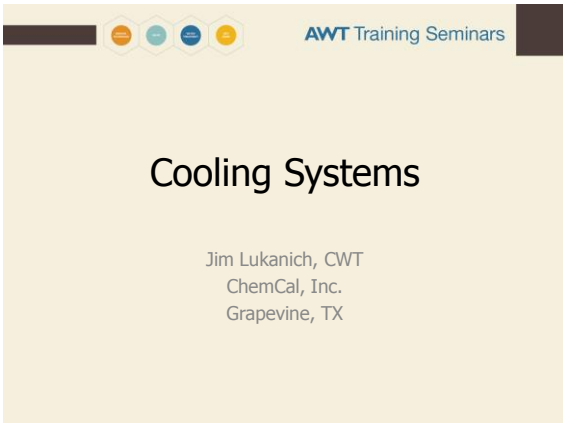




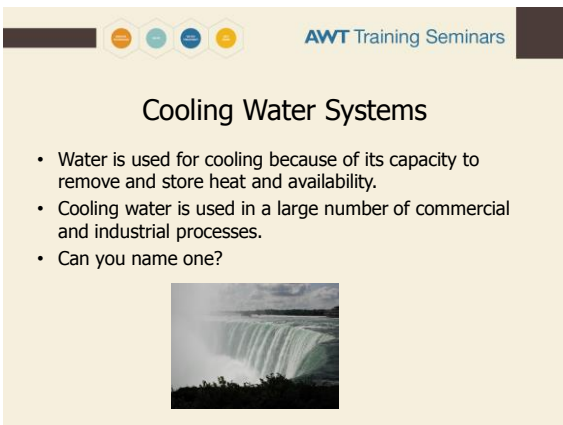
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Cooling Systems

Jim Lukanich, CWT
ChemCal, Inc.
Grapevine, TX



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Cooling Water Systems

- Water is used for cooling because of its capacity to remove and store heat and availability.
- Cooling water is used in a large number of commercial and industrial processes.
- Can you name one?



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Processes Requiring Cooling Water

- Air conditioning (HVAC)
- Ammonia refrigeration (poultry and meat processing)
- Chemical manufacturing reactor cooling
- Air washers (temperature and humidity control)
- Power generation surface condensers
- Steel mill blast furnace, mold, and roll cooling
- Refinery and petrochemicals
- Injection molding
- Food processing (canning and bottling)
- Many more

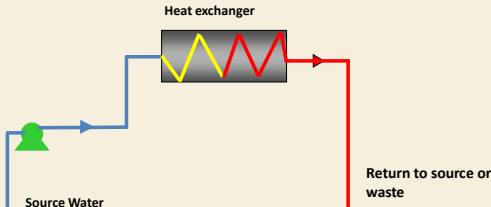
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Types of Cooling Water Systems

- Once Through
- Open Recirculating
 - Cooling Towers
 - Evaporative condensers
 - Spray Ponds
- Closed Systems

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Once Through Cooling



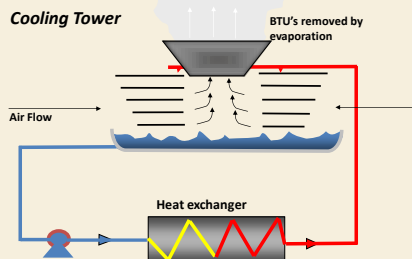


Evaporative Cooling

- It takes approximately 1,000 BTU's to evaporate 1 Lb of water. (970.4 btu's latent heat of vaporization)
- Evaporative type cooling equipment increases both the surface area and air flow around the water droplet thereby increasing evaporation.

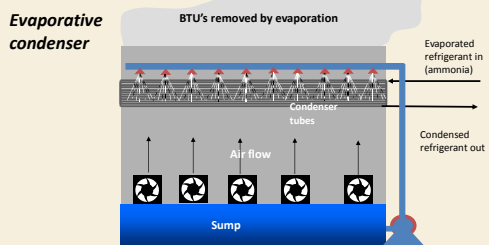


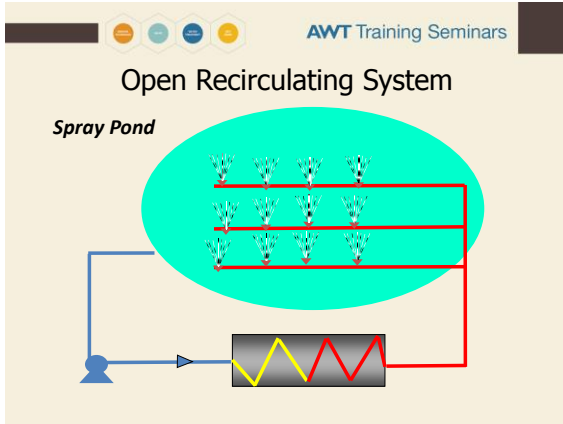
Open Recirculating System

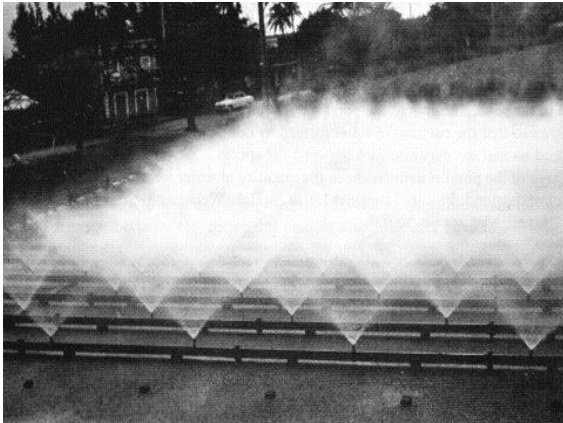


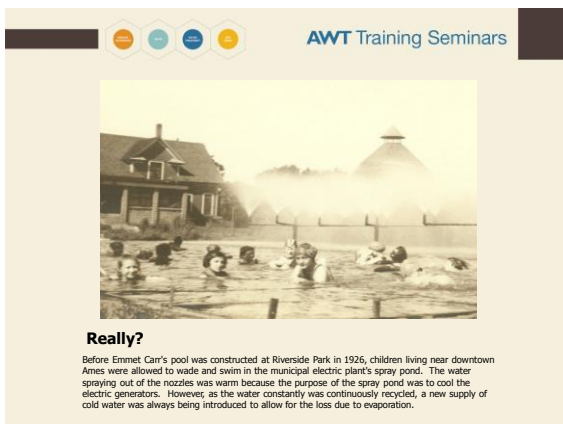


Open Recirculating System











HVAC Systems

- Water cooled HVAC systems provide air conditioning for most large building environments.





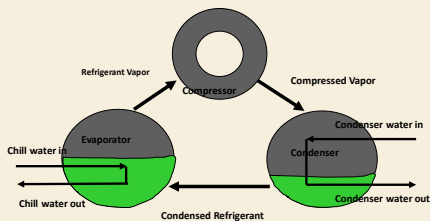
Why a Ton?

- The BTU's per hour required to melt 1 ton of ice in 24 hours.
- Latent heat of fusion of ice is 144 BTU's per Lb.
- Try the math.
- $2000 \times 144 / 24 = ?$



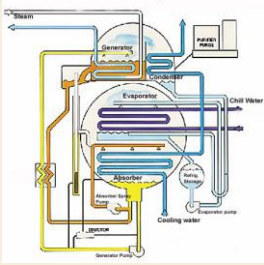


Centrifugal Chiller



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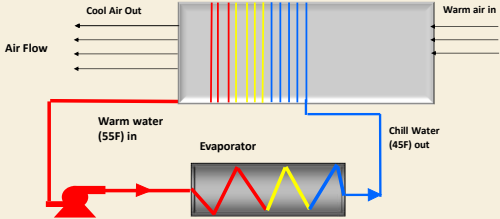
Steam Absorber



- Water is refrigerant.
- Steam or hot water evaporates water from brine in generator.
- Vapor is condensed by cooling water.
- Hot brine is cooled in absorber by cooling water.
- Concentrated brine is hygroscopic and absorbs water(refrigerant) and creates vacuum causing more evaporation.
- BTU's for evaporation are removed from chilled water.
- Dilute brine is regenerated in generator.
- Evaporation rate per ton 1.5 – 2x electric chillers.

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Closed System (HVAC)



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Chiller info

- What is condenser approach?
 - It is the difference between the condenser water exit temperature and the condensed refrigerant temperature.
- What is indicated by an increase in approach temperature?
 - Deposits will reduce heat transfer requiring the compressor to work harder to increase the pressure in order to condense the refrigerant.
- What is the typical kW/ton of a centrifugal chiller?
 - 0.4-0.6



Rules of Thumb

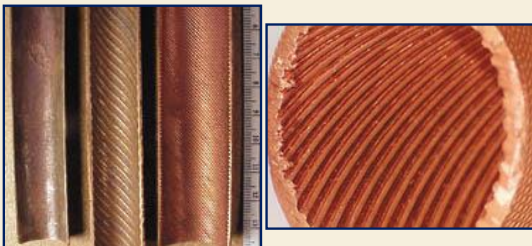
- Centrifugal Chillers:
 - Recirc rate = 3 gpm per ton @10°F delta T.
 - 1.8 gph per ton evaporation rate.
 - With sensible heat loss 1.5 – 1.7 gph actual.
 - You will evaporate about 10 gpm per 1,000 gpm of flow at 10°ΔT. Using sensible heat loss about 8.5 gpm.
- Absorption refrigeration:
 - Recirc rate = 6 gpm per ton @10°F delta T
 - 3.6 gph per ton evaporation rate.

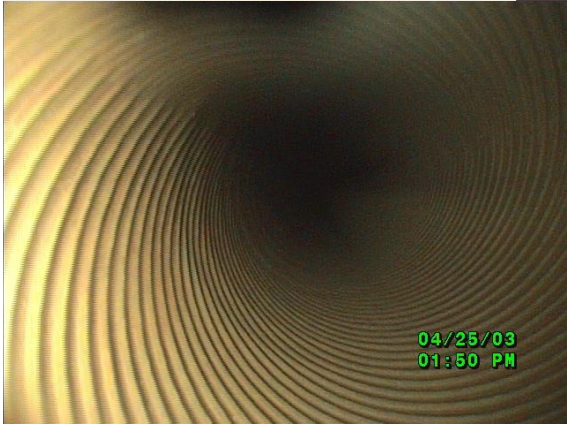


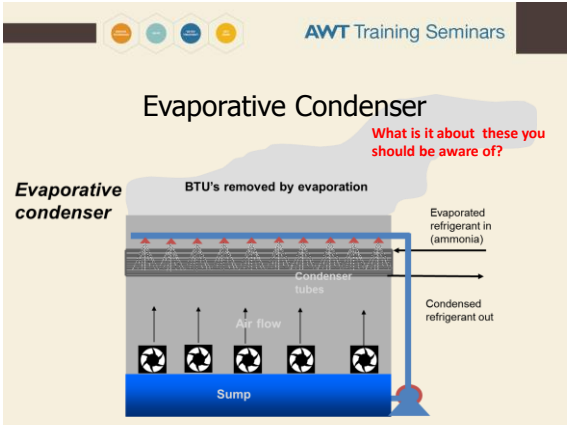
Enhanced Tubes

- What is the purpose of an enhanced tube?
- What are the problems compared to smooth tubes?

















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Other types of HX

- Heat exchangers come in a variety of different types and configurations and used for a variety of processes.



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Air Handler

Chilled water is pumped through coils (like a radiator) found in the air handler where building air is cooled and humidity removed.

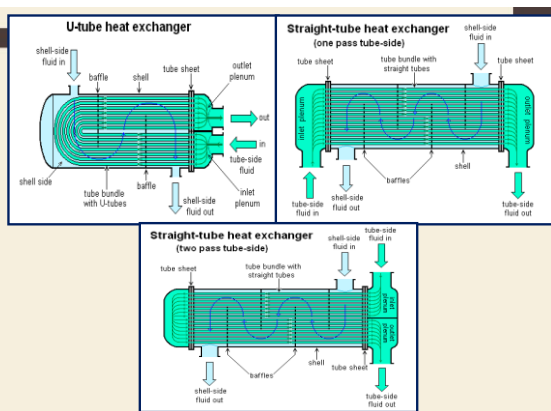


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Coils

Important to keep these clean.





Typical Shell and Tube











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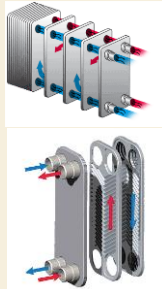
Spiral Tube HX



They are designed to handle high suspended solids fluids, slurries or sludge at high temperatures and/or high pressure.



Plate and Frame HX





Air Washers

- Air washers scrub the air where clean air is required.
- Air washers also provide humidity and temperature control.
- Can also reduce static electricity in textile mills.
- What do you think might be the biggest issue?





Air Washers

- Air washers require close attention to biofilm and fouling control.





Scrubbers



Scrubbers are used to remove solvents, acid vapors, or particulate from process exhaust. Media can become fouled or scaled.

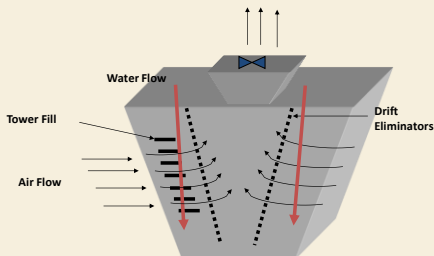


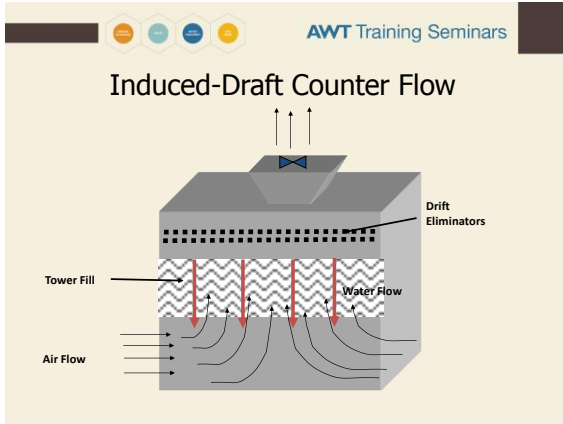
Cooling Towers

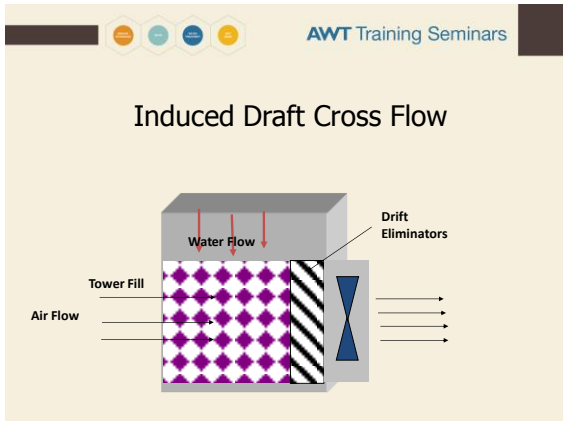
- What is the Purpose of a Cooling Tower?
- Cooling towers come in all sizes and shapes but they all have similar functional components.
- Cooling towers are designed to evaporate large amounts of water by greatly increasing the surface area and by drawing a high volume of air across the water's surface.



Induced Draft Cross Flow



























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Materials of Construction

- Wood
- Plastic
- Fiberglass
- **Galvanized steel**
- Stainless steel
- Concrete
- Ceramic



Cooling Tower Components

- Distribution deck
- Tower Fill
- Sump
- Fan
- Drift Eliminators
- Directional Louvers







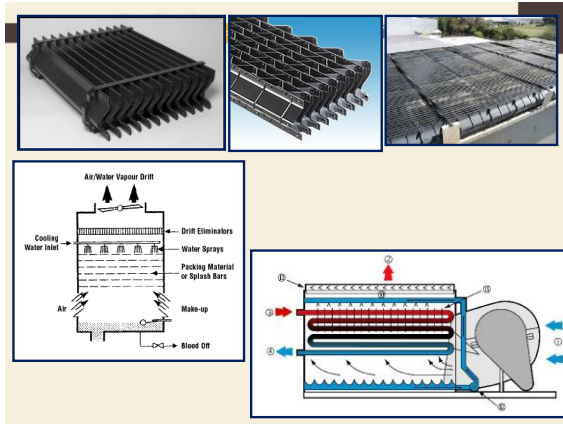


















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Review
