Reinhold Environmental Ltd.

2009 APC Round Table & Expo Presentation

July 12-14, 2009, in The Woodlands, TX

July 14, 2009

Kiewit

ZLD Treatment

Clint Davison, PE

Courtesy Of Aquatech

What Is (ZLD) Treatment?

- Zero Liquid Discharge
- Evaporation Process
- Technology of choice for the removing total dissolved solids (TDS)
- Used to recycle cooling tower blowdown, and to treat integrated gasification combined cycle (IGCC) waste water.
- Starting to be used to treat FGD blowdown
  - Flue Gas Desulfurization (FGD) blowdown – High in Chlorides, Sulfates, and TDS.

Proposed Regulations May Force Some Plants to Invest in ZLD Technology To Treat TDS.

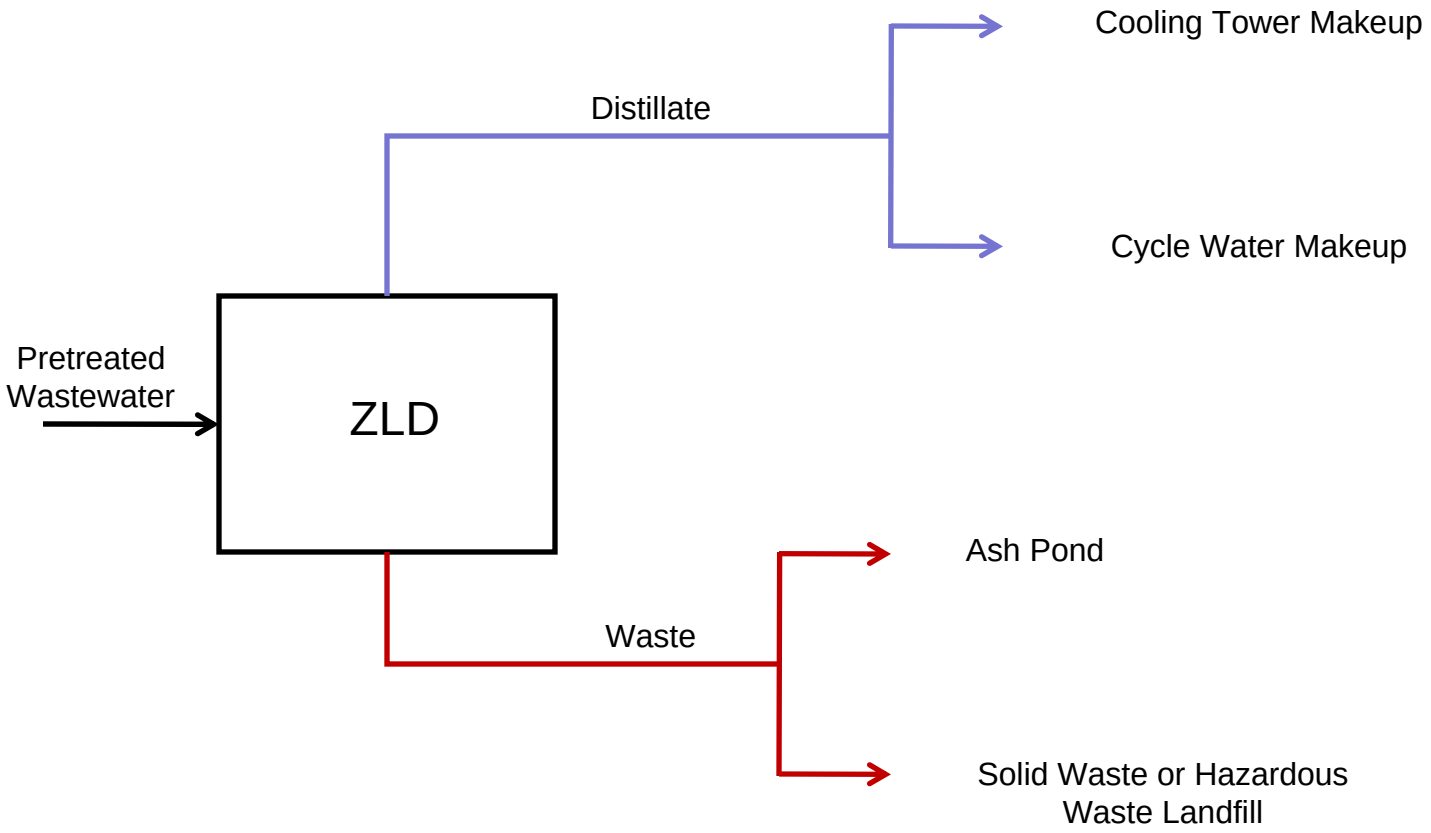
- Pennsylvania Department of Environmental Protection Agency is attempting to tighten their TDS discharge limits for new plants, the new rule is expected to go into affect in fall of 2011.

- Monongahela River exceeded PA DEP TDS concentration limit of 500 mg/l. Impaired river conditions led to one Northeast Power Plant to be required to obtain a new NPDS permit, this new permit would force the plant to purchase a zero liquid discharge water treatment system. The decision is currently being challenged.

Where Is ZLD Technology Being Used To Treat FGD Blowdown Today

- Six systems in Italy
- One system in the Philippines
- One is getting ready to into operation in the Weston, Missouri. Will be the only one in operation in the US. Will treat both FGD and cooling tower blowdown.

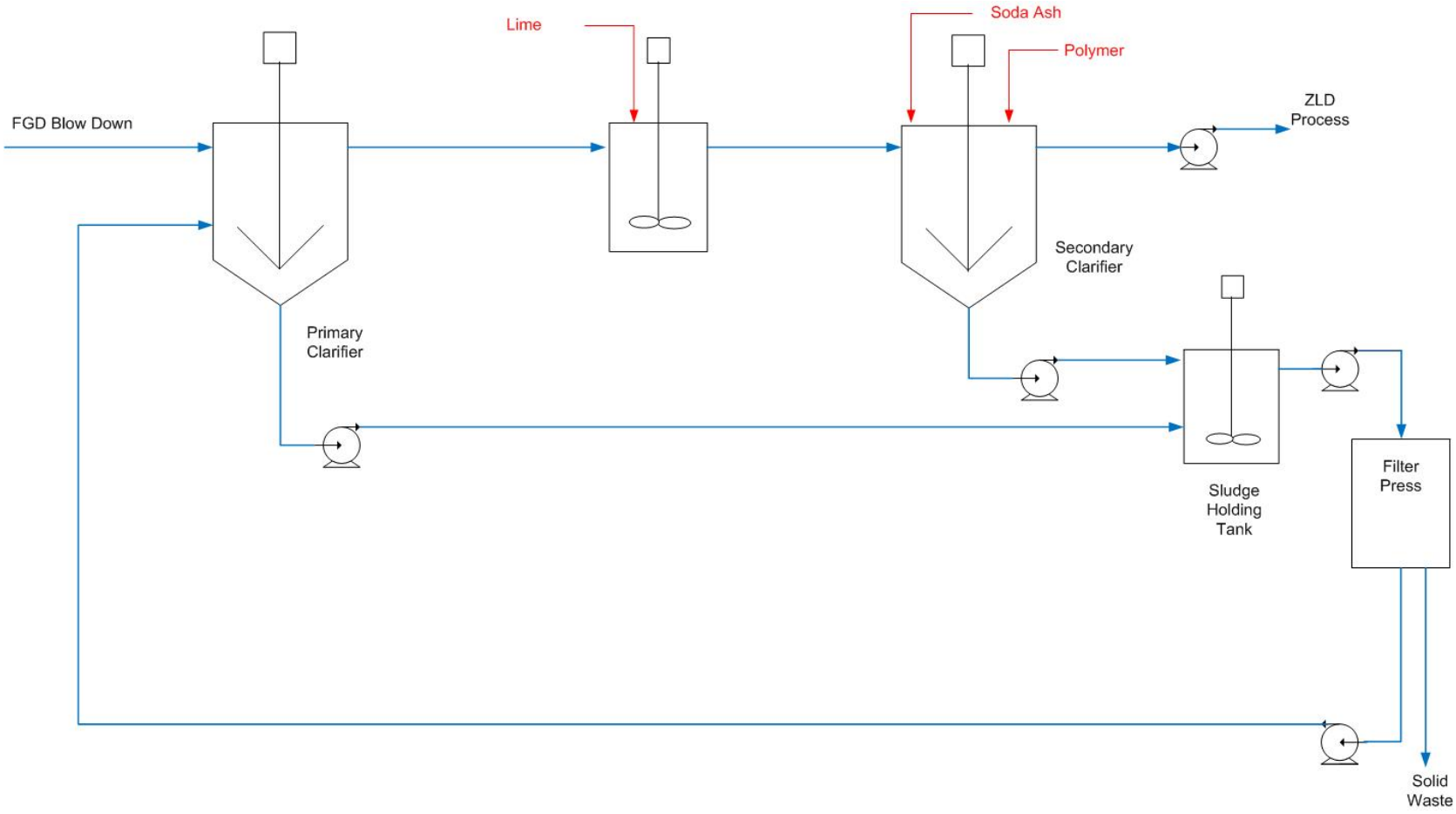
Zero Liquid Discharge (ZLD)



Typical Three Steps In FGD Wastewater ZLD Process

- Pretreatment
- Evaporation
- Dewatering

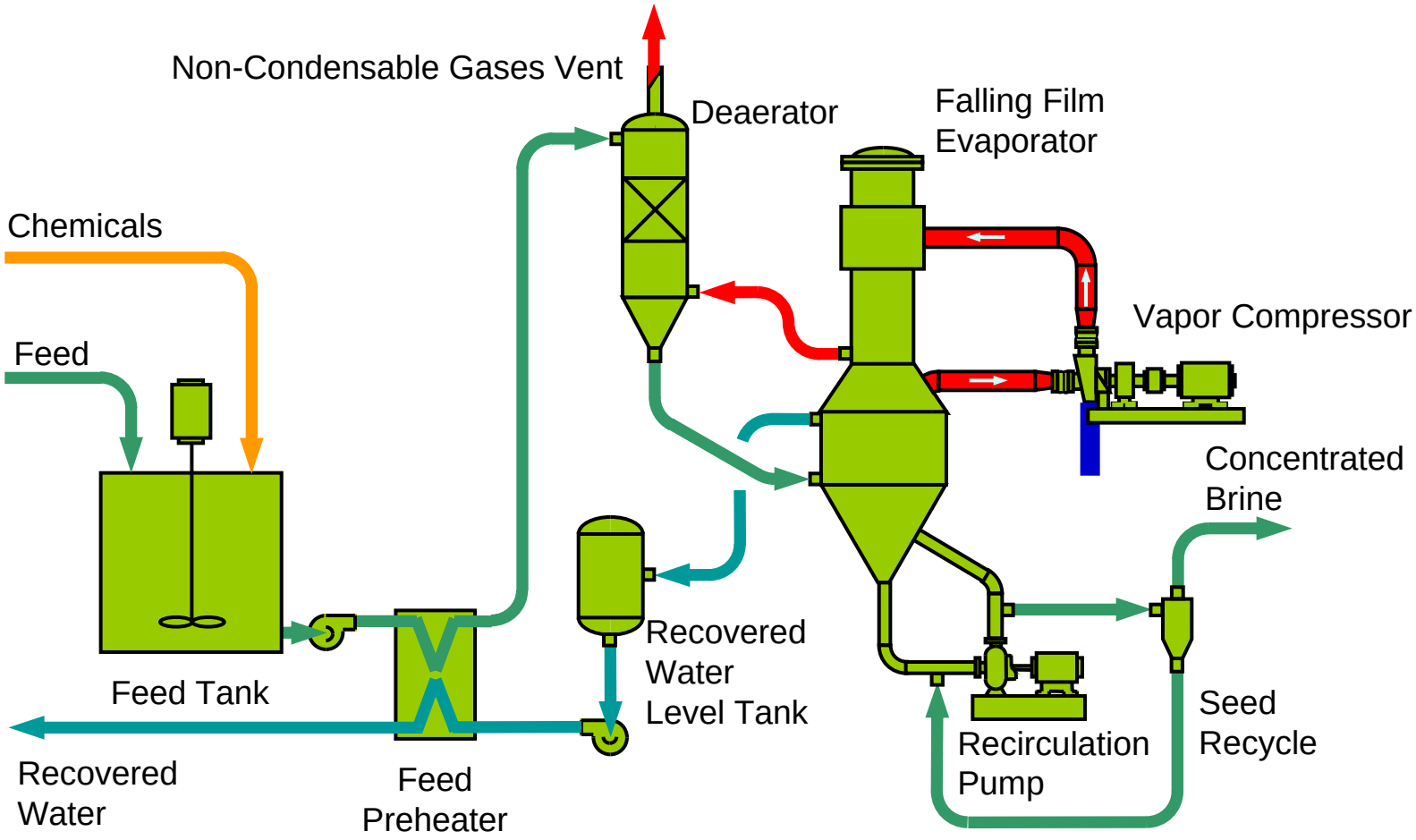
FGD Wastewater Pretreatment



Evaporation Process

- Basically there are three ZLD evaporation systems to choose from.
  - Brine Concentrator or Falling Film Evaporator
  - Crystallizer
  - Combination Brine Concentrator and Crystallizer

Brine Concentrator

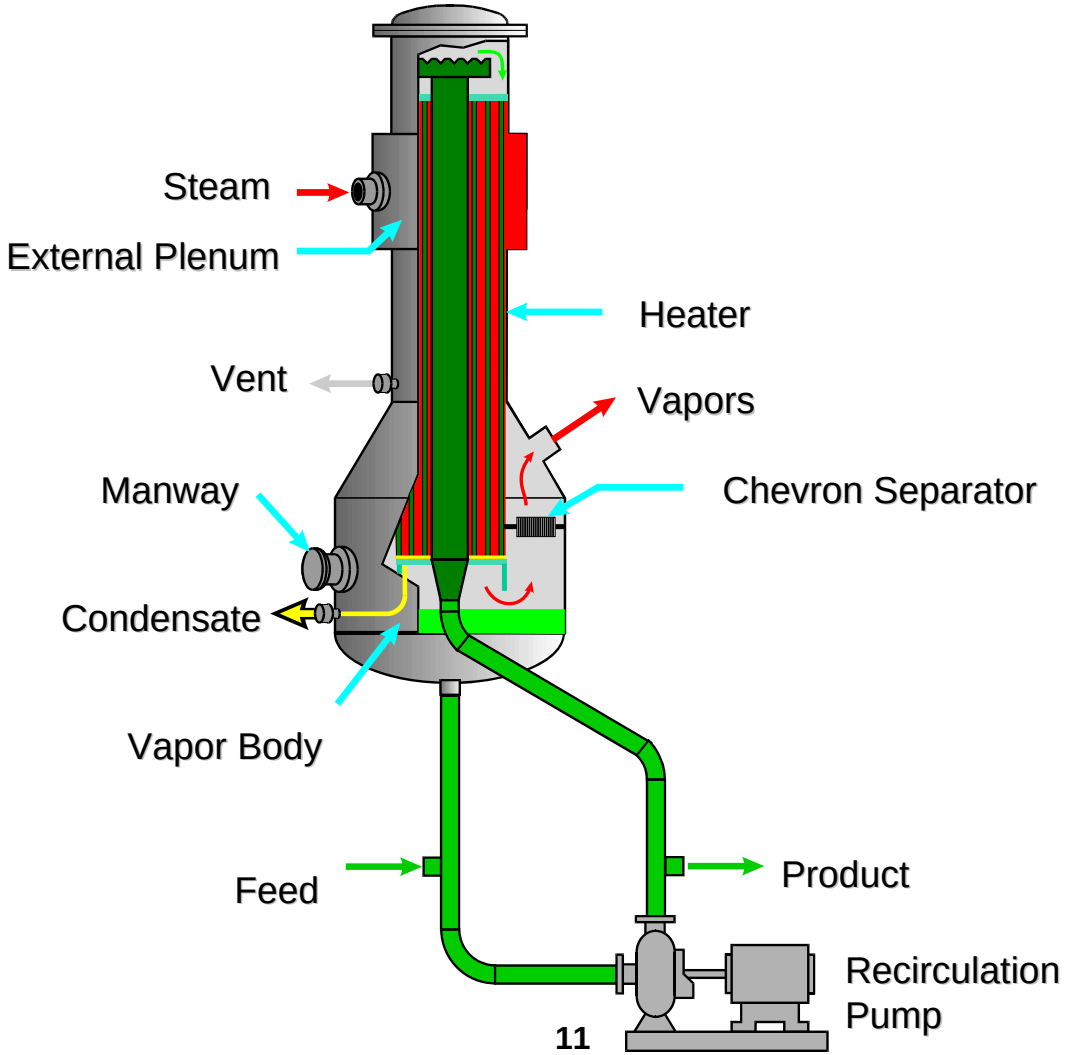


Courtesy Of HPD Veolia

Falling Film Evaporation Systems

Courtesy Of Aquatech

Preheat Falling Film Evaporator



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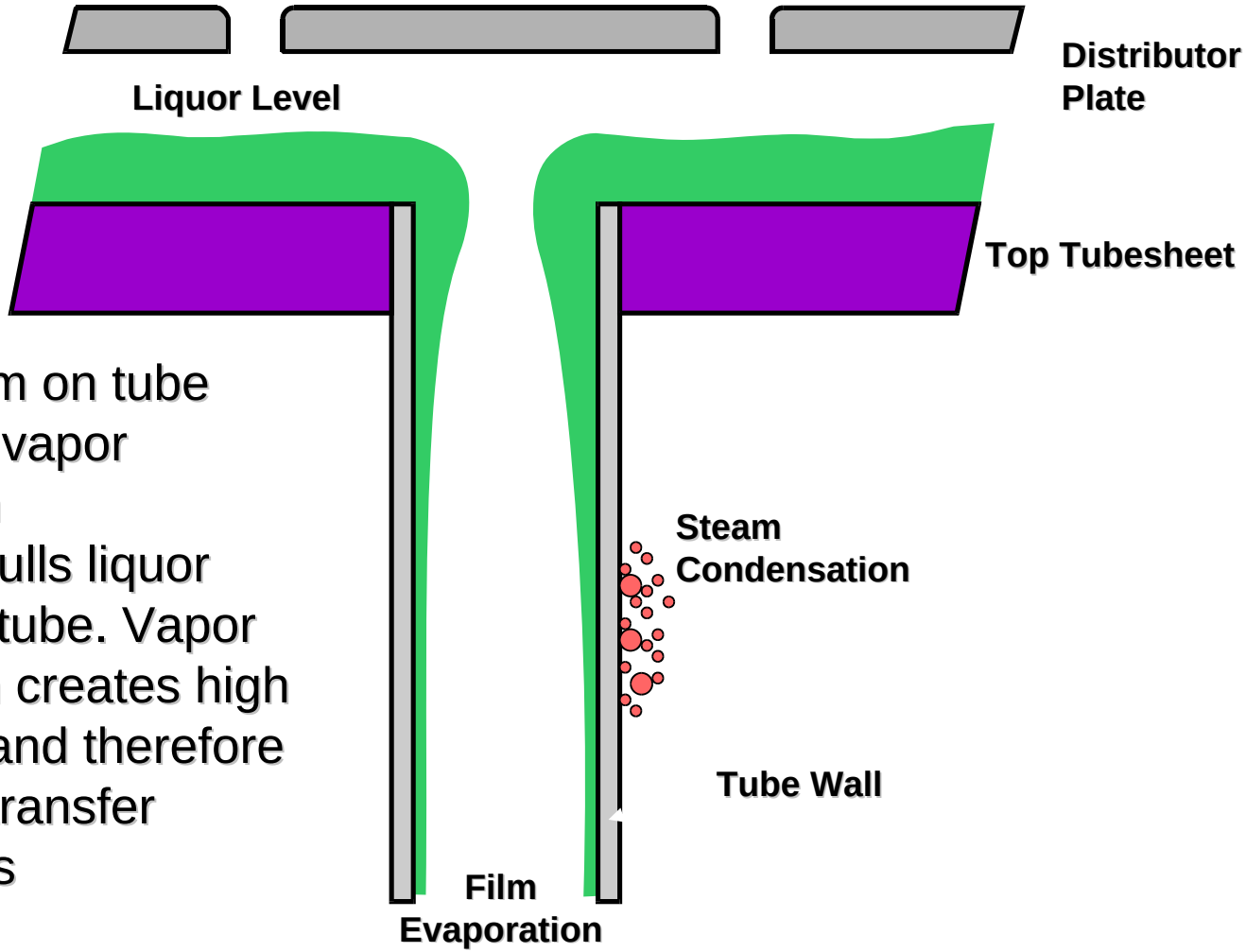
Falling Film Heat Transfer

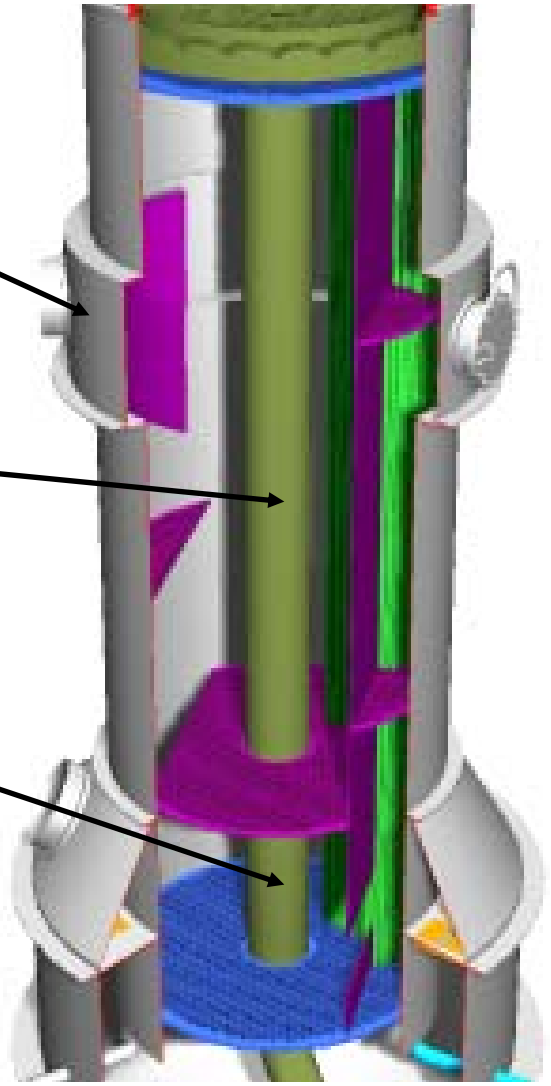


- Liquor film on tube formed by vapor generation
- Gravity pulls liquor down the tube. Vapor generation creates high velocities and therefore high heat transfer coefficients

Courtesy Of HPD Veolia

Falling Film Evaporator Internals

- Steam Distribution Plenum to slow incoming steam velocity
- Internal Recirculation Line reduces heat loss and simplifies installation
- Concentric design allows for more even distribution



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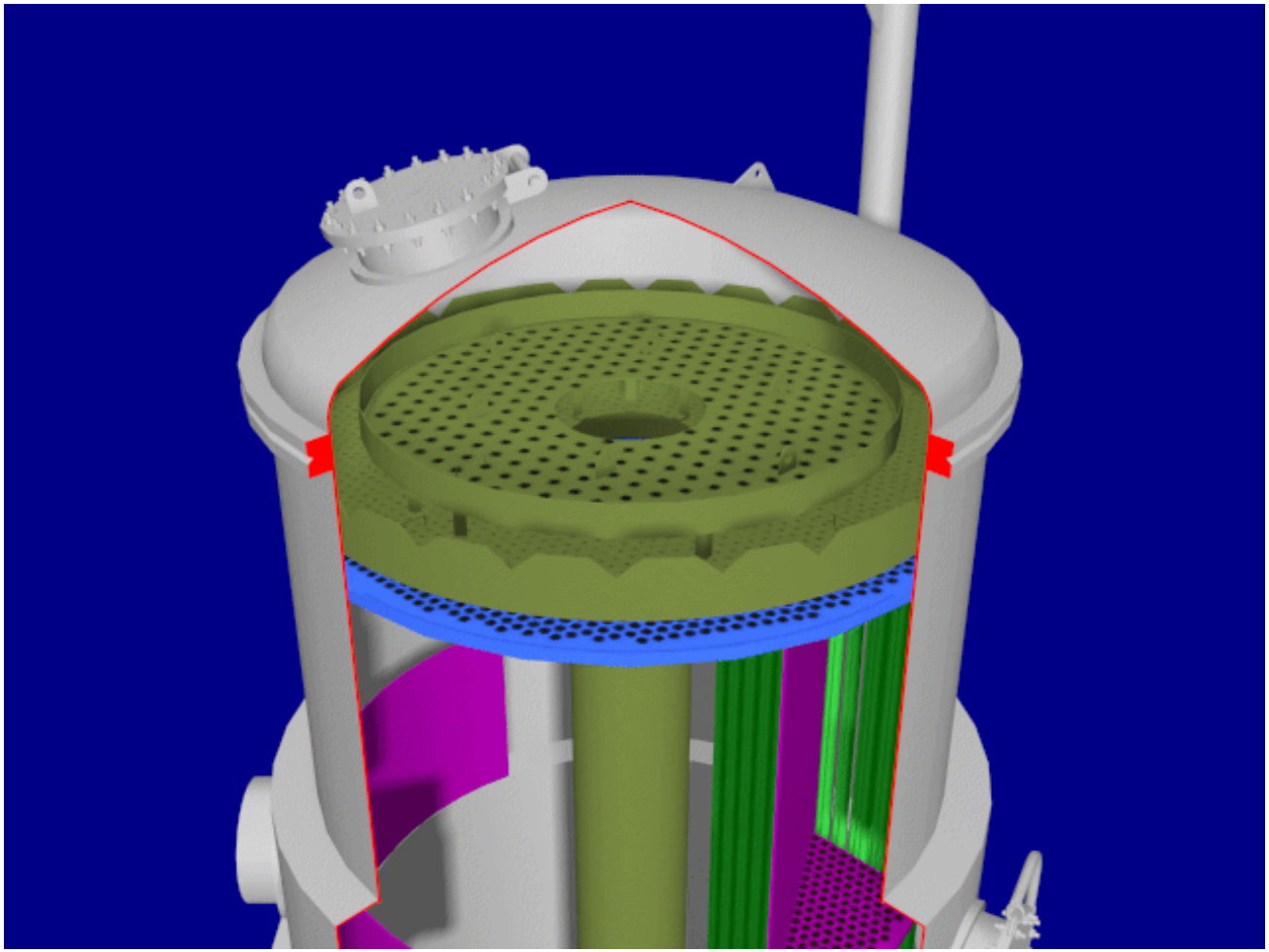
Evaporator Double Distribution Plate



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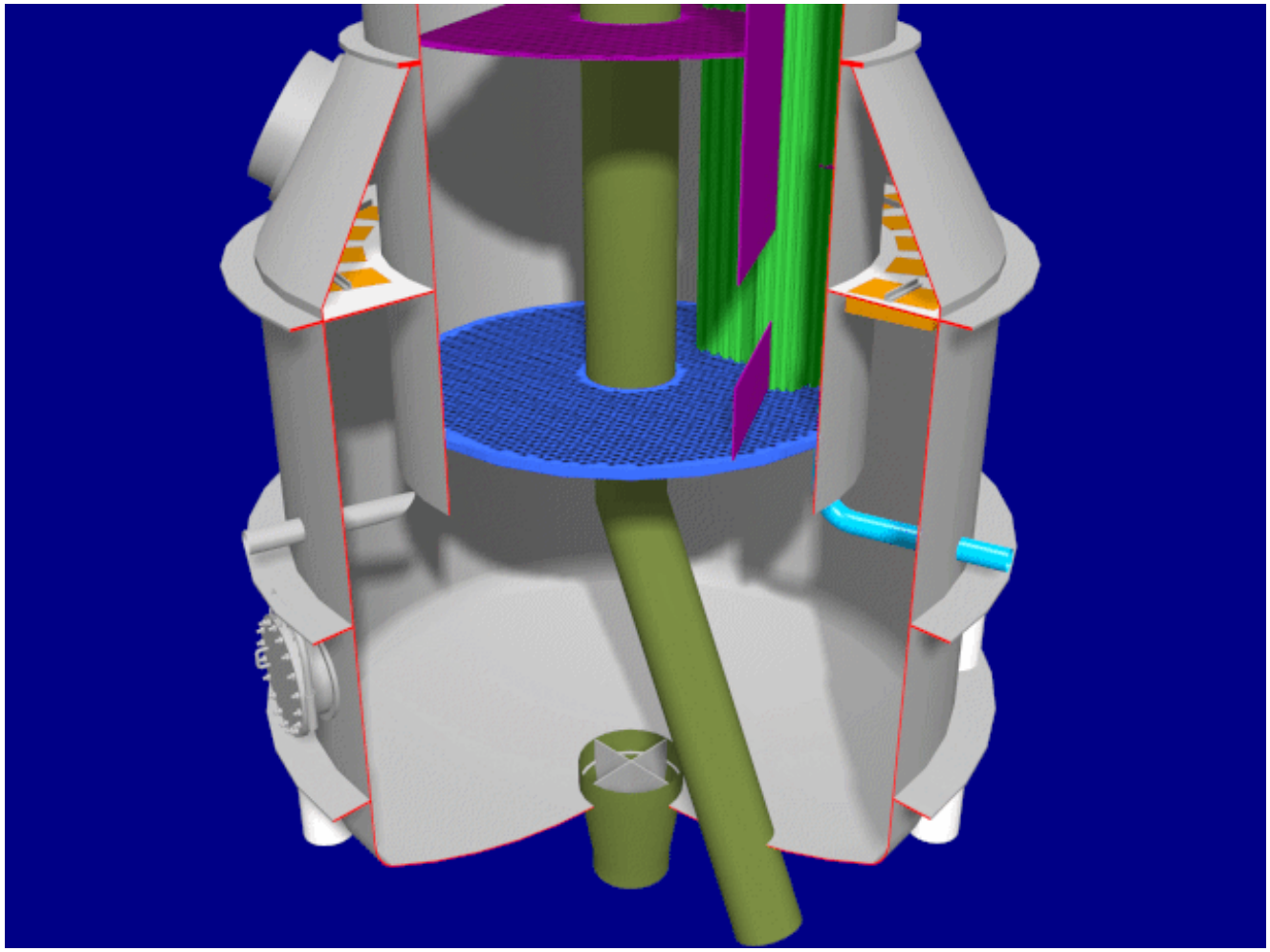
Evaporator Internals



Courtesy Of HPD Veolia

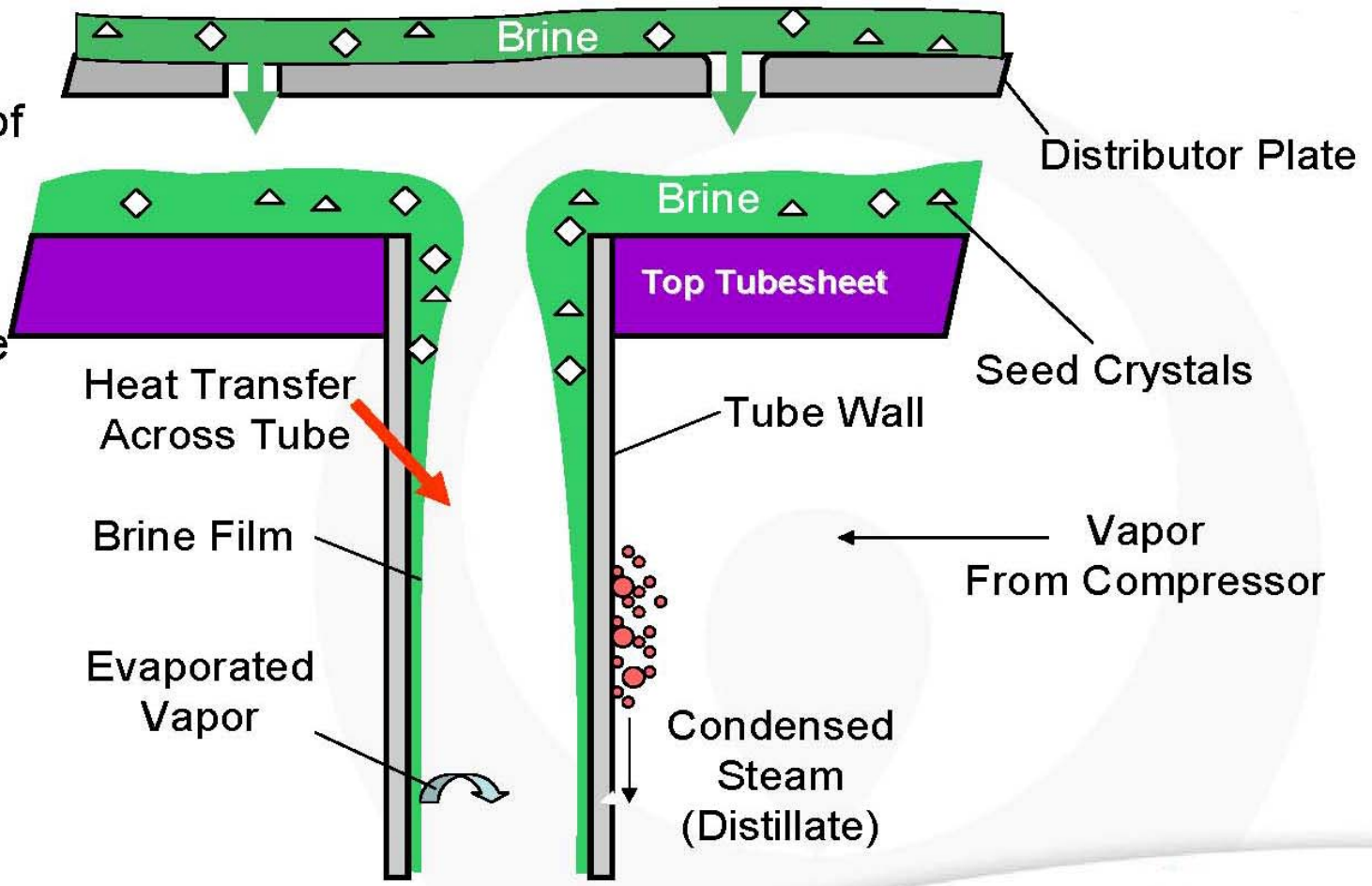
Seeding

- Brine Concentrators typically require seeding to prevent scaling on the falling film evaporator tubes.

- ~1% by weight calcium sulfate crystal pumped into the evaporator.

Falling Film Heat Transfer with Seeding

- Seed crystals of CaSO4 distributed throughout the circulating brine
- Preferential precipitation of low solubility salts (CaSO4, CaF2, Ca3(PO4)2) on seed crystals instead of tube surface



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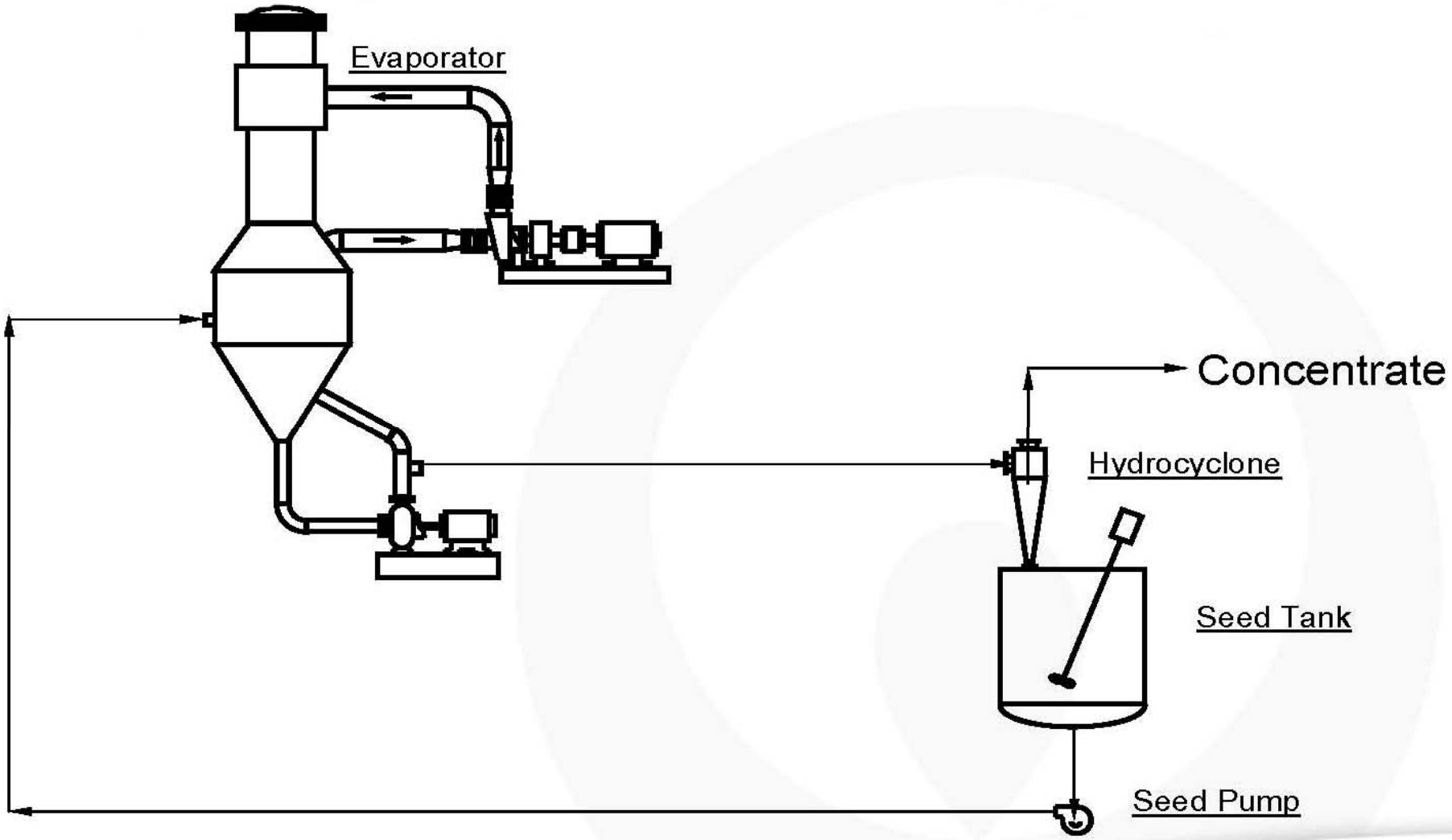
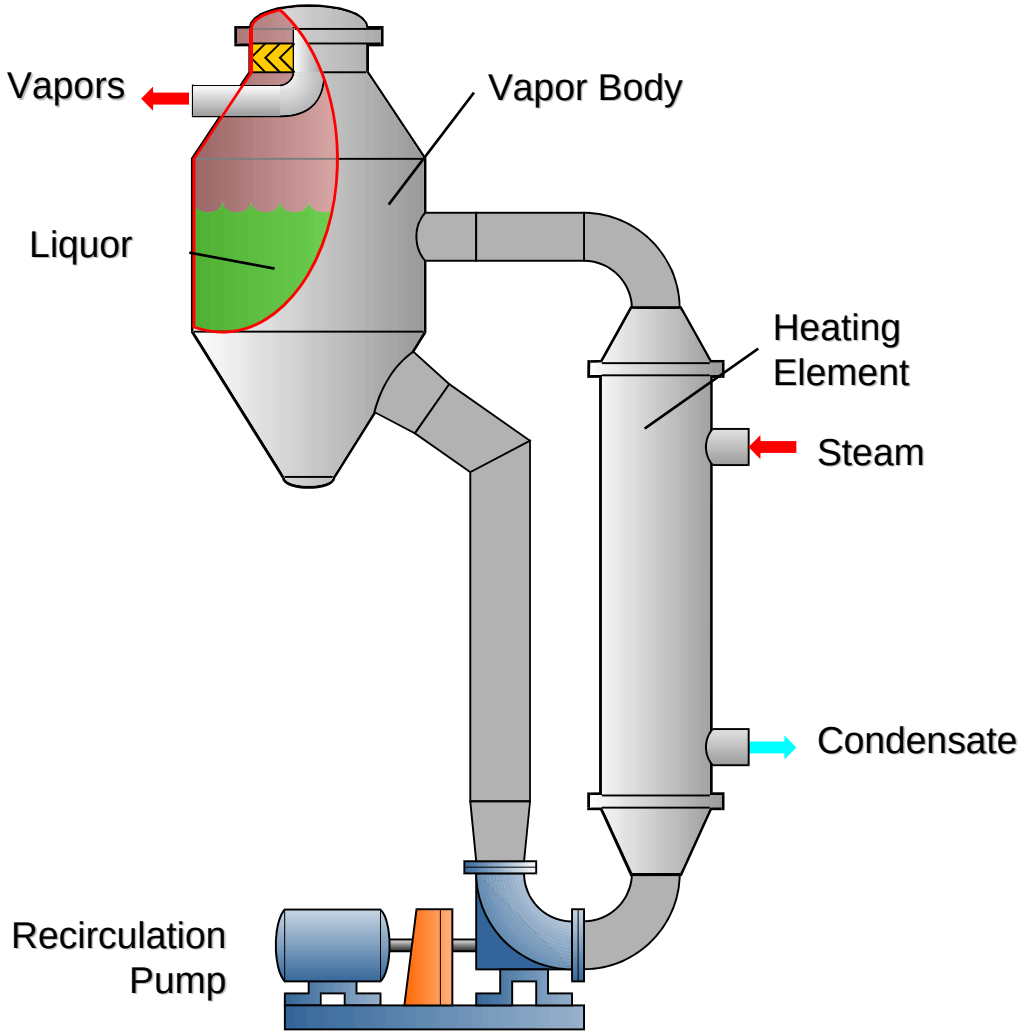
Seeding Slurry Process



Courtesy Of HPD Veolia

Forced Circulation Crystallizer



Courtesy Of HPD Veolia

Crystallizer

Courtesy Of Aquatech

Choosing A Brine Concentrator, Brine Concentrator/Crystallizer, Or Crystallizer

- Driven By
  - Capital cost
  - Plant space
  - Wastewater disposal options
  - TDS limits for the equipment
    - » Inlet concentration of the FGD waste water, how much can you cycle up.
    - » Approximately 200,000 mg/l is the limit for the brine concentrator, 500,000 mg/l for the crystallizer.
  - Energy required for evaporation
    - » Brine Concentrator - Approximately 80 kW per 1000 gallons
    - » Crystallizer – 320 kW per 1000 gallons
  - Typically FGD wasterwater flows less than 90 gpm will be handled with just a crystallizer, 200 gpm are typically handled with a combination system brine concentrator/crystalizer.

Dewatering System

Filter Presses

Filter Cake

Courtesy Of Aquatech

Operation Issues

- Gypsum scaling in the pre-heater and deaerator
- Calcium and magnesium chloride build up in the evaporator
- Insufficient calcium sulfate (CaSO4) seed slurry in the evaporator
- pH
- Foaming
- Moisture content of dewatering cake
- Flushing system during shut down

Operation/Maintenance

- One ZLD requires an estimated 6 full time operators operate the system.

- Chemical cleaning is typically required once or twice a year.

Questions