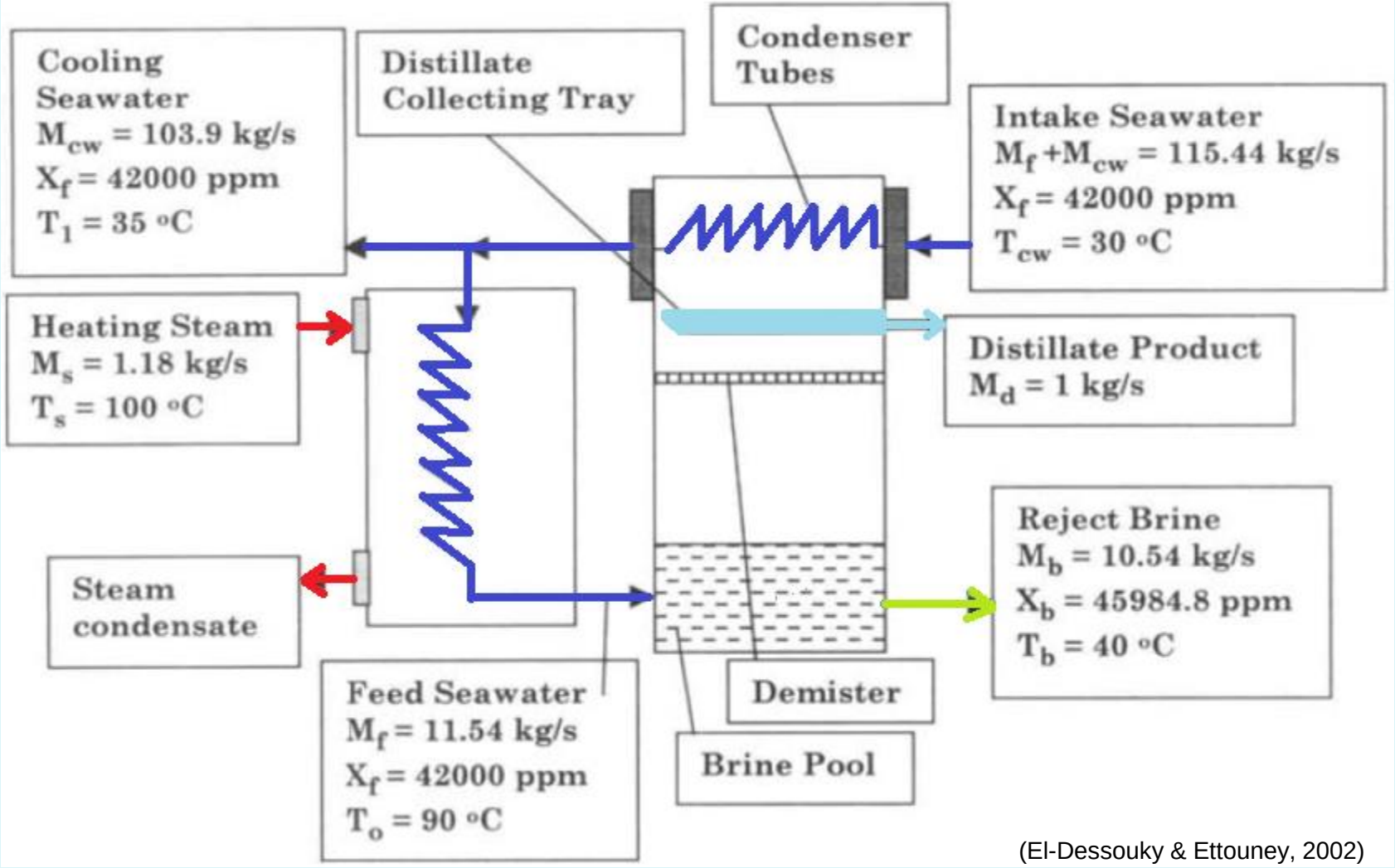
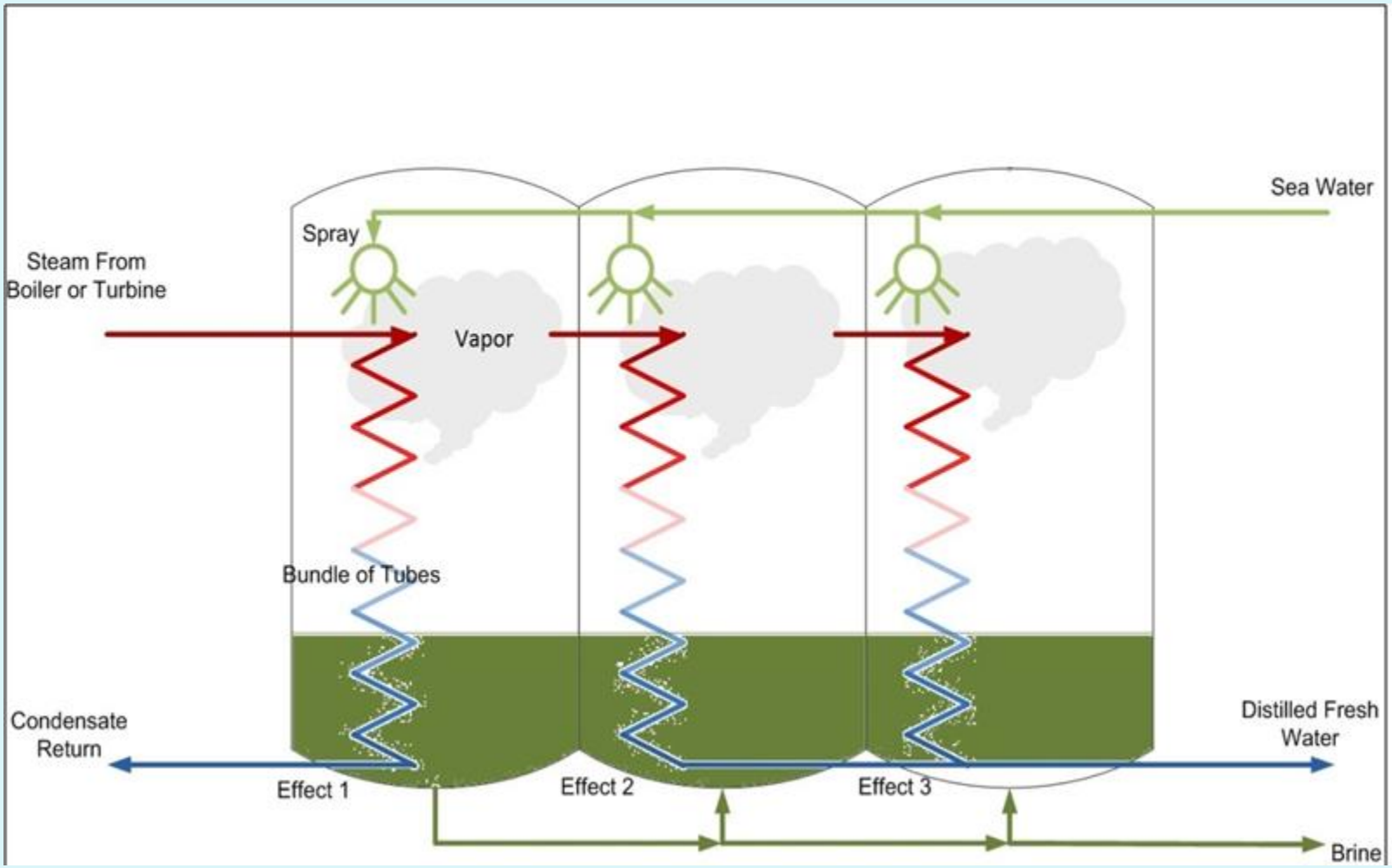


(El-Dessouky & Ettouney, 2002)

2.1.2 Multiple Effect Evaporation



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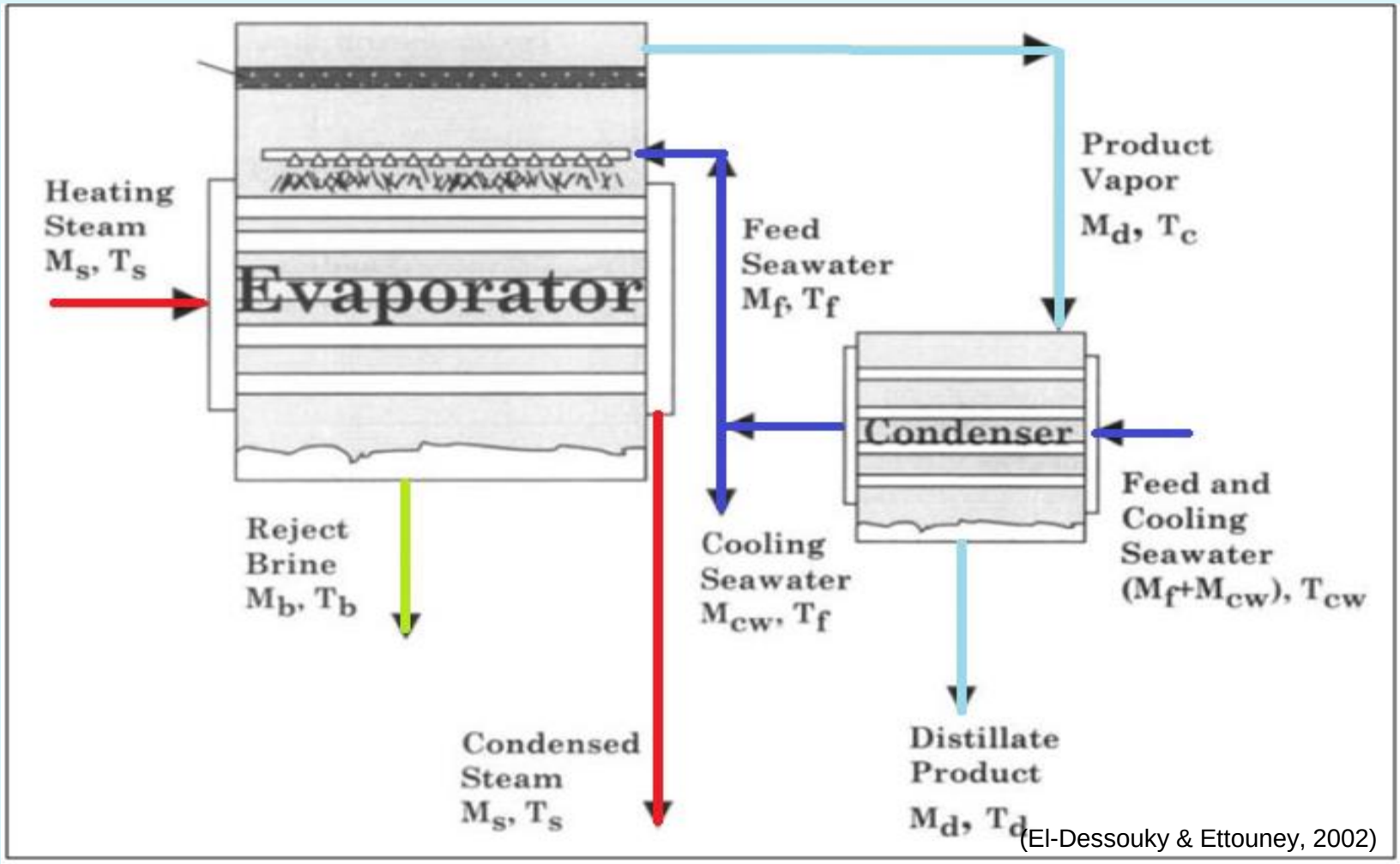
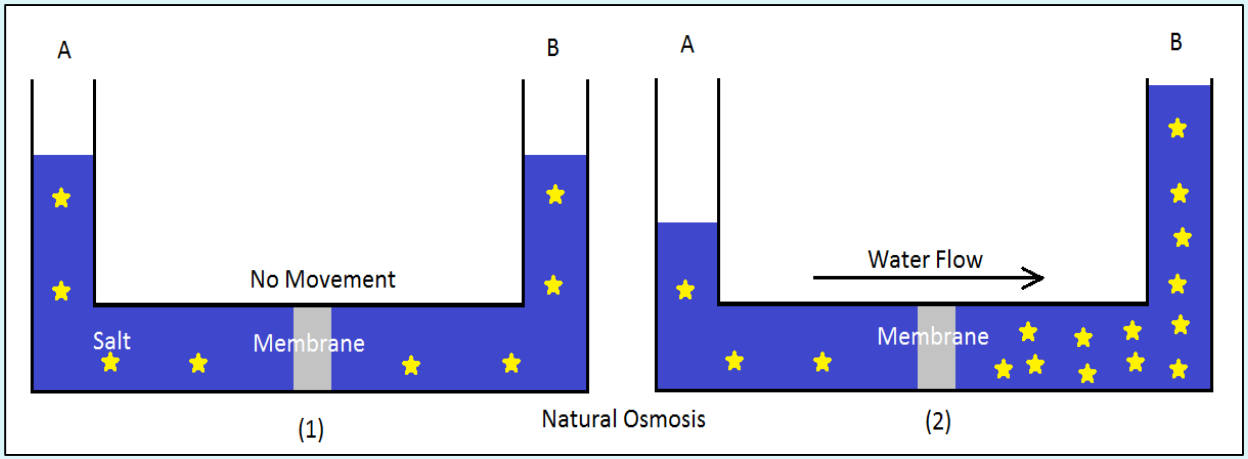


(El-Dessouky & Ettouney, 2002)

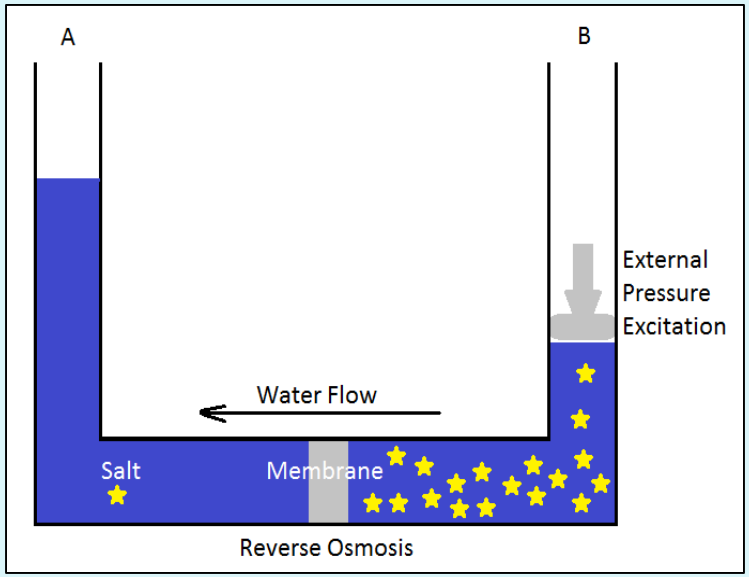
2.2 Membrane Desalination (Reverse Osmosis)

Osmosis (Natural Osmosis)
Water movement through a membrane from low salinity side to the high salinity side.



2.2 Membrane Desalination (Reverse Osmosis)

- Reverse Osmosis



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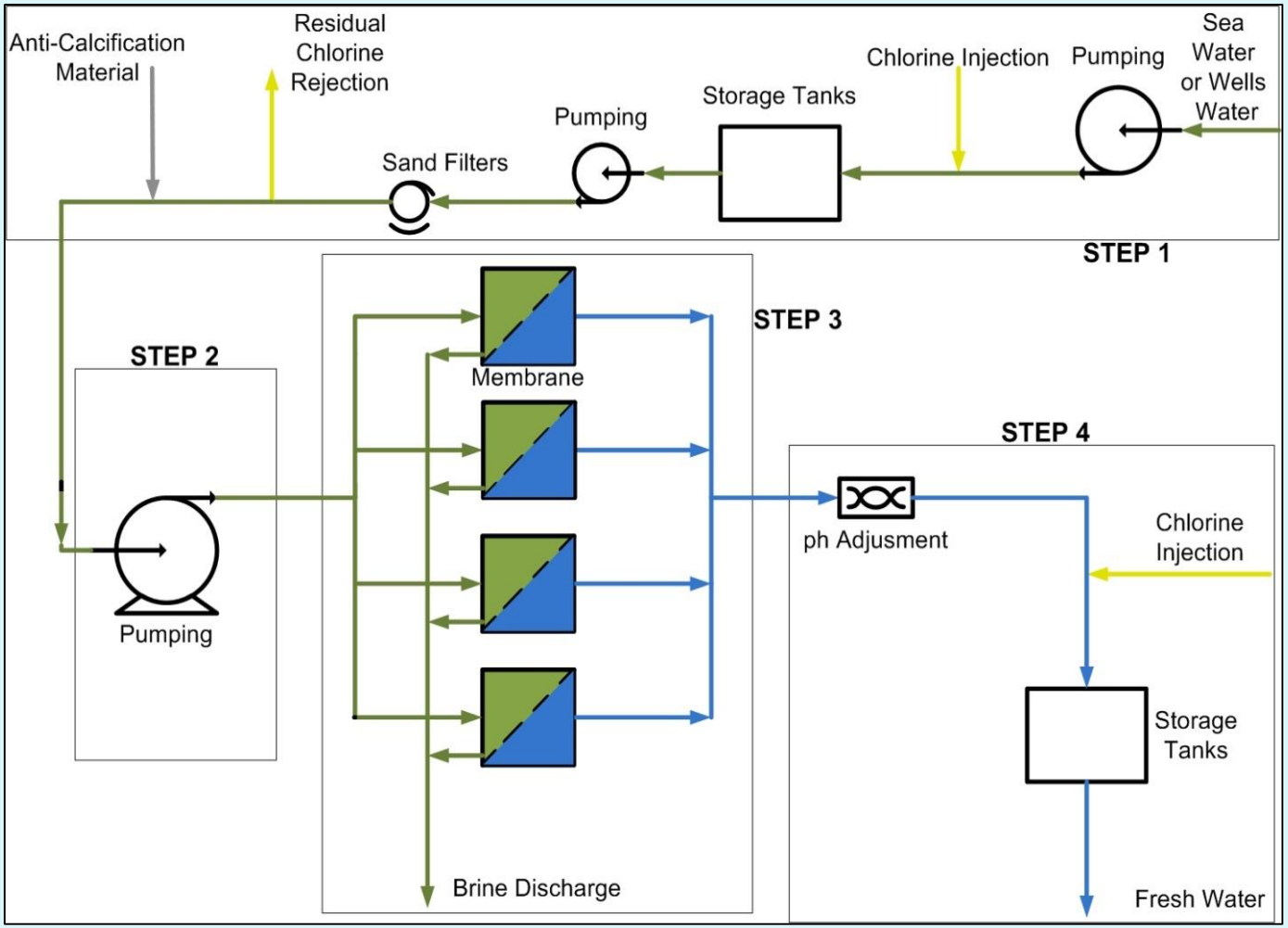

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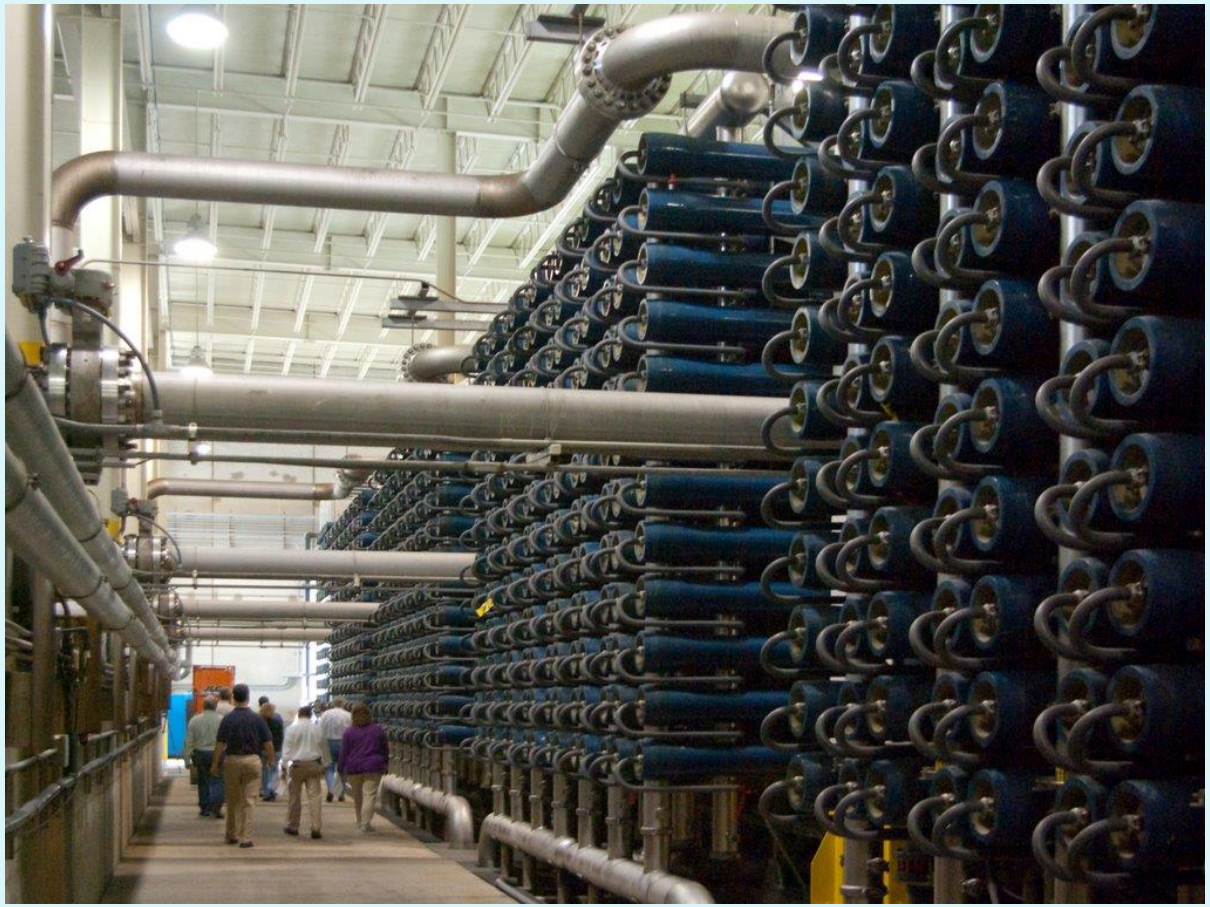


Tampa Bay RO Desalination Plant, Florida, US, 2007

3. Desalination Barriers

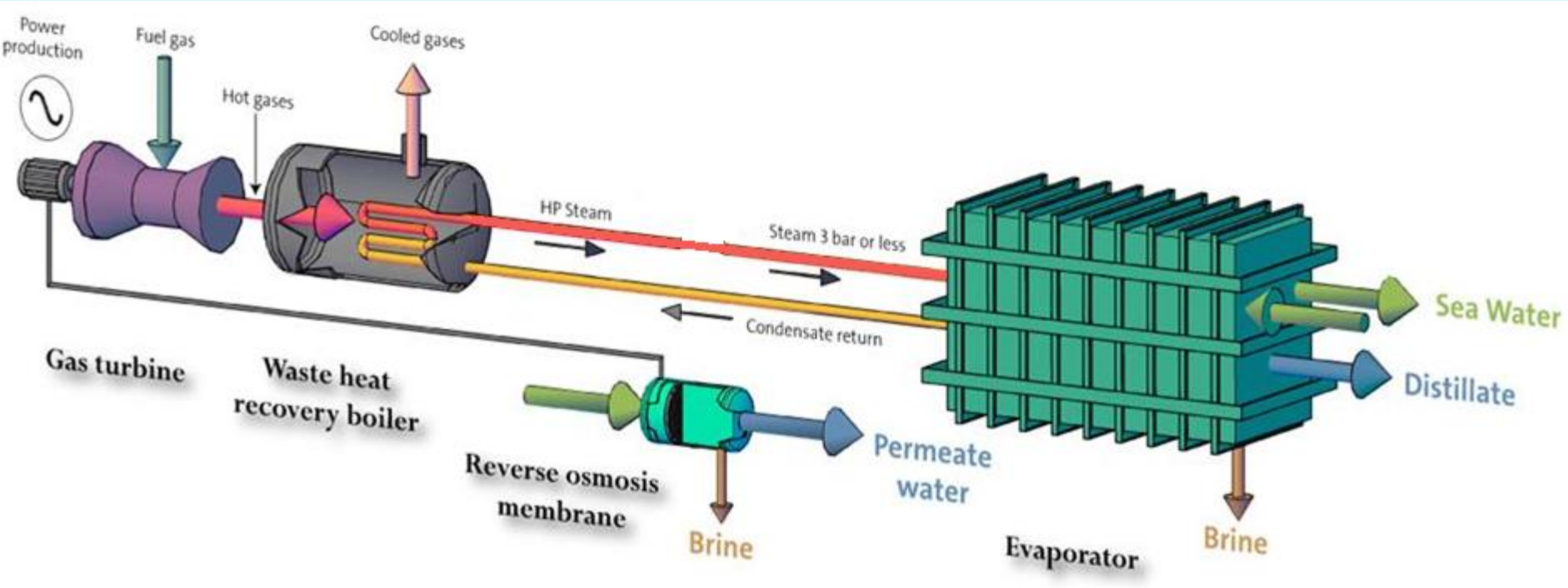
- Energy Consumption
- Cost
- Scaling
- Environment Impact

3.1 Energy Consumption

Multi Stage Flash & Multiple Effect Evaporation (Thermal)	Reverse Osmosis (Membrane)
10 – 200 kWh/m^3	1 – 10 kWh/m^3

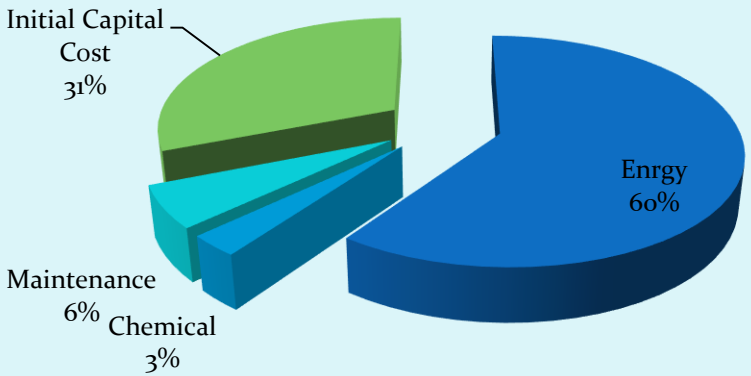
	Steam Turbines	Gas Turbines	Steam and Gas Turbines
Power (MW) to Water (MIGD) Ratio	5 : 1	10 : 1	15 : 1

3.1 Energy Consumption

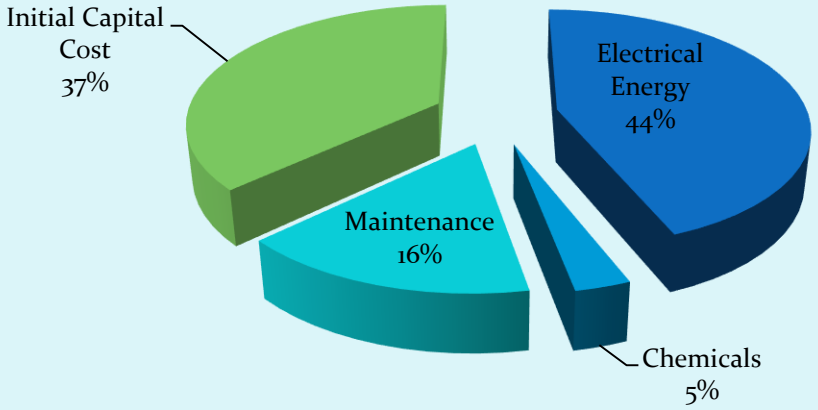


3.2 Cost

Cost Analysis for MED Thermal Desalination Process



Cost Analysis of RO Membrane Desalination Process



(Semiat, 2000)

3.3 Scaling

- What is scaling?

  The accumulation of salt particles on the desalination plant components.

- How to minimize scaling?

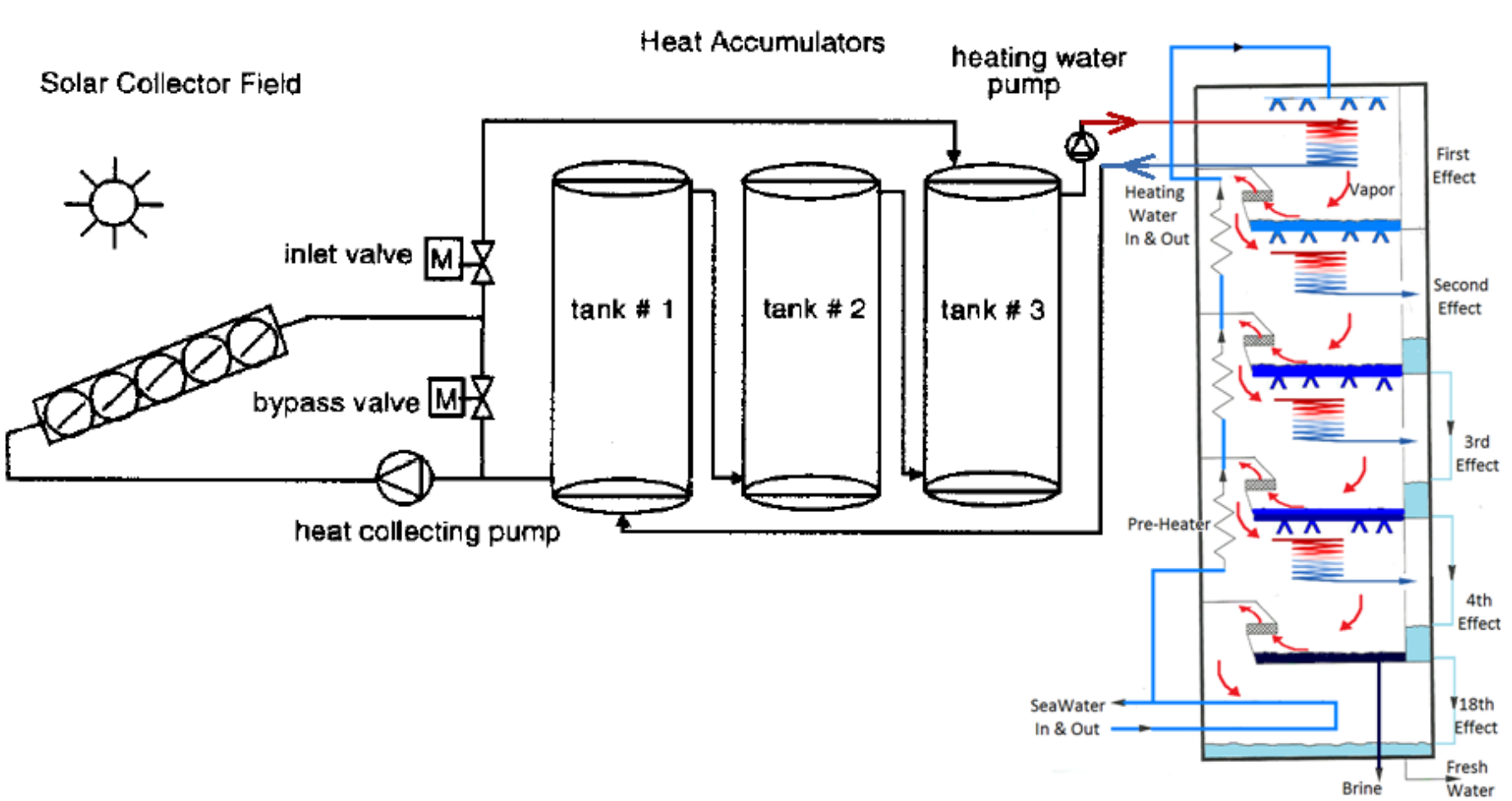
  Addition of chemicals, like Polyphosphate.

3.4 Environmental Impact

- Energy consumption and carbon footprint.

- Rejection of brine back into sea.

4. Abu Dhabi Solar Desalination Plant



(El-Nashar, 2008)

5. Useful Resources

Fundamentals of Salt Water Desalination, by El-Dessouky & Ettouney	Thermal analysis, mass balance, energy balance, efficiencies, ratios.
Desalination Research Progress, by Delgado & Moreno	Renewable energies and desalination.
Multiple Effect Distillation of Seawater Using Solar Energy, by El-Nashar	Solar desalination plant in Abu-Dhabi.