

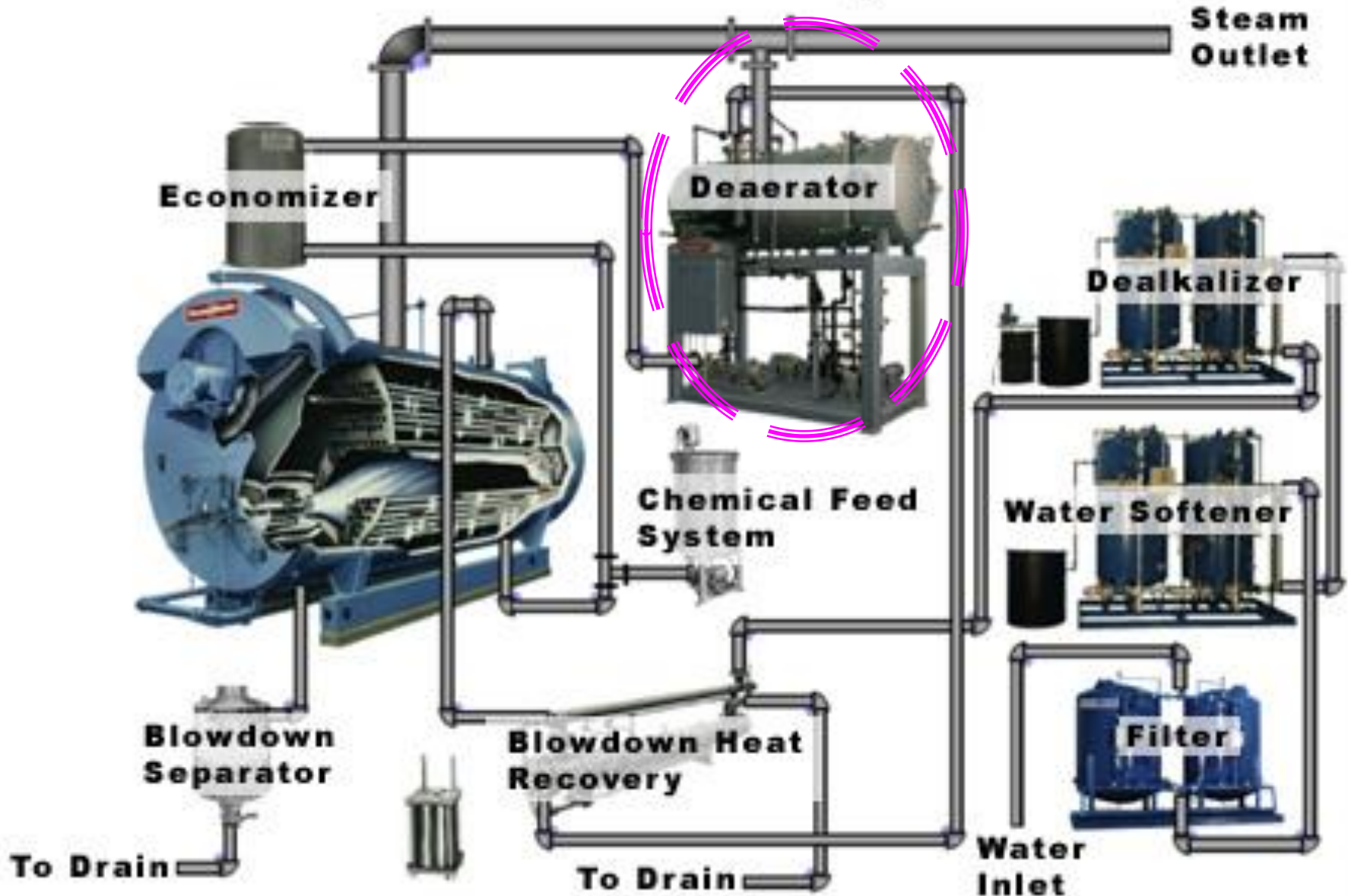


The power of commitment.™

Deaerators

Packaged Water Systems

Total Steam System



Let's See What Will Happen?

Given: Cans of Soda

- Introduce a Mechanical Disturbance = Shaking
- Introduce Heat = Cans in the trunk on a hot day
- Reduce Pressure = Shake the can again , open it up



Deaeration

The process of removing air and gases from boiler feedwater prior to its introduction to a boiler.

DEAERATORS

Primary Jobs

- Remove dissolved gases in make-up
- Pre-heat boilerfeed water
- Storage of Feedwater & recovery of condensate
- Improves Equipment Longevity

DA COMPONENTS

1. Gas Removal Portion
2. Gas Vent (Orifice/Valve)
3. Water Storage Tank



DEAERATOR OPERATIONS

- Nozzles spray incoming water or trays/packing let it cascade down
- Agitated water falls through steam space gaining heat
- **Goal** = 0.005 cc/l O₂ concentration at operating pressure's saturation temperature with liberated gases leaving through a continuous vent

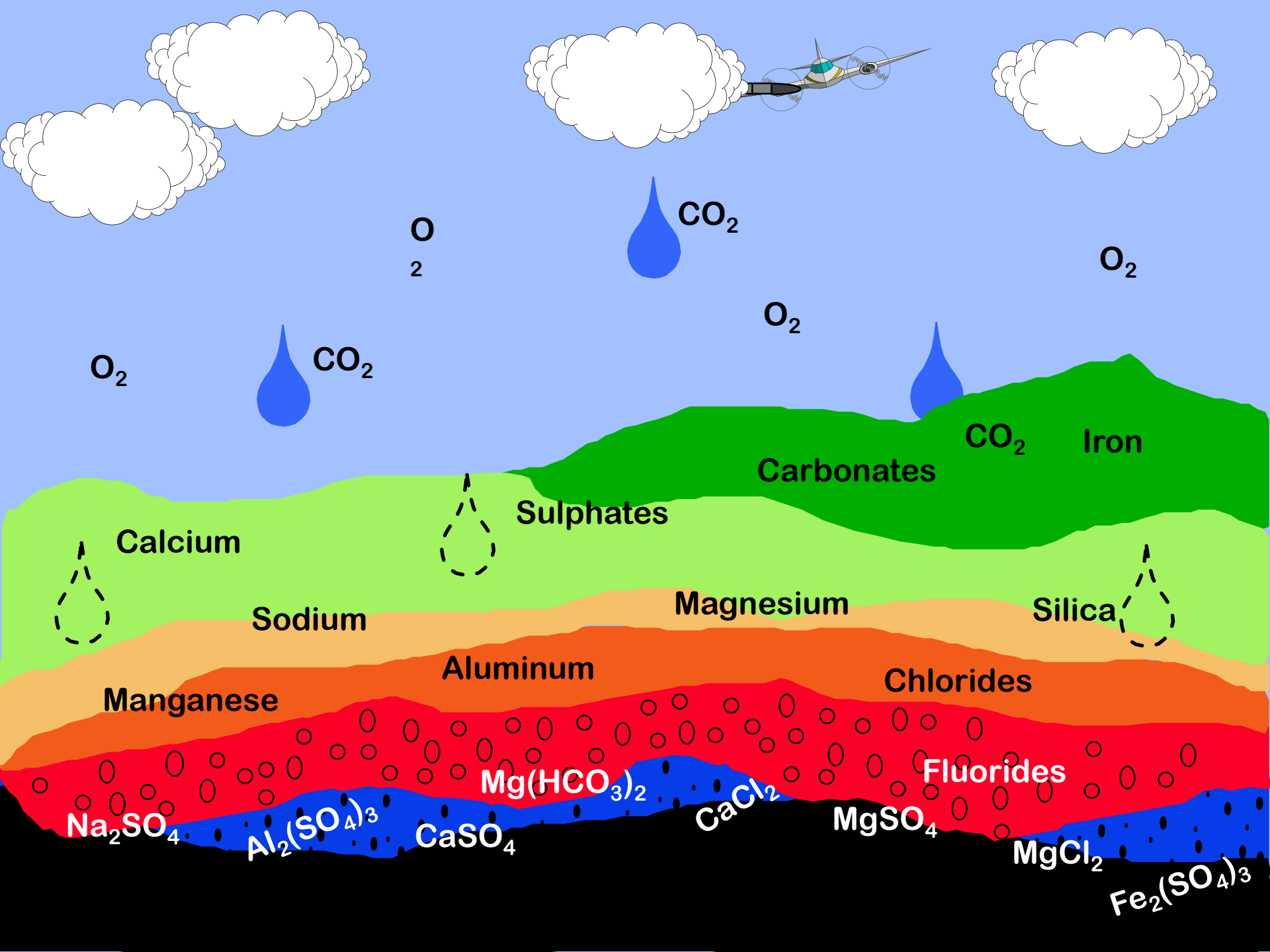


WATER

Very close to being the
Universal Solvent.

Most gases dissolve in water.





DISSOLVED GASES

- O_2 – Atmosphere / Rain
- N_2 – Atmosphere / Rain
- CO_2 – Soil / Bicarbonates



CORROSION

- O_2 – Iron, Steel & Brass
- N_2 – Inert
- CO_2 – Carbonic Acid

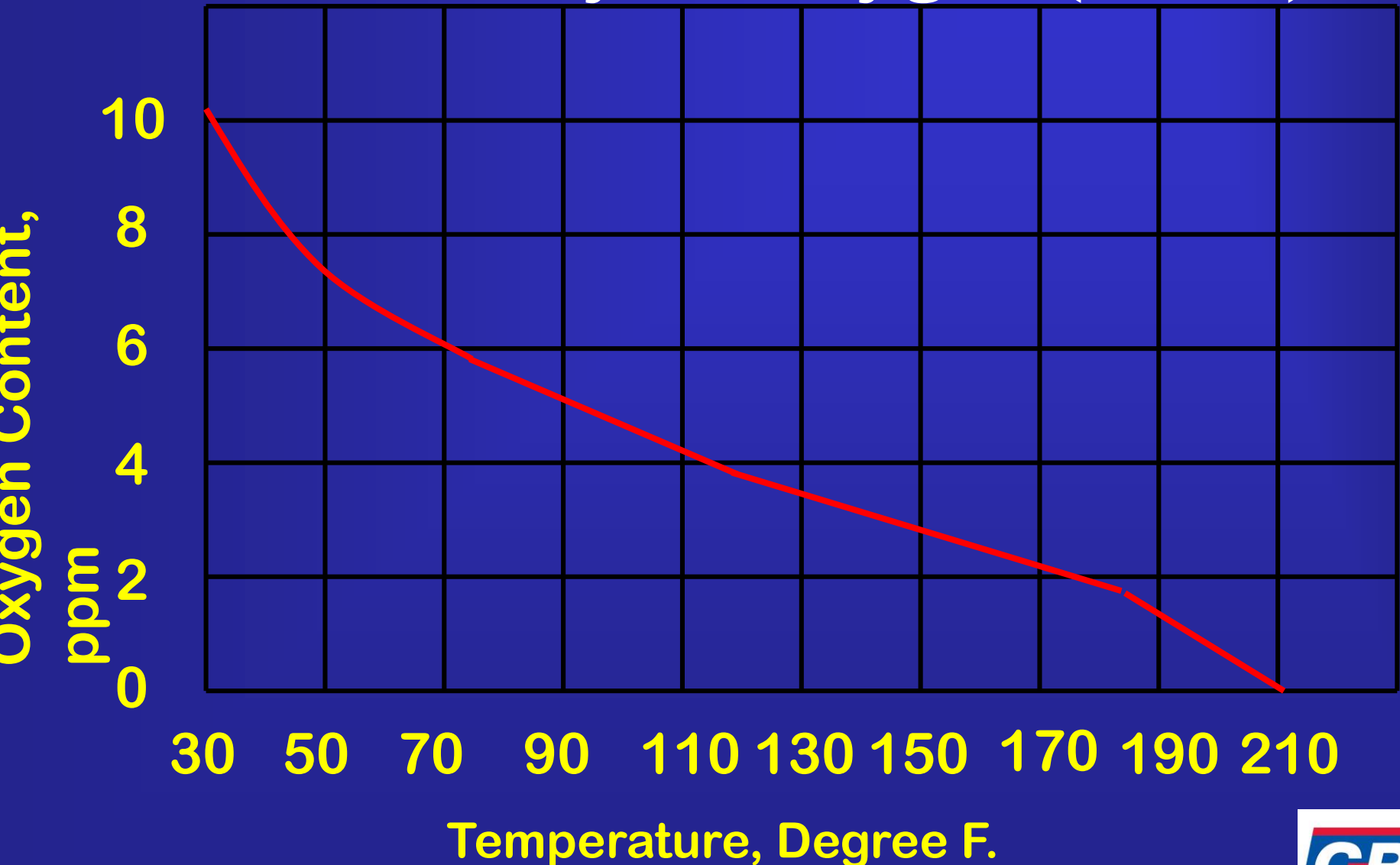


Theory in Practice

Free Gases Are Insoluble At
Saturation Temperature



Solubility of Oxygen (1 atm)



Deaeration METHODS

- Mechanical - Agitation
- Heating - Separation
- Scrubbing - Removal



What is a Deaerator

- ANSI
 - American National Standard Institute
- ASME PTC 12.3 deaerator performance test codes.
 - American Society of Mechanical Engineers Performance Test Code



What is a Deaerator

- Modern deaerating equipment is designed to reduce corrosion in boiler caused by the presence on non-condensable gases such as oxygen specifically, to reduce dissolved oxygen in feedwater, levels of 7.0 PPB (.005 cc/liter.)



What's the Best Deaerator Operating Pressure?

- Low pressure, typically 5-7 psig and _____°F
- What about higher pressures?
 - o Higher operating pressures can increase overall system efficiency
 - o Maximum operating pressure depends on steam system operations



Why should a deaerator be considered?

- Deaeration is widely recognized as the most acceptable method for removal of non-condensable gases (oxygen (O_2) and carbon dioxide (CO_2) from boiler make-up water and condensate.



Why should a deaerator be considered?

- Carbon dioxide in feedwater will also carry over into the steam and into the condensate forming corrosive carbonic acid that will attack piping and heat transfer equipment.



Why should a deaerator be considered?

- The presence of undissolved oxygen (O_2) in the feedwater is the principal factor in corrosion of steam system components. Carbon dioxide (CO_2), besides being itself corrosive, will accelerate corrosion when combined with oxygen.

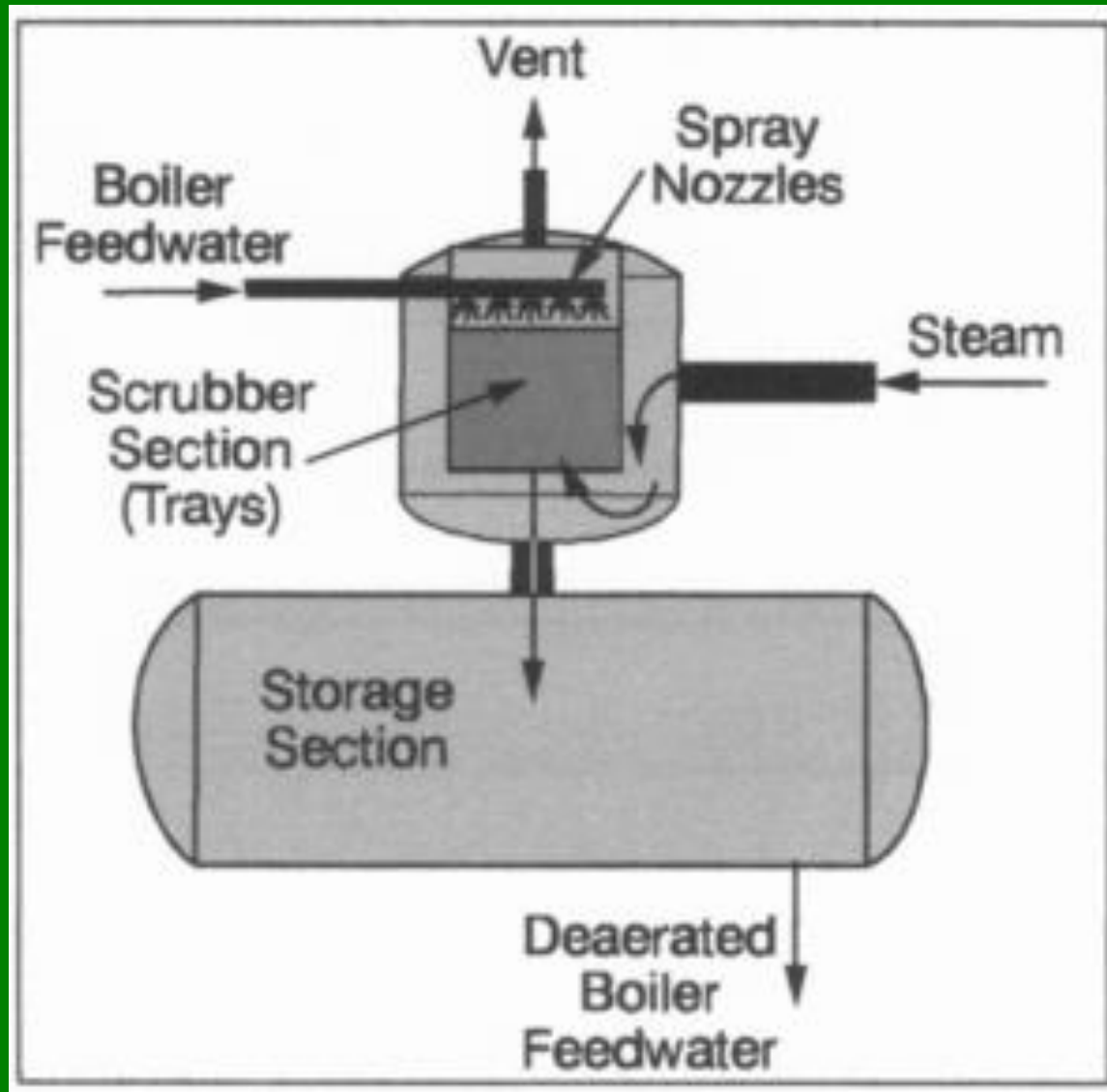


Types Of Deaerators

- Packed column type
- Spray type
- Tray type
- All operate under the same principle



Tray Deaerator

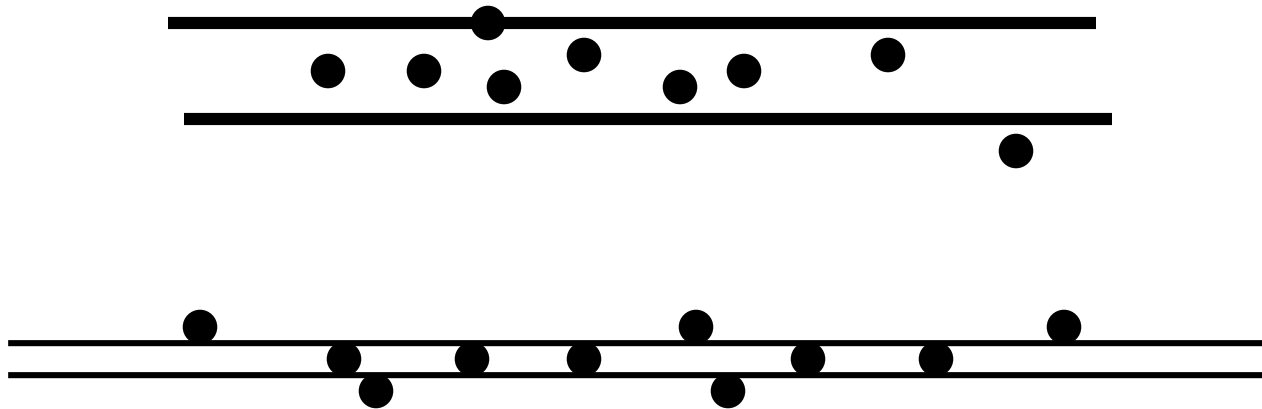


TRAY THEORY

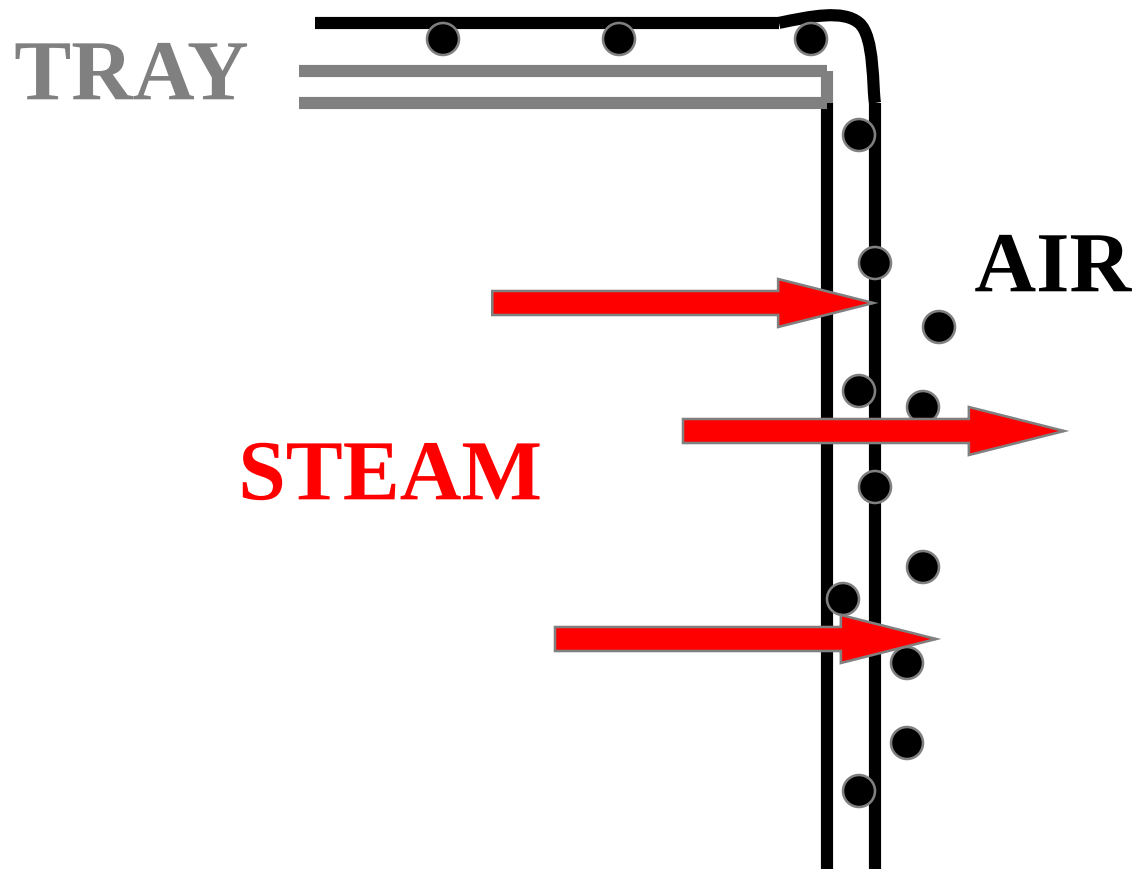
Thin Water Film Reduces Gas
Bubble Surface Tension

Helps bubble exit liquid.





Easier for air bubbles to exit



TRAY ADVANTAGES

- Less Steam Required Per Gallon.
- Responds To Load Changes.
- Water Temp. Same As Steam Feed Temp.
- Trouble-Free Operation.

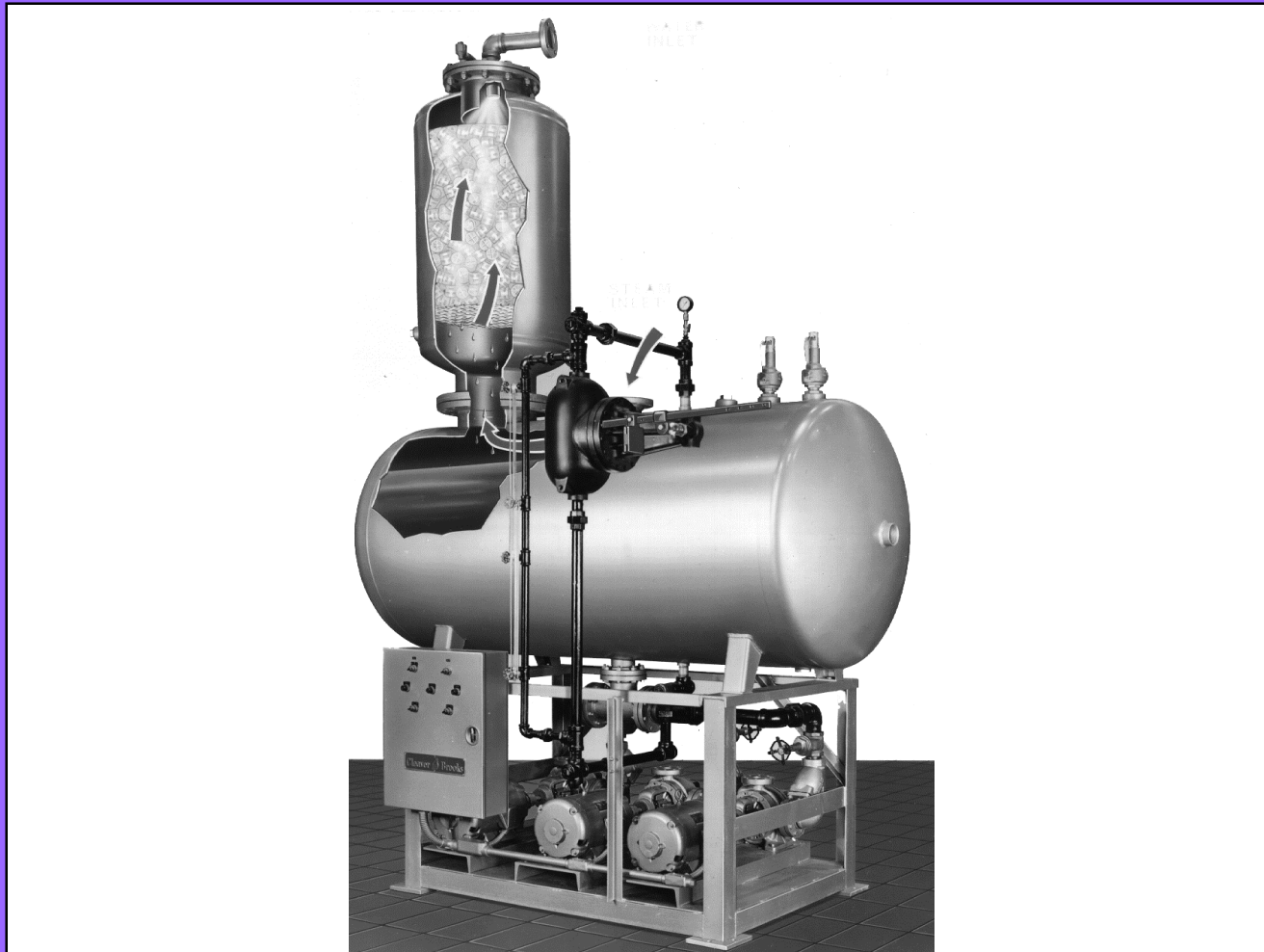


TRAY DISADVANTAGES

- Higher Initial Price.
- Trays Must Be Level.
- Edges Must Be Sharp.
- Dirt Creates Problems.



Typical Packed Column Deaerator



Packed Column ADVANTAGES

- Reliable
- Effective & Simple
- Versatile with Condensate Return

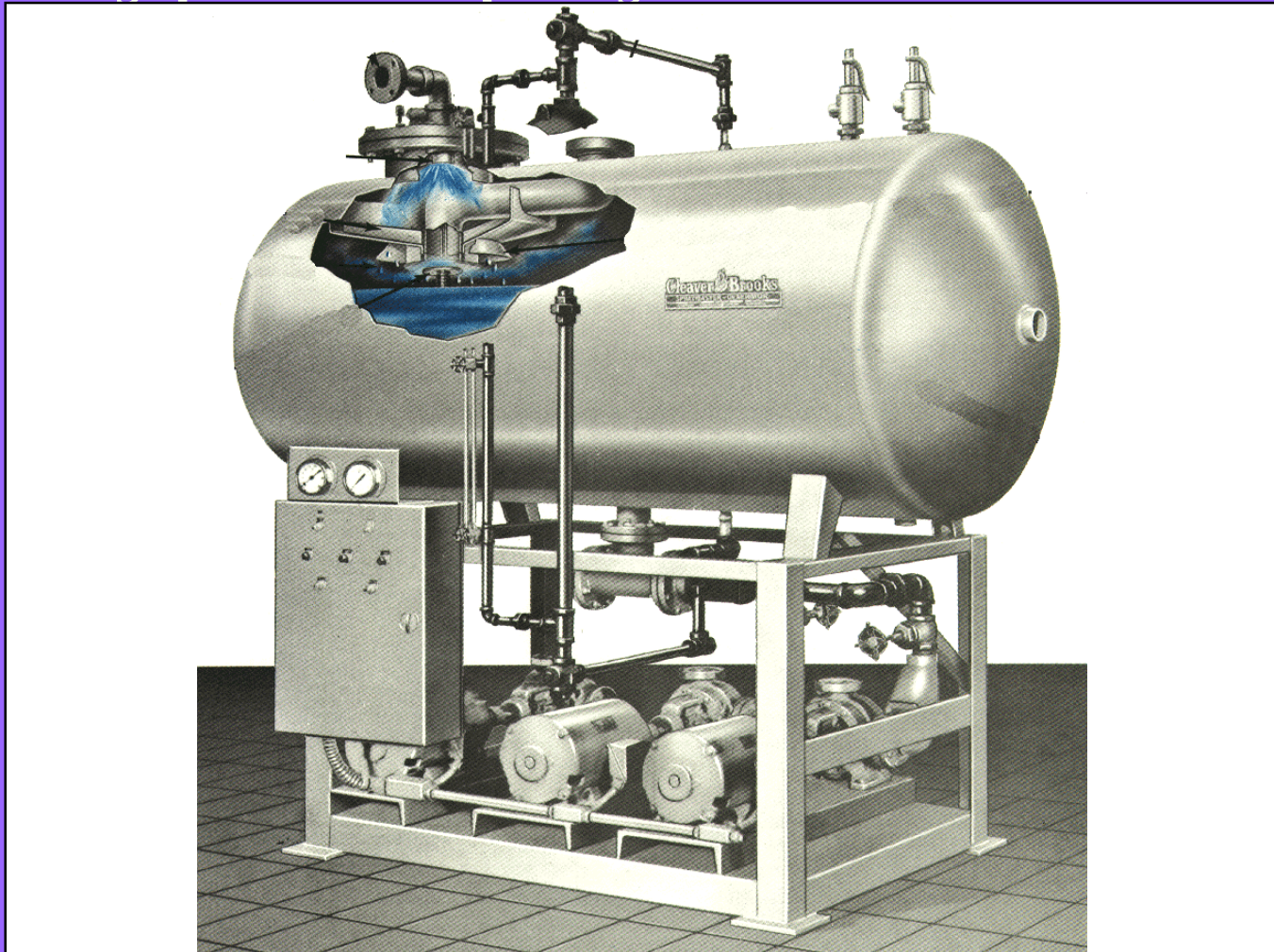


Packed Column DISADVANTAGES

- Height Limitation



Typical Spray Deaerator



SPRAY ADVANTAGES

- Low Height
- Lower Price Per Capacity
- Does Not Have To Be Level (Ships)



SPRAY DISADVANTAGES

- Requires More Steam Per Gallon
- Water Temp Lower Than Steam Feed Temp
- Does Not Respond To Rapid Load Changes
- Not as effective with high percentage of pressurized condensate recovery



Cleaver-Brooks has two type of Deaerator

- Packed Column
 - Which we call our Boilermate®
- Spray Type
 - Which we call our Spraymaster®
 - They both operate under the same principle.



Packed Column DA

- Water spray head
- Column packed with stainless steel rings
- Storage tank



Boilermate® Deaerator

- The column and storage tank are designed in accordance to ASME section VIII division 1 of the pressure vessel code.
- The column liner, grid support, water spray valve and packing are constructed of 316L stainless steel.



Boilermate® Deaerator Operation

- Water enters the top through a spring loaded, self-cleaning spray nozzle which sprays the water into the vent condensing section.
- The temperature of the water is raised to within 2 or 3 degrees of the saturated steam temperature here.



Boilermate® Deaerator Operation

- Approximately 90% of the deaeration is done at this point.
- The water then drops down through the exchange packing counterflow to the steam, which enters at the bottom of the column.



Boilermate® Deaerator Operation

- When the water drops into the storage tank, it is at the zero oxygen level and at full saturation temperature of the steam at the operating pressure.
- The released non-condensable gases are vented to atmosphere at the top of the column.



OPERATION

- Gas vent is sized by the manufacturer.
- Do not replace with standard valve.
- Typical plume is 24”.
- 1/10 of 1 % capacity



Boilermate® Deaerator Selection

- This graph shows the relationship between capacity and feedwater mix temperature

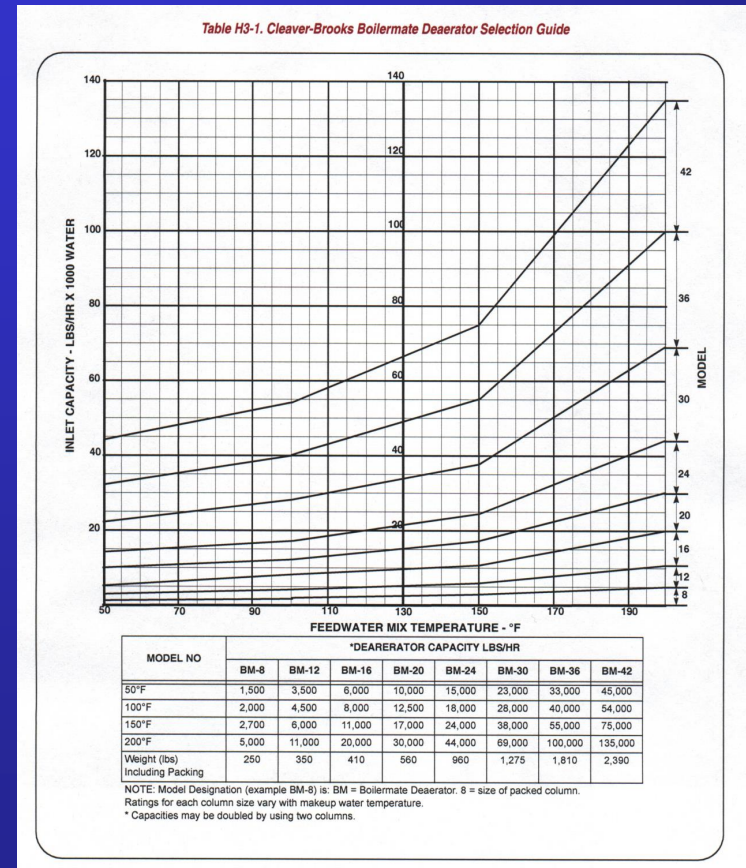
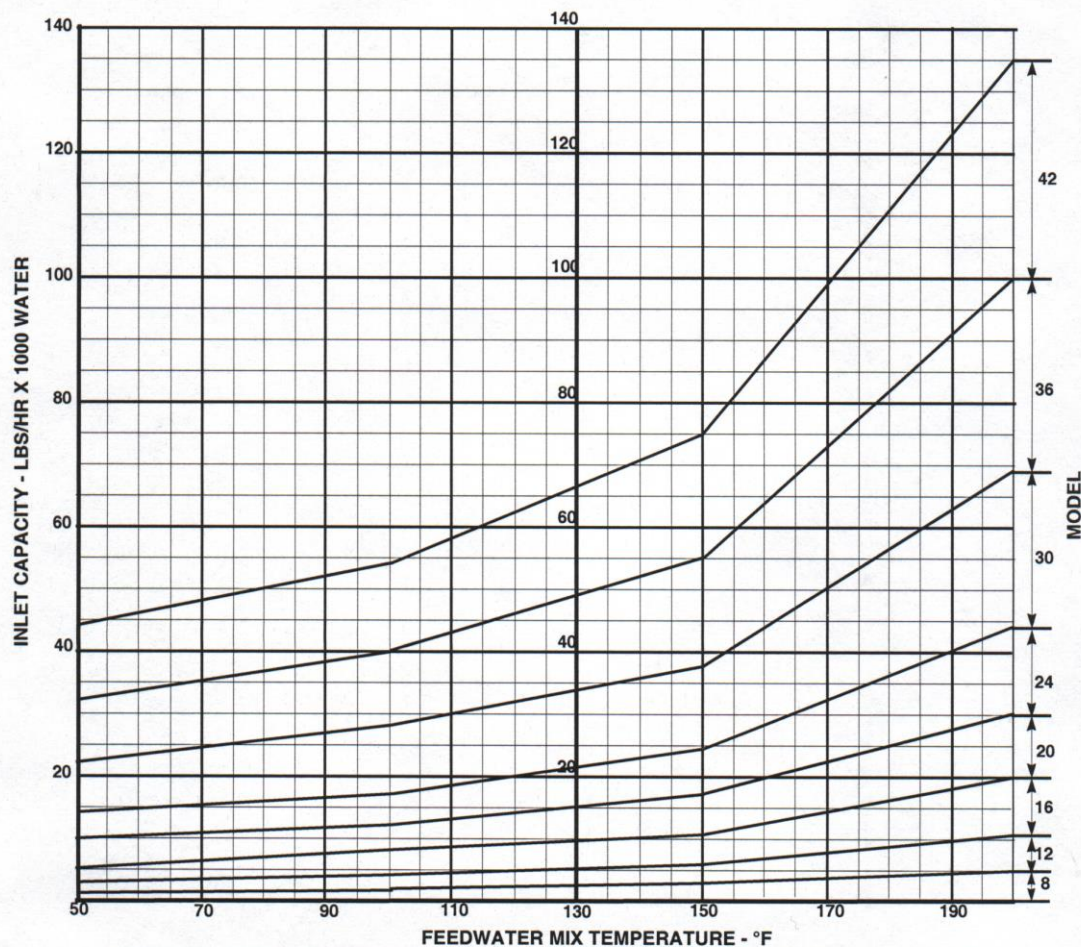


Table H3-1. Cleaver-Brooks Boilermate Deaerator Selection Guide



MODEL NO	*DEARERATOR CAPACITY LBS/HR							
	BM-8	BM-12	BM-16	BM-20	BM-24	BM-30	BM-36	BM-42
50°F	1,500	3,500	6,000	10,000	15,000	23,000	33,000	45,000
100°F	2,000	4,500	8,000	12,500	18,000	28,000	40,000	54,000
150°F	2,700	6,000	11,000	17,000	24,000	38,000	55,000	75,000
200°F	5,000	11,000	20,000	30,000	44,000	69,000	100,000	135,000
Weight (lbs) Including Packing	250	350	410	560	960	1,275	1,810	2,390

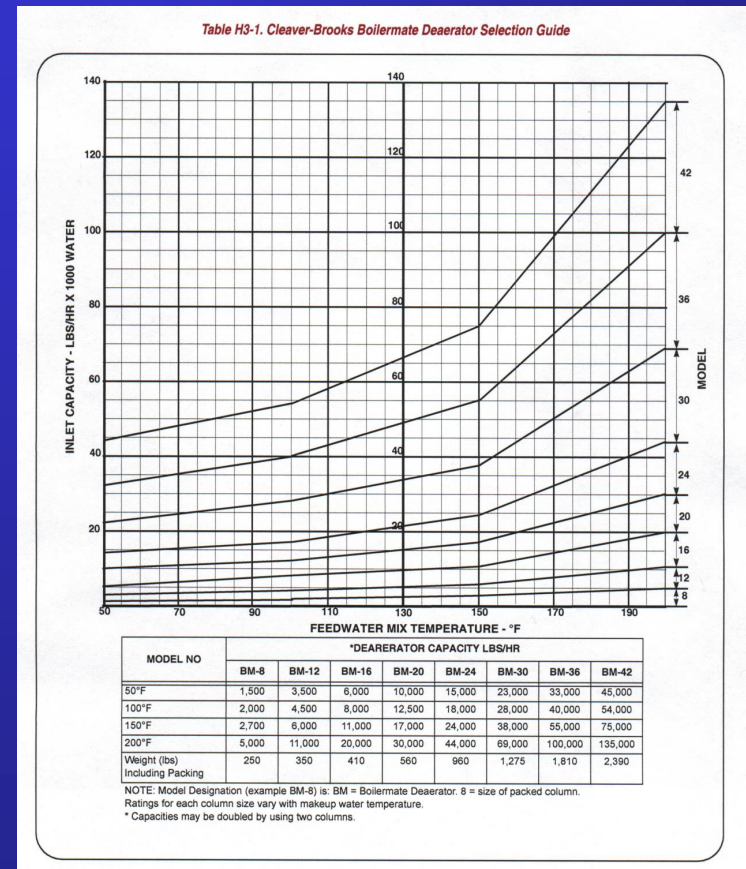
NOTE: Model Designation (example BM-8) is: BM = Boilermate Deaerator. 8 = size of packed column.

Ratings for each column size vary with makeup water temperature.

* Capacities may be doubled by using two columns.

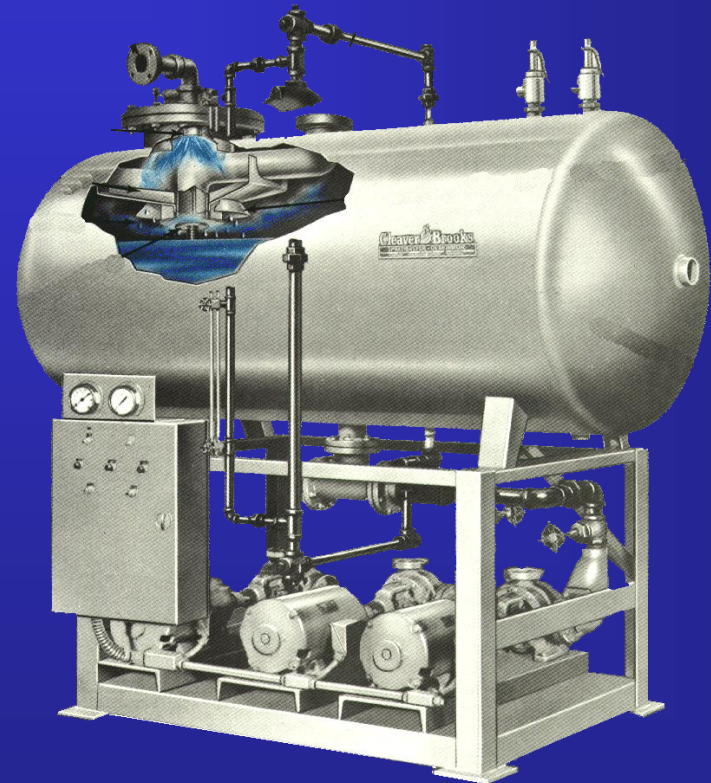
Boilermate® Deaerator Selection

- You can see that each model column has a higher capacity deaeration rating as feedwater mix temperature increases.
- 1500 - 135,000 pph



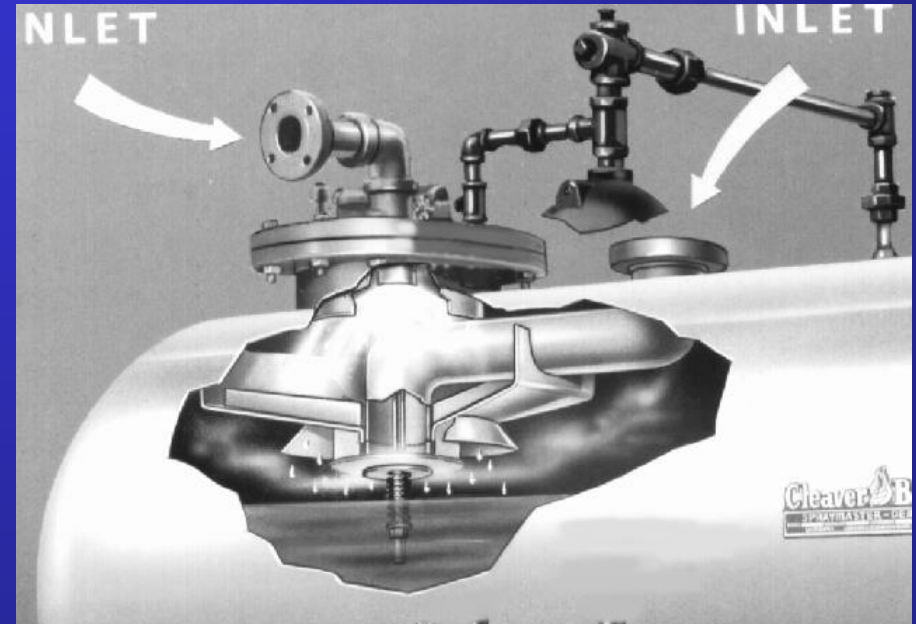
Spray Type DA

- Internal collector cone assembly
- Steam spray valve
- Water spray valve
- Storage tank



Spray Type DA

- Internal collector cone assembly
- Steam spray valve
- Water spray valve
- Storage tank



Spraymaster® Deaerator

- The storage tank is designed in accordance to ASME section VIII division 1 of the pressure vessel code.
- The water spray valve, skirts, steam baffling and steam atomizing valve are constructed of 316L stainless steel.



Spraymaster® Deaerator Operation

- Water enters the top through a spring loaded, self-cleaning spray nozzle which sprays the water into the vent condensing section.
- The temperature of the water is raised to within 2 or 3 degrees of the saturated steam temperature here.



Spraymaster® Deaerator Operation

- Approximately 90% of the deaeration is done at this point.
- The heated water drops down into the water collector and is directed through an orifice where it is violently sprayed with clean, hot steam entering the Spraymaster at this point through the steam atomizing valve.



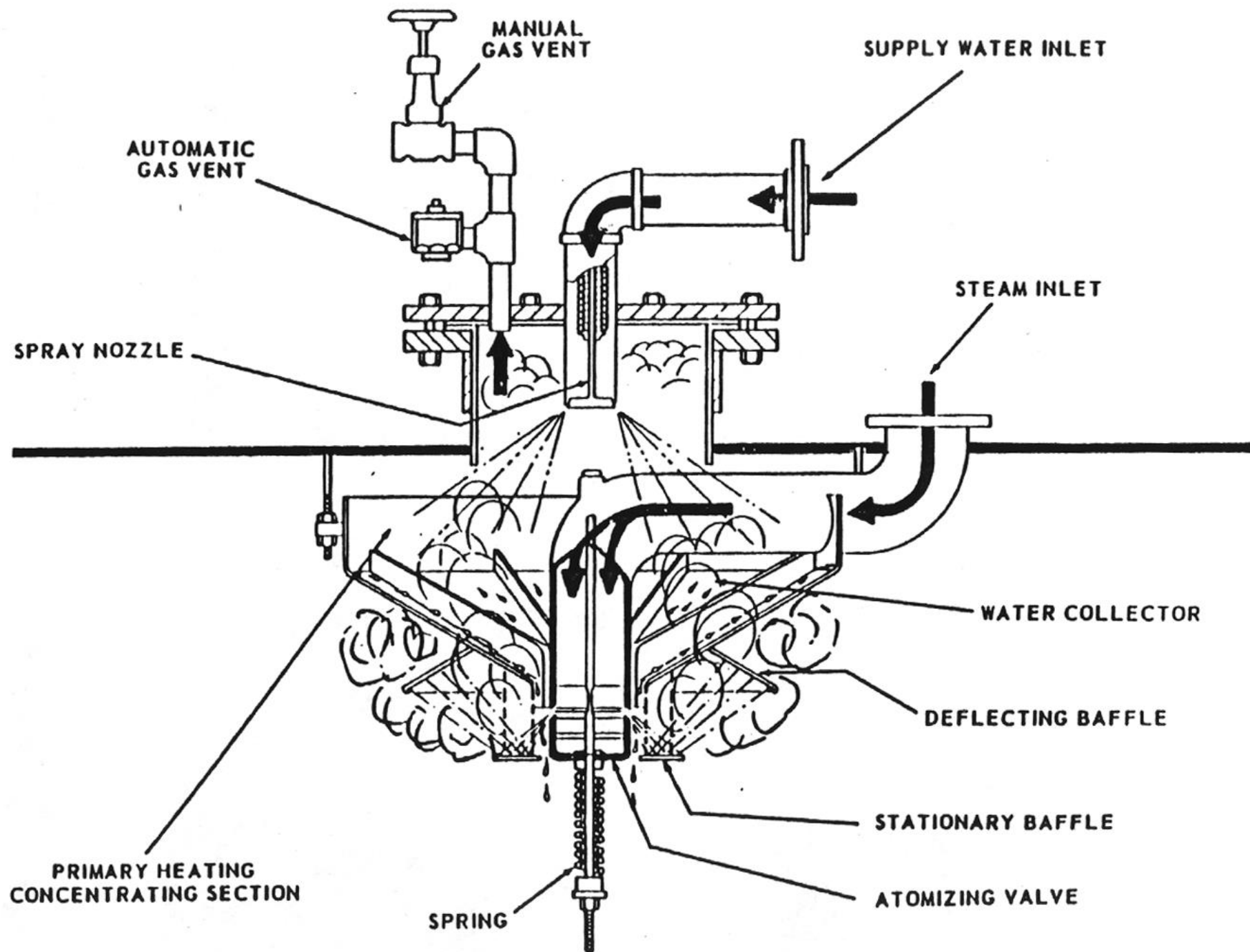
Spraymaster® Deaerator Operation

- The water and steam are deflected against baffles where the water separates, drips into the storage tank, and the steam and non-condensables gases continue up and out the vent outlet.



Internal Cone Assembly





OPERATION

- Gas vent is sized by the manufacturer.
- Do not replace with standard valve.
- Typical plume is 24”.
- 1/10 of 1 % capacity



Spraymaster® Deaerator Selection

- The selection of a Spraymaster is simply the capacity required.
 - The total load



Deaerator Storage Selection

- The selection of storage tank capacity, be it Boilermate or Spraymaster is the same.
- The industry standard is 10 minutes storage capacity rated to overflow.
 - Remember overflow and not normal operating level.



Deaerator Storage Selection

- Example:
 - 70,000 pounds per hour deaerator output is 140 gallons per minute times 10 is 1,400 gallon capacity.



When should a deaerator be considered:

- All boiler plants operating at 75 PSIG or higher.
- All boiler plants with little or no standby capacity.
- All boiler plants where production depends on continuous operation.
- All boiler plants operating with cold water make-up of 25% or more.



Why should a deaerator be considered:

- Yearly operating cost savings.
- Accepts exhaust or flash steam.
 - But must not exceed the required amount of steam for deaeration.
- Reduces boiler blowdown
- Reduces usage oxygen scavenger.
- Reduces cold water makeup.



Savings

- In addition to removing oxygen and carbon dioxide, deaerators heat boiler feedwater, which helps reduce boiler maintenance caused by thermal shock.



Thermal Shock

- A rapid change in temperature causes thermal shock. Thermal shock occurs as a result of difference in thermal expansion.
- Too much stress created at the point of feedwater inlet to the boiler may result in weld cracking.



Savings

- With deaeration you can further your savings result from reduced need for oxygen scavenging chemical treatment.



Oxygen levels

- Cleaver-Brooks Spraymaster® and Boilermate® Deaerators totally remove carbon dioxide and remove oxygen to .005 cc/liter. or 7 parts per billion



Deaerators

- The effects of non-deaeration are costly in terms of:
 - Poor Fuel Efficiency
 - Frequency of Maintenance
 - Premature Boiler Failure



Benefit Summary

- Removes dissolved gasses
 - Oxygen (O_2)
 - Carbon Dioxide (CO_2)
- Heats water to
 - 227 °F @ 5 psi of pressure in the tank.
- Oxygen reduce to
 - .005 cc/liter
 - 7 parts per billion



Deaerator Sizing

- Capacity
 - Water required to supply boiler
- Operating pressure of boiler
- Water pressure to cold water make up valve
- Percentage of:
 - Cold water make up
 - Condensate return



Deaerator Selection

- There are two basic systems used almost exclusively with occasional minor variations.
 - The first is the single tank deaerator, referred to “Plan A”
 - The second is a two tank system or duo deaerator / surge tank, referred to “Plan B”

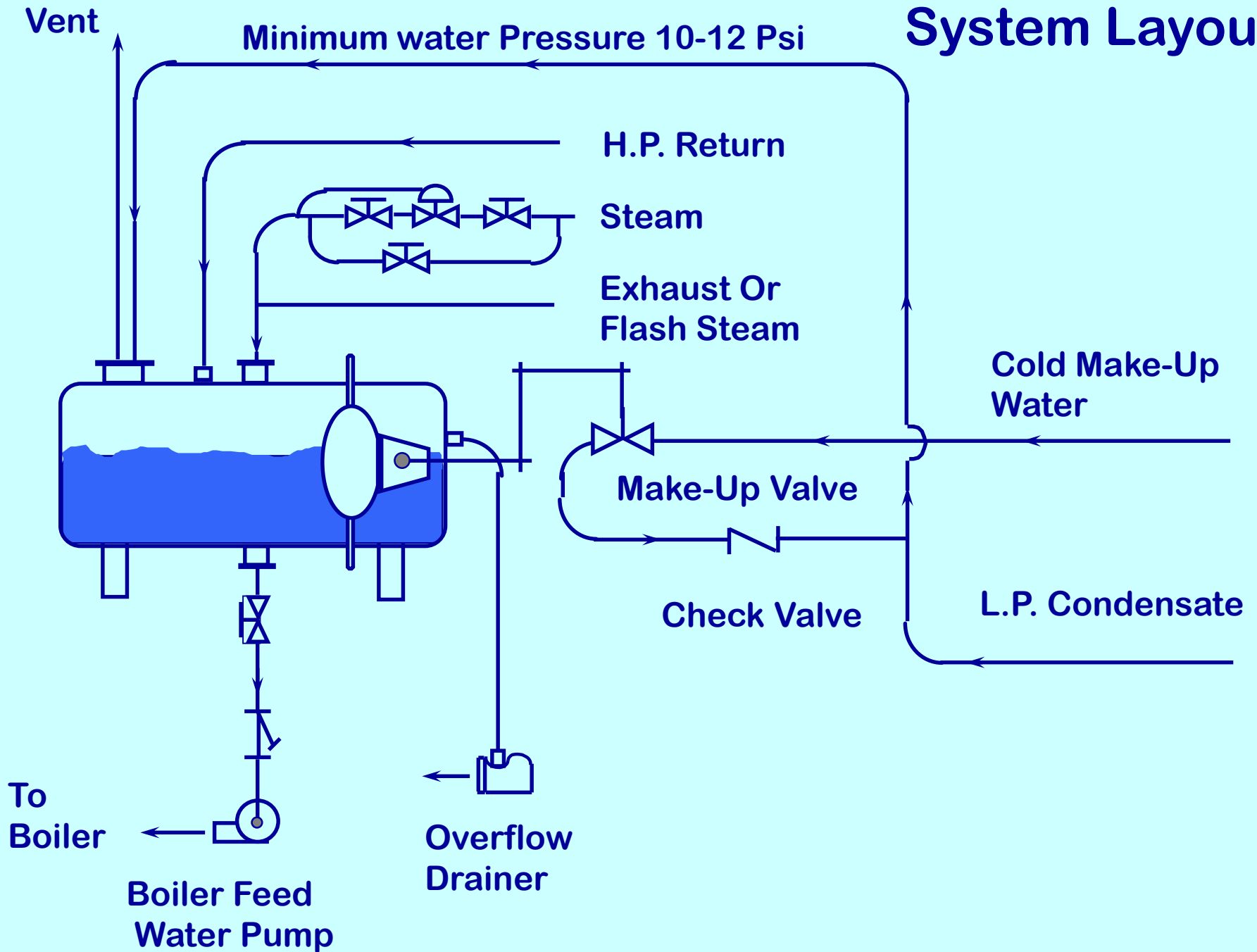


Deaerator Selection

- “Plan A”
 - The low pressure or low temperature condensate is fed to the deaerator directly through a condensate pump. The makeup water directed through the makeup valve on the deaerator and is allowed to enter the deaerator only if the condensate cannot maintain the desired operating level.



System Layout



Two Tank System

- “Plan B”
 - This is used primarily for two reasons:
 - First, when the low pressure condensate does not have enough pressure to be put directly into the deaerator and therefore, it is returned to an atmospheric surge tank. You must have at least 12 lbs. Pressure to enter into our deaerator operating at 5 psig.



Two Tank System

- “Plan B”
 - This is used primarily for two reasons:
 - Secondly there are several collection points for low pressure returns or high pressure and it is more convenient to return these to an atmospheric surge tank.



Surge Tanks

- Also known as:
 - Condensate Tanks
 - Receiver Tanks
 - Atmospheric Receivers
 - Condensate Receivers
 - Hot wells
 - Vented Receivers



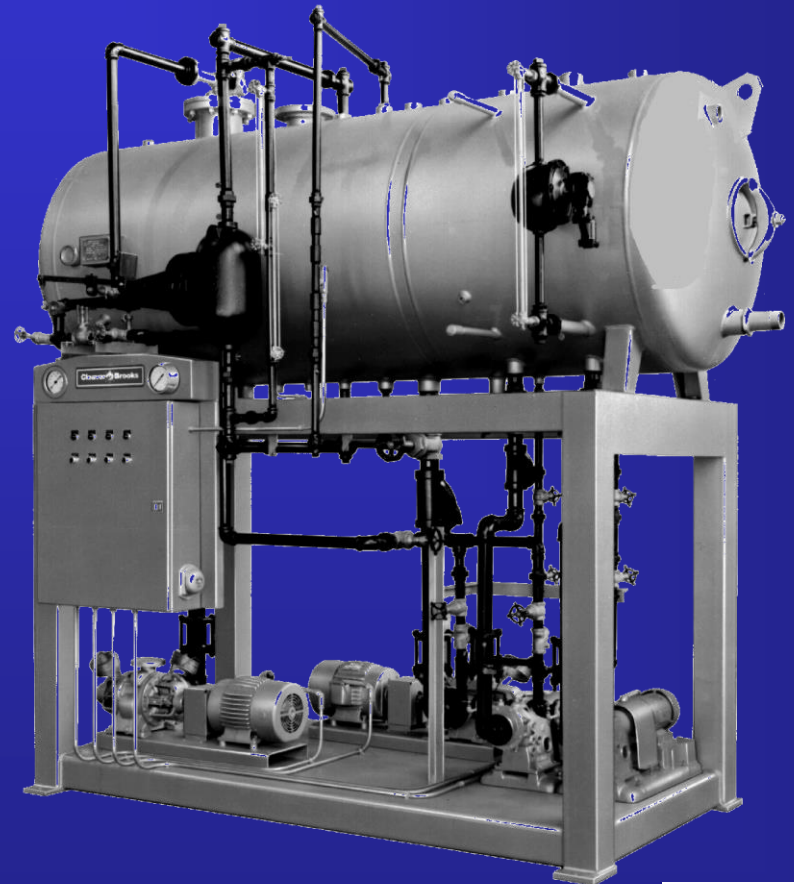
Surge Tanks

- Storage tank



Spray Type Duo DA

- Internal collector cone assembly
- Steam spray valve
- Water spray valve
- Storage tank
- Attached surge tank



When do I need a surge tank?

- When you have a greater return volume of condensate than you have condensate storage capacity in the deaerator.
 - This is the area between the normal water level and the overflow.
- When you have gravity returns



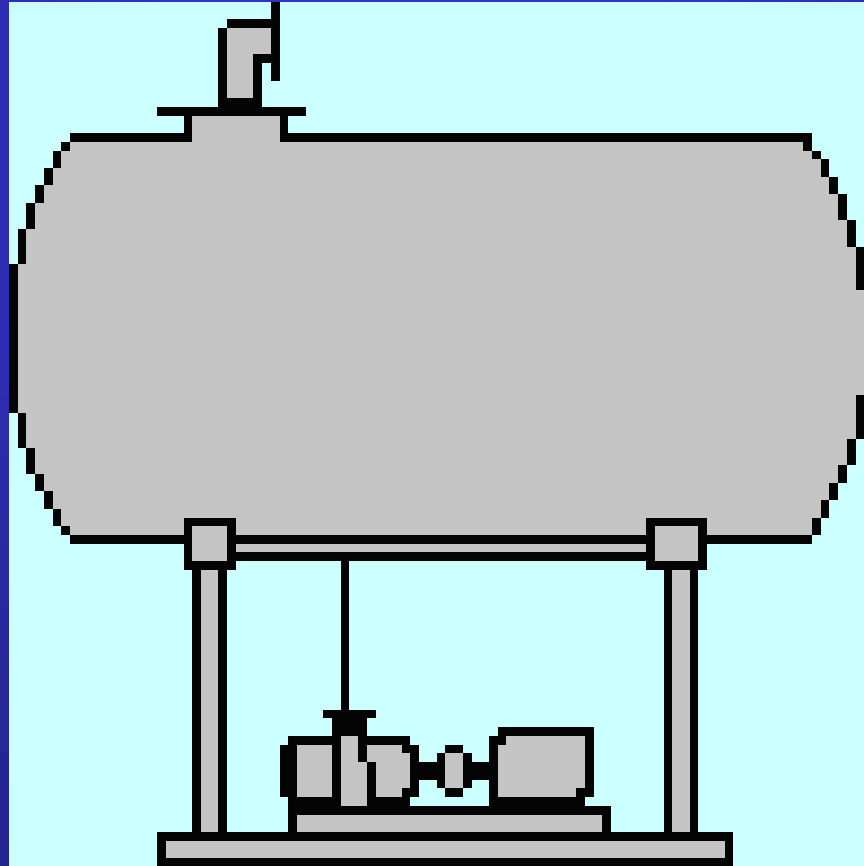
When do I need a surge tank?

- When you have over 25 to 30% of high pressure condensate return.
 - Otherwise, the flash steam would take away from the scrubbing steam.

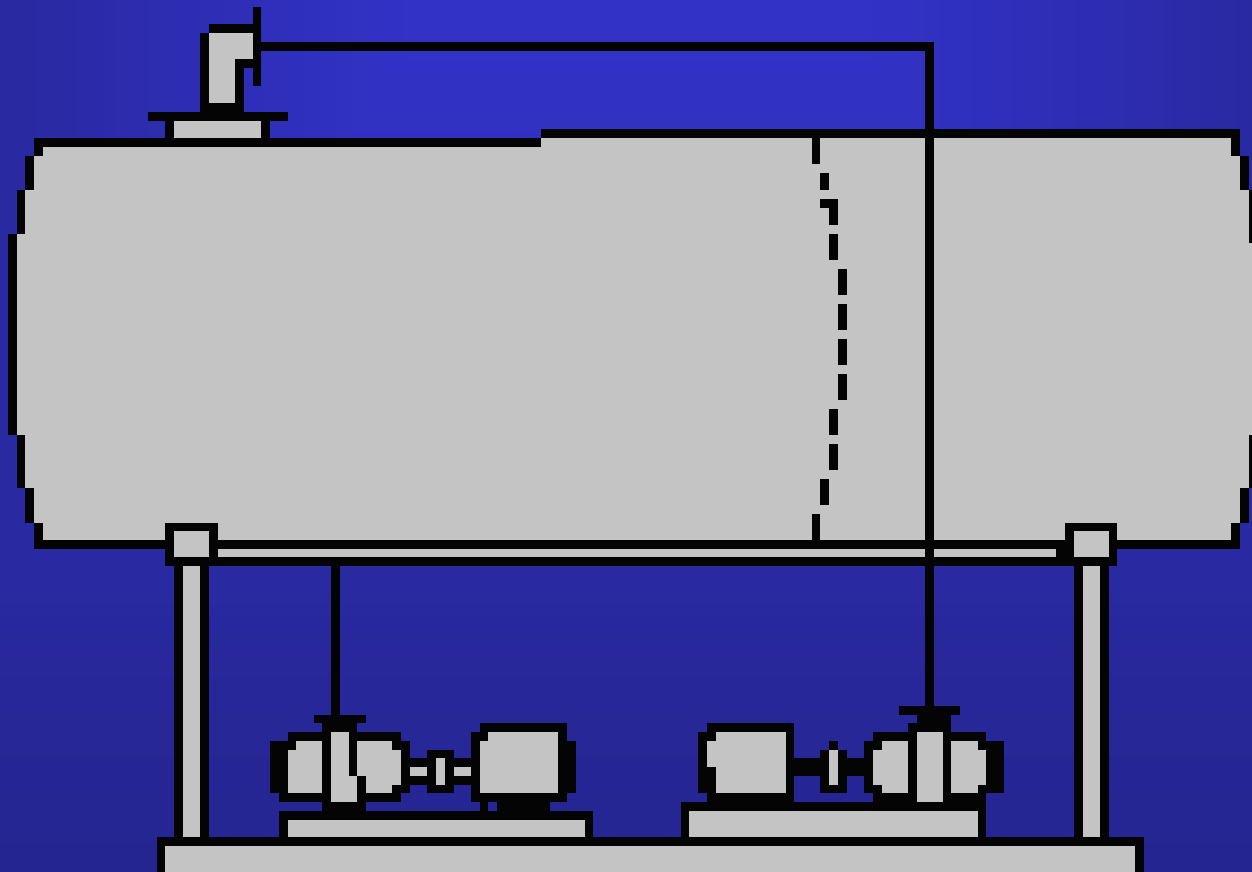


Deaerators and Surge Tanks are
available in several different
arrangements

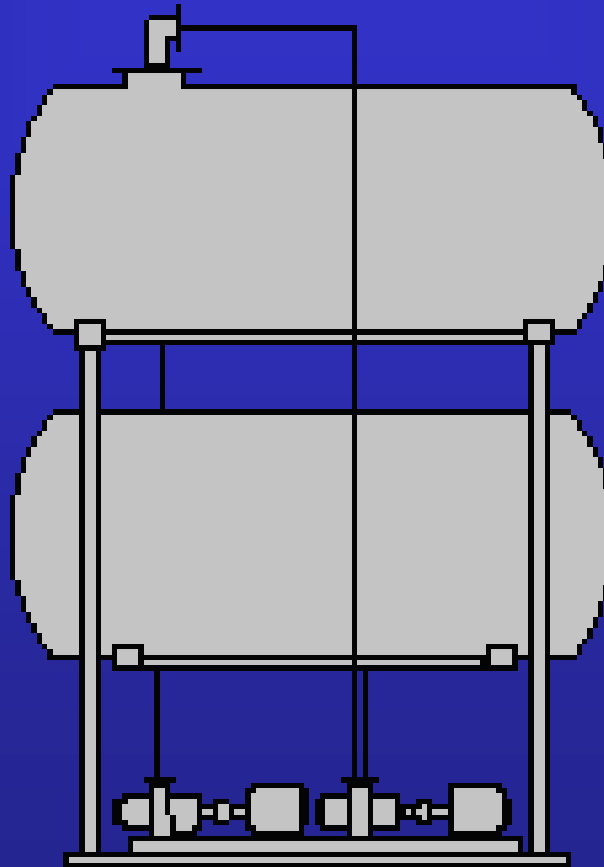
Single Tank Spraymaster® or Boilermate®



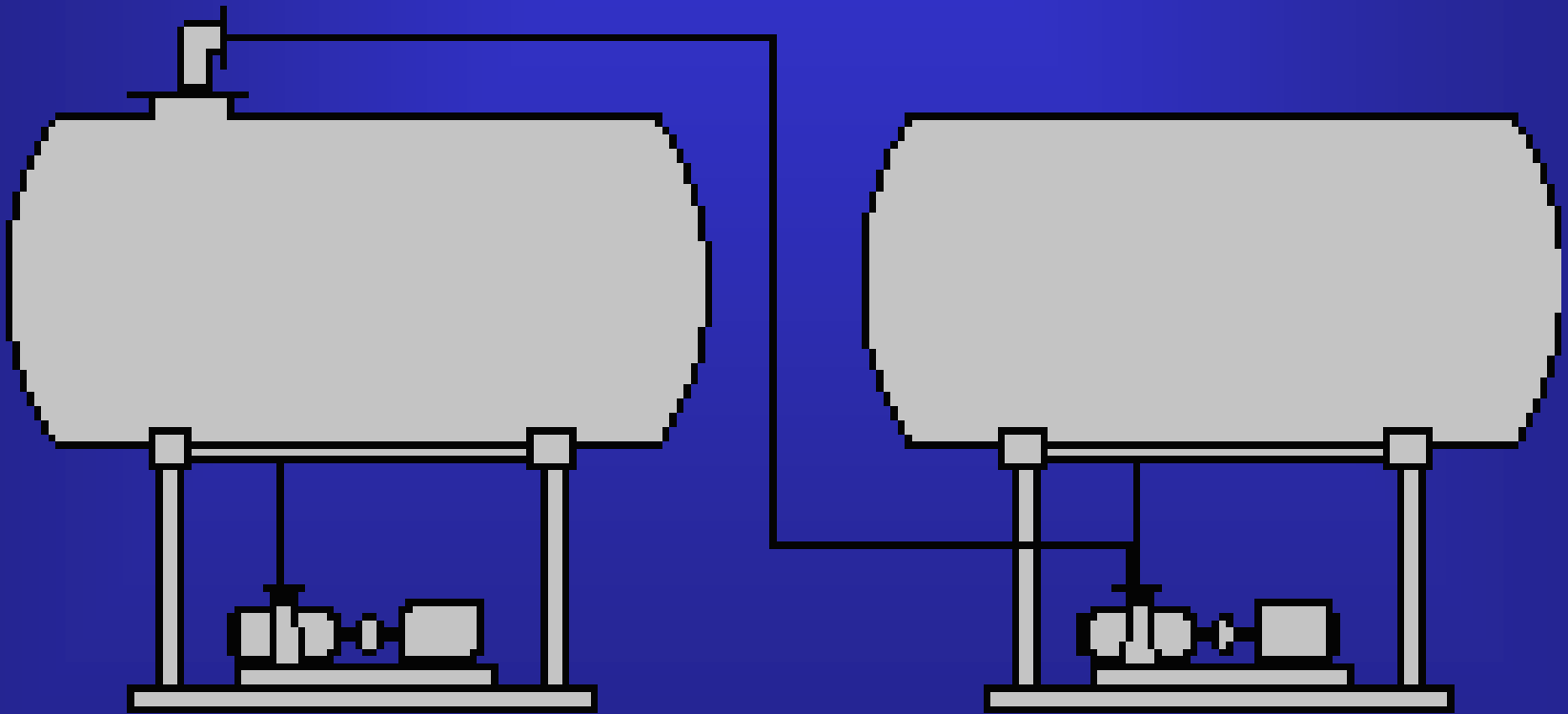
Duo Tank - Spraymaster®



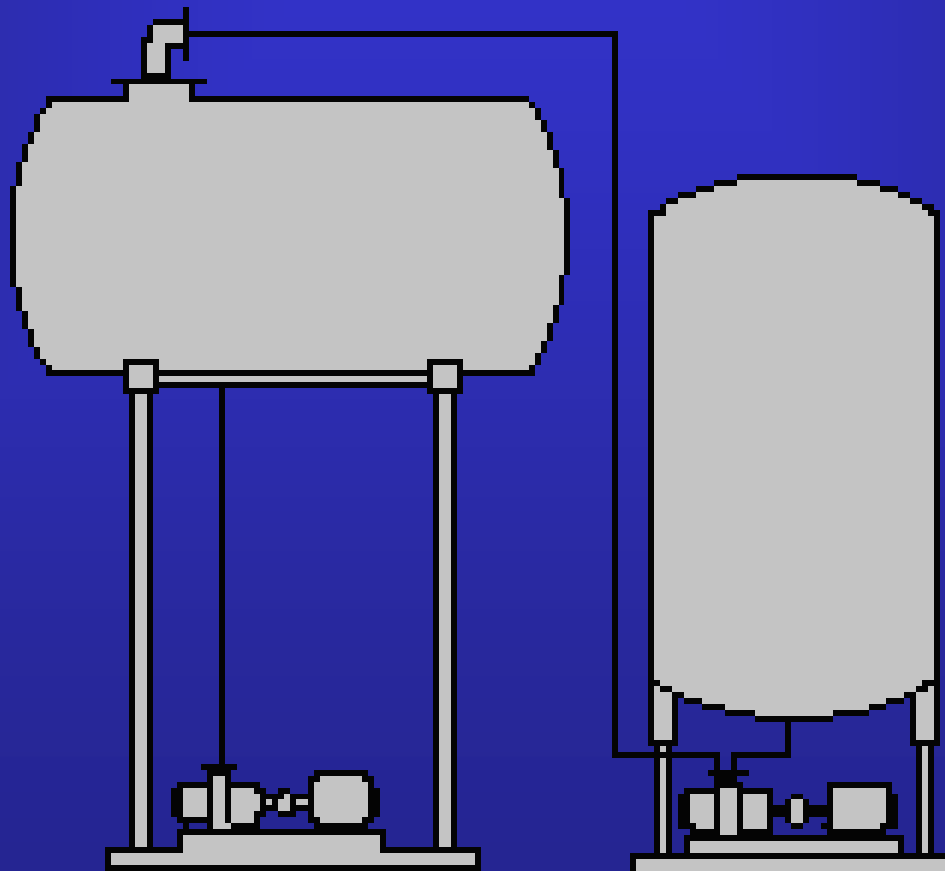
Two-Tank Piggy Back Spraymaster®



Two-Tank Horizontal Surge Spraymaster® or Boilermate®



Two-Tank Vertical Surge Spraymaster® or Boilermate®



Questions?

