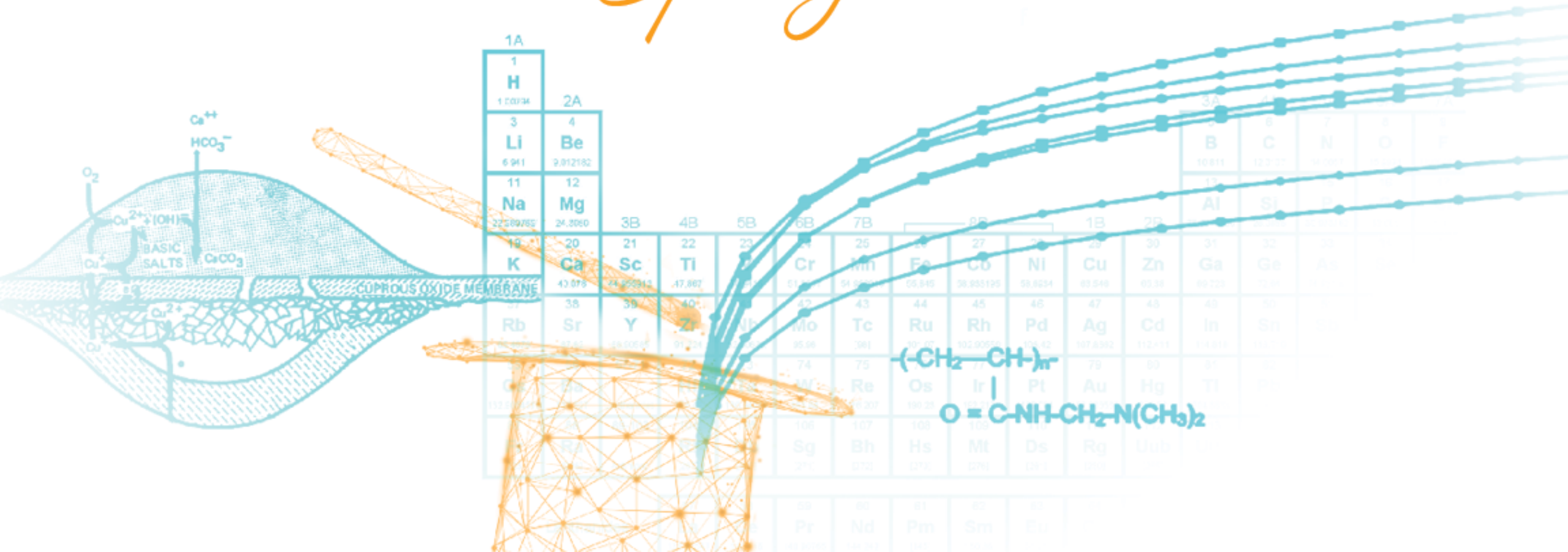
Annual Convention & Exposition

September 11-14, 2019

Palm Springs Convention Center and
Renaissance Palm Springs Hotel

Palm Springs, CA



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Pre-Treatment
Ins and Outs of Deaerator

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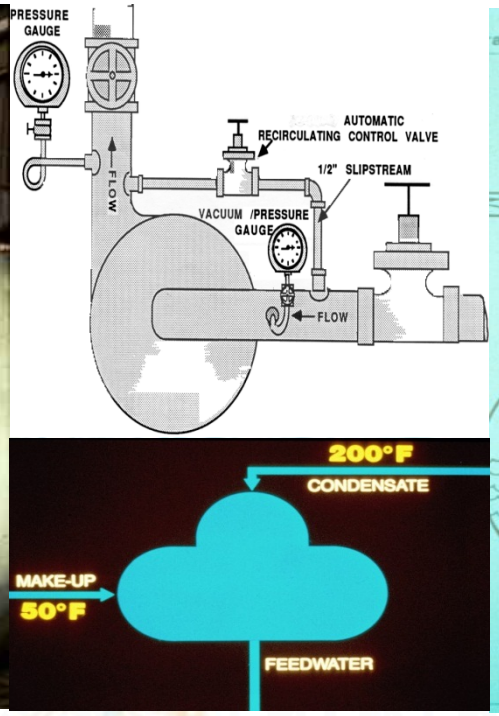
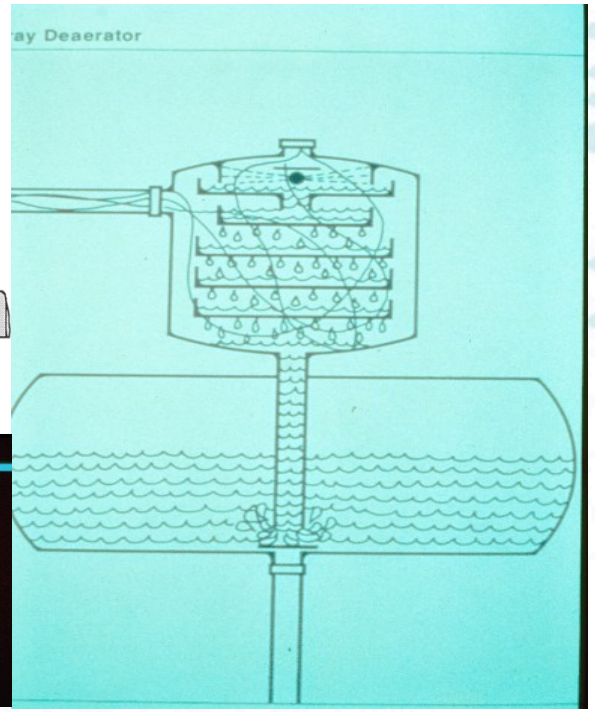
OXYGEN & DEAERATION

FEED WATER – OXYGEN REMOVAL

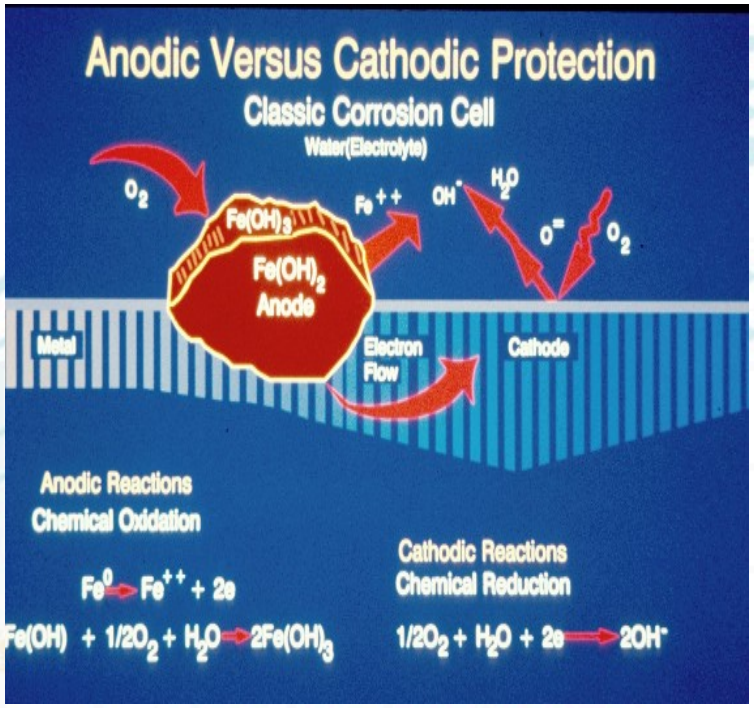
Oxygen is removed from the make up water in the feed water system. Dissolved gasses are driven off to varying degrees by increasing the temperature of the water..





Oxygen The Cause of Corrosion

- The addition of oxygen to a system with water and heat will initiate corrosion.
- Heat, found in the feed water system, is a driving force for corrosion
- Mechanical deaeration, can remove most, but not all of the oxygen from the water.
- An oxygen scavenger is used to eliminate the remaining oxygen.
- Properly applied, oxygen scavengers will minimize oxygen pitting



Oxygen Pitting

- Oxygen pitting increases by a factor of two for every 10ºC (18ºF) rise in temperature.
- Oxygen can be 512 times as aggressive at 212º than it was at 50ºF.
- Once heated, the oxygen has to be removed via mechanical and/or chemical means.
- Oxygen pitting occurs when the oxygen has been heated up and then is not removed.

Feed Water Corrosion

- Dual tank DA systems have a cold side where the makeup water is added and a hot side where deaeration occurs.
- Have a steam lance installed on the cold side
- Inject oxygen scavenger into cold end

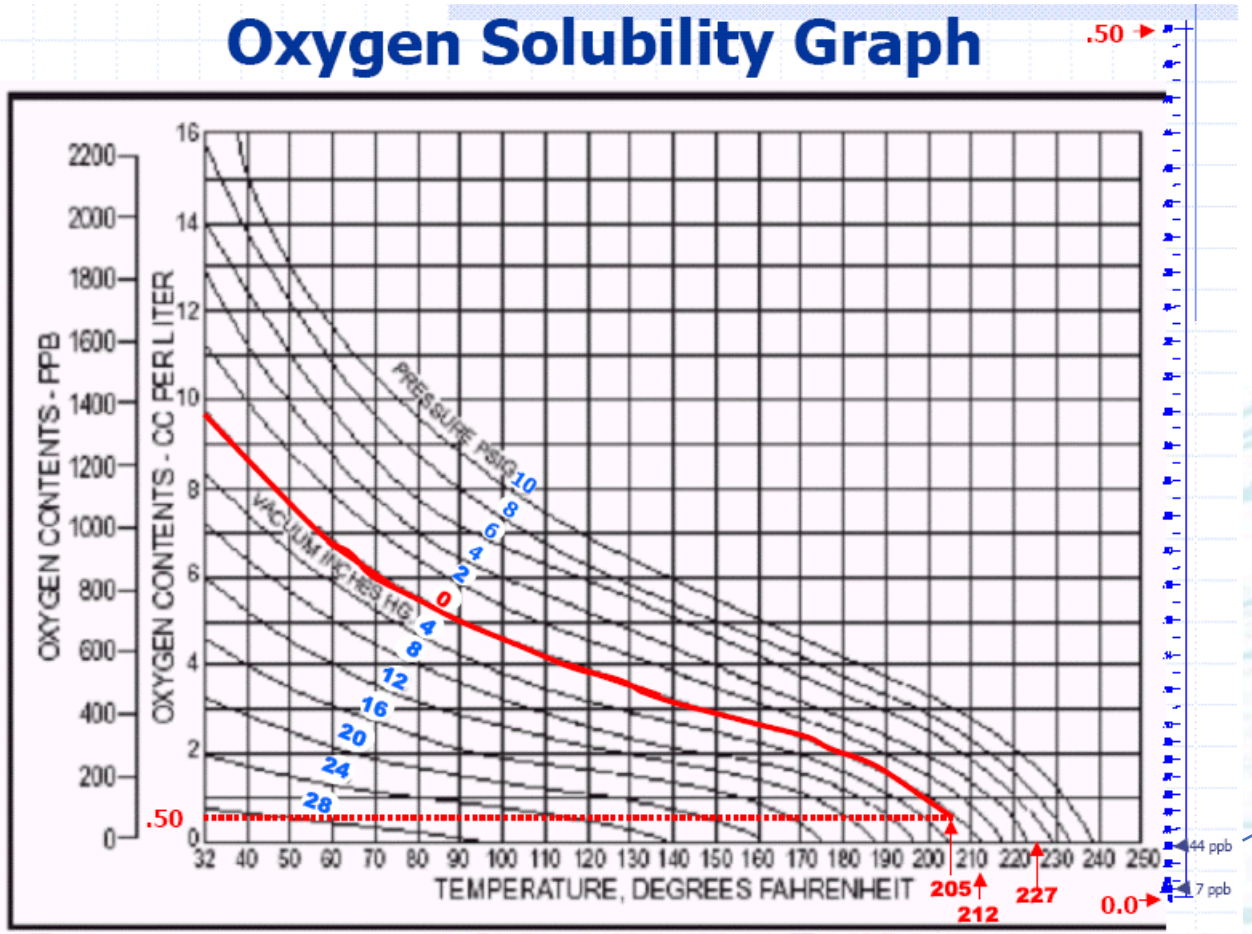
Feed Water pH

- The pH of the feed water should be above 8.5 to prevent corrosion of iron in the system
- The pH of the feed water should be below 9.2, to prevent copper loss in the system
- Optimum pH in the feed water should be 8.5-9.2

Deaerator Ratings

- Deaerators are categorized by the quantity of oxygen that they are able to remove at boiling point. The categories are;
  - Preheat Boiler Feed (Atmospheric Feed Water Tank)
    - 195° - 205°F (0.1 – 1 ppm Oxygen)
  - 0.03 DA Pressurized **(within 3˚F of saturation)**
    - 44 ppb Oxygen remaining
  - 0.005 DA Pressurized **(within 3˚F of saturation)**
    - 5- 7 ppb Oxygen remaining

Oxygen Solubility Graph



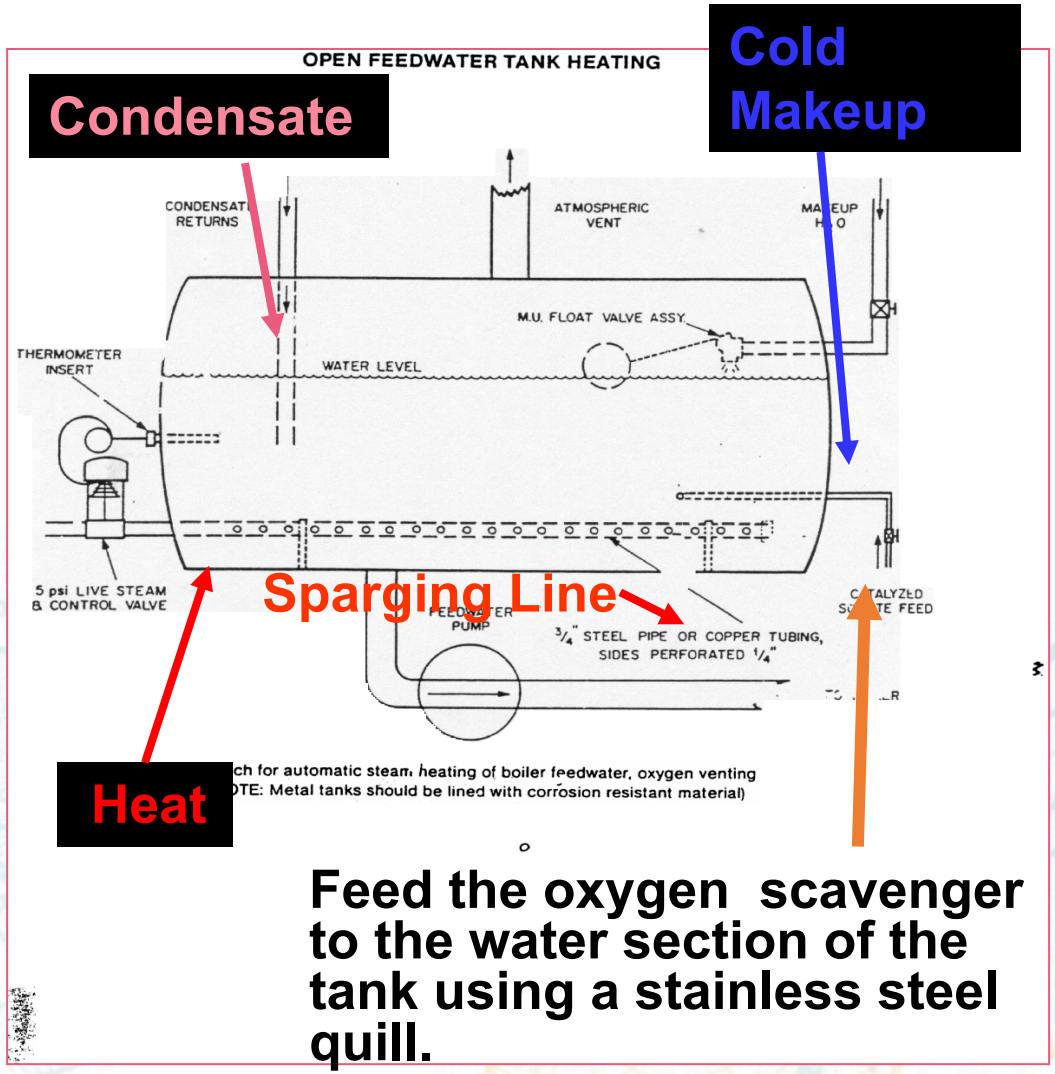
0.03 DA

0.005 DA

DA Operation Factors

- Temperature – Increased temperature improves removal of dissolved gasses
- Turbulence – Required to scrub gasses out of the water
- Time – Efficiency is a function of time
- Thin Film – Increases the surface area of the water, which improves efficiency, the reason for trays
- Transients – The addition of fresh cold make up water to the system and the method used to maintain the boiling point in the DA to maintain efficiency.
- Venting – Must be a straight run. Elbows reduce the efficiency of the deaeration. Check the fixed plate orifice on pressurized units
- Vent Condensing – The DA's economizer

Atmospheric Feed Water Tank

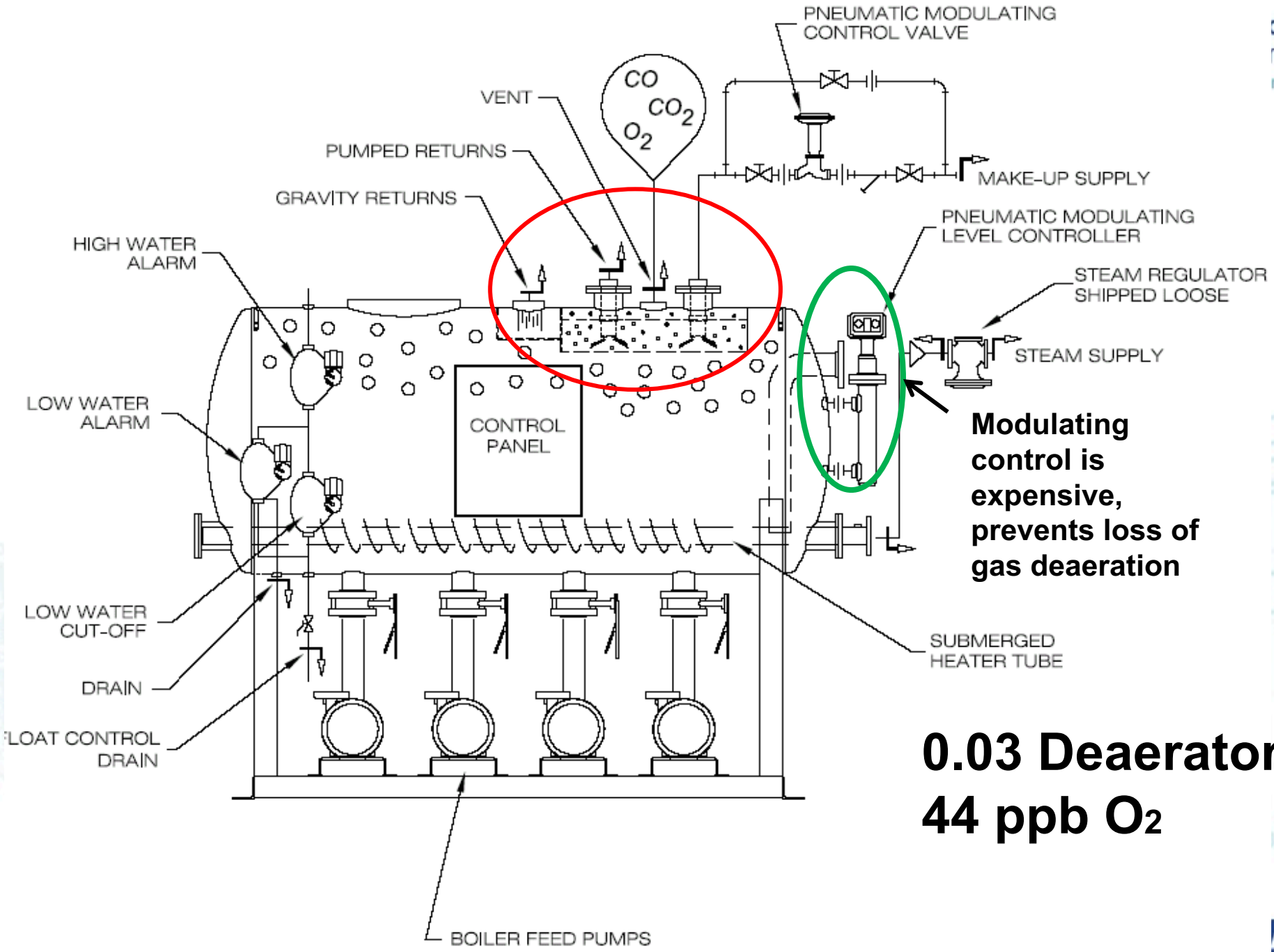


Feed the oxygen scavenger to the water section of the tank using a stainless steel quill.

Water temperature is important for oxygen removal. With this system, the temperature limitation is feed water pump cavitation. When the feed water pump activates, the boiling point of water is reduced

Feed Water Tank Specifications

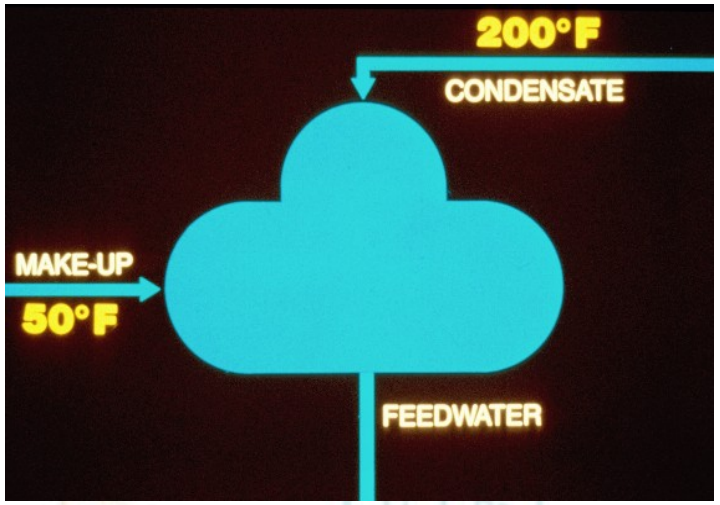
- Feed water tank is an atmospheric tank.
- Oxygen scavenger is to be fed to the water section of the tank using a stainless steel quill.
- In that water temperature is important for the removal of oxygen. This tank needs to be as hot as possible.
- The problem with this type of system in particular is that if the tank temperature is held above 195° F there is a potential for feed water pump cavitation.
  - Temperature gauges fail, therefore optimum operating temperature should be 200ºF - 205ºF.
  - When the feed water pump comes on, the boiling point of water is reduced
  - Deareators use head pressure (1 psi for every 2.3 feet of height above the pump), where a feed water tank is barely 3 feet above the feed water pumps.
  - Watch the temperature closely to prevent pump loss due to cavitation.



Modulating control is expensive, prevents loss of gas deaeration

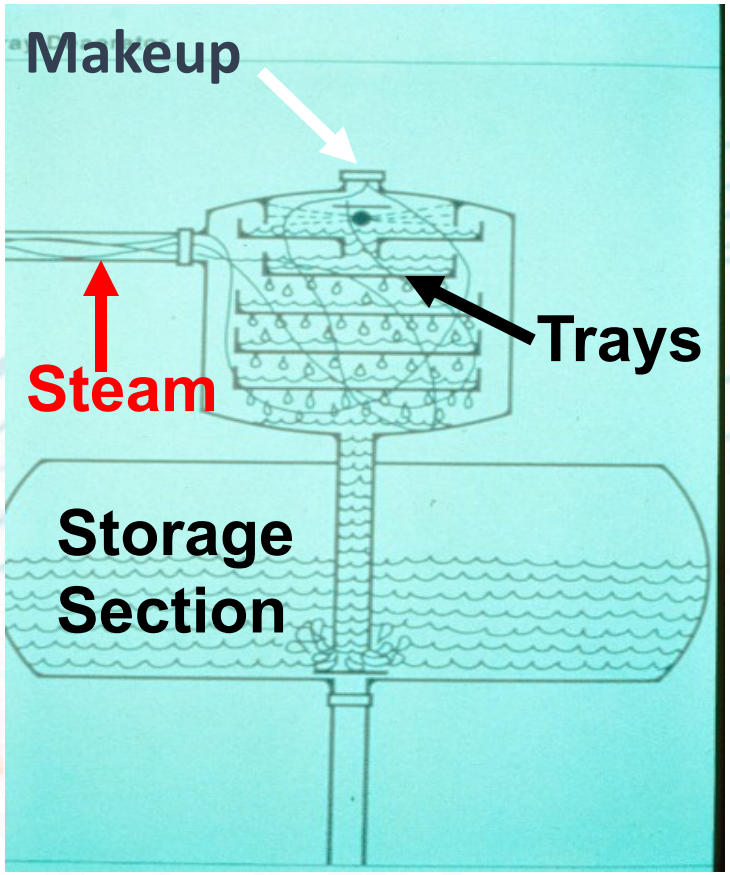
0.03 Deaerator
44 ppb O_2

Feed Water and Tray Deaeration

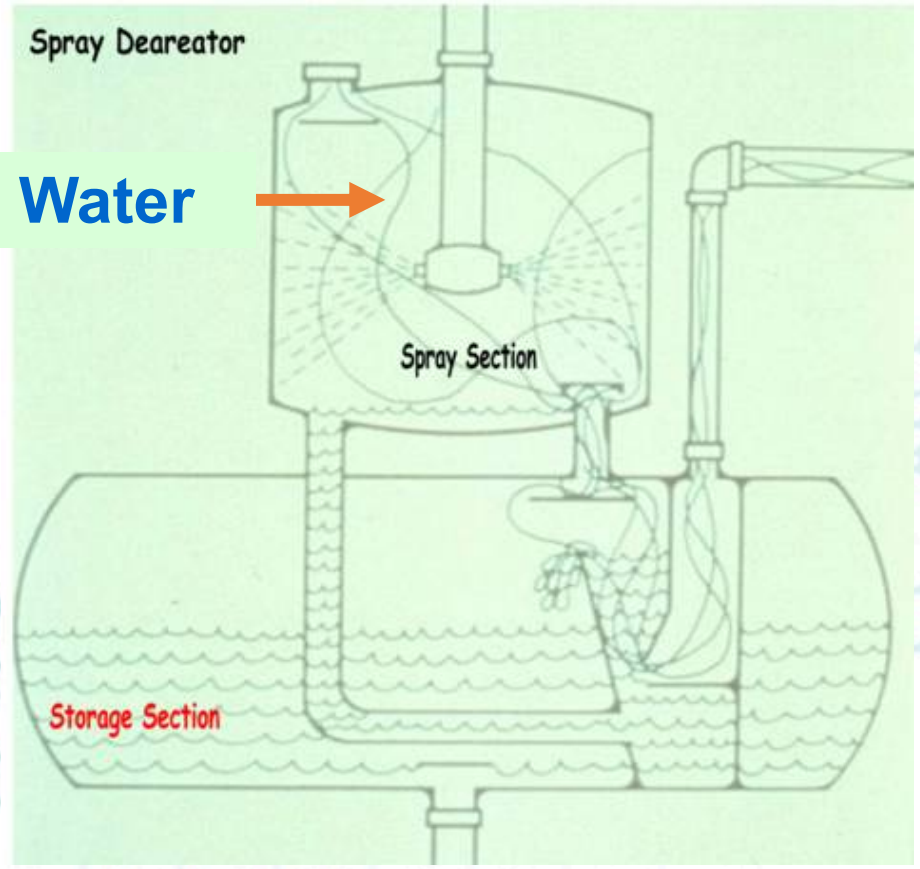


Feed Water is make up water plus condensate. This blending occurs in the feed water tank or a deaerator. Controlled heat should be added to reduce thermal shock and drive off the dissolved gasses.

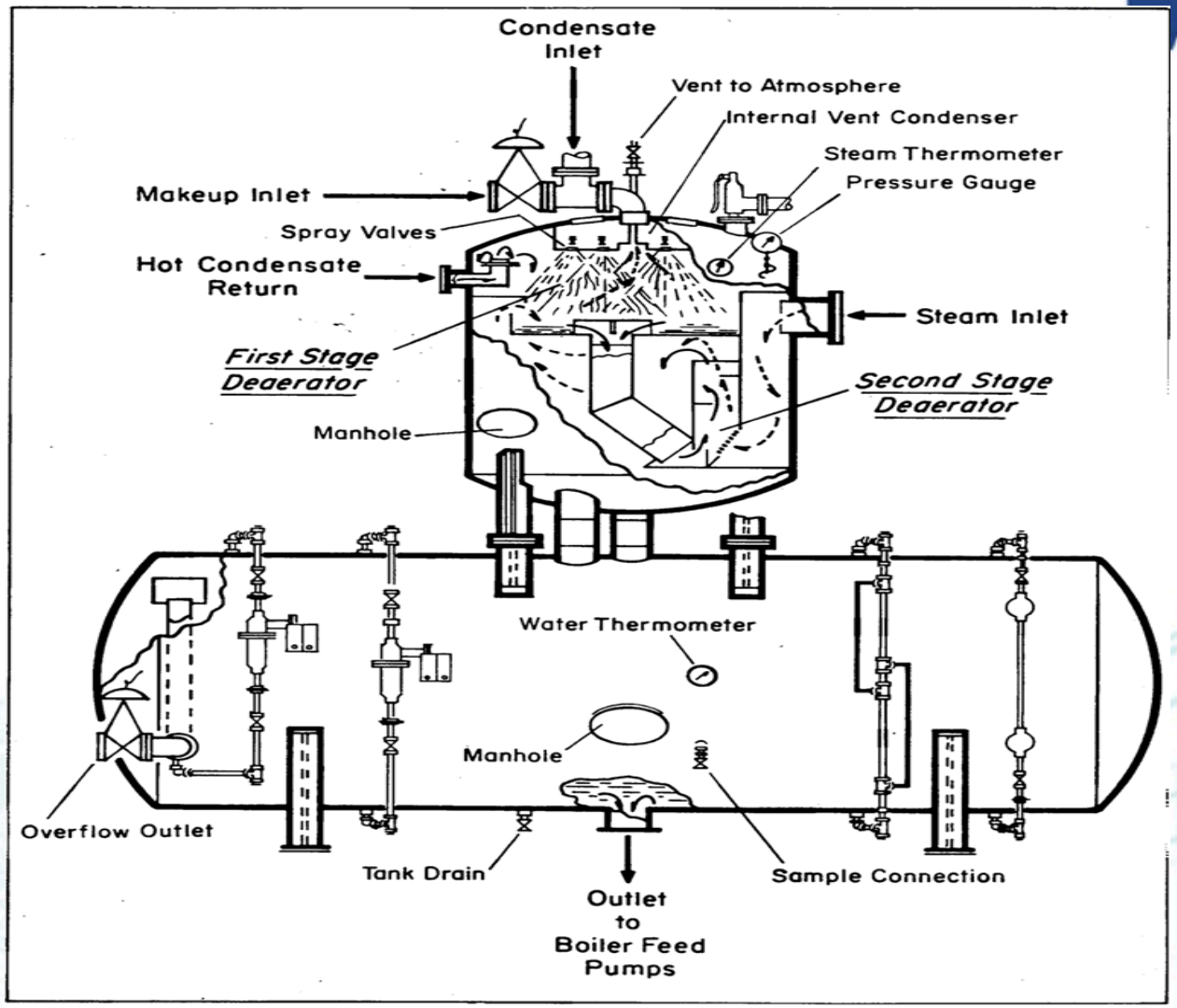
Tray Type Deaerator



Spray Deaeration



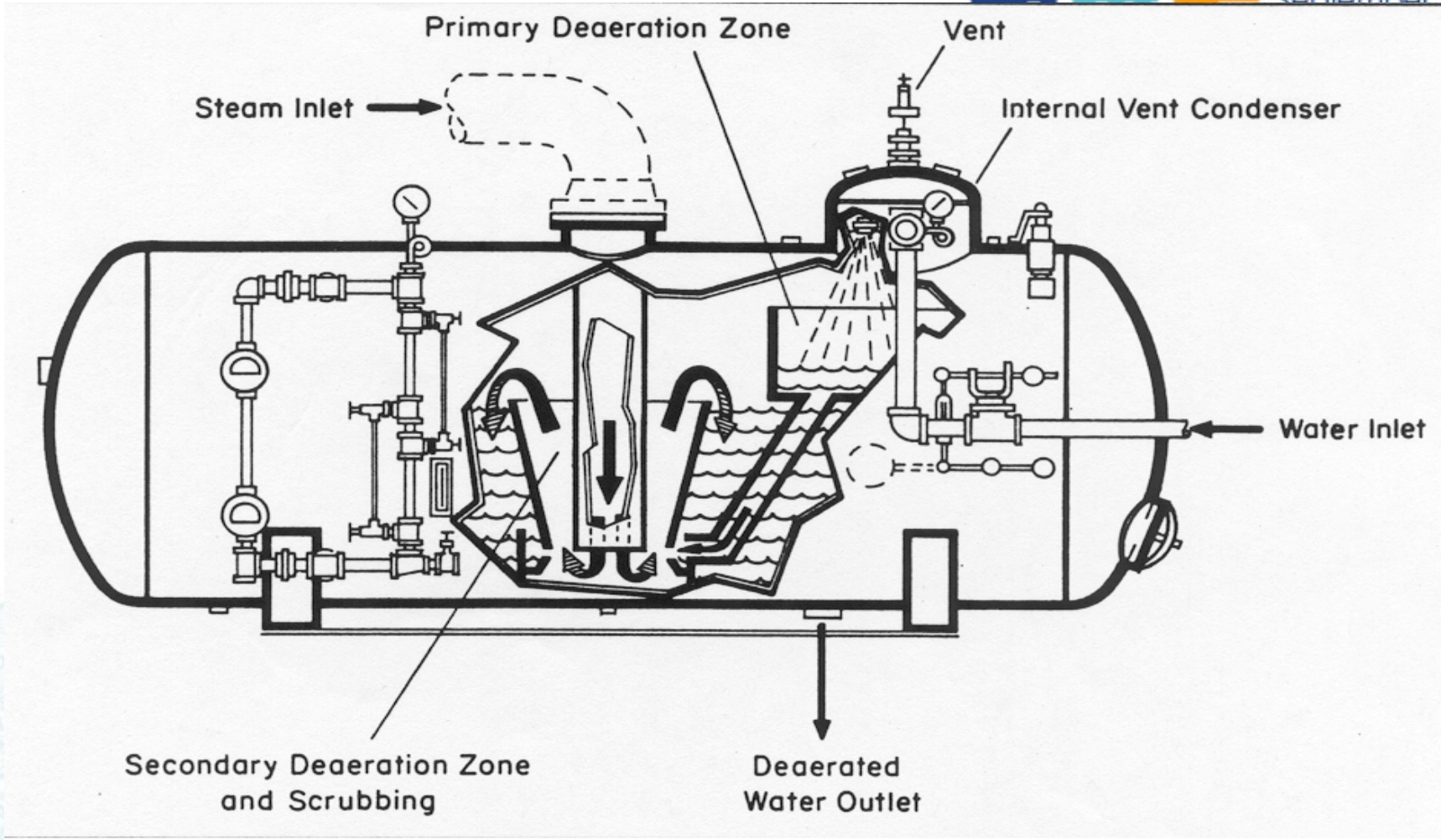
A Deaerator should operate at or above 5 psi and approximately 224ºF. Altitude and design will vary these operating parameters to some degree



SPRAY-TYPE DEAERATOR.

Condensate inlet and Make Up line are close together.

This will cause pitting unless the valve and the "T" are replaced with Stainless Steel.



HORIZONTAL SPRAY-TYPE DEAERATOR.

Surge Tanks

- Used to control transient heat migration
- Can be used as a feed water tank and feed the boiler in lieu of the DA
- Can be an integral part of the DA (two compartment design) or free standing two tank system.
- Must be vented to allow oxygen to be removed
- Should be heated to maintain a minimum of 180°F with either an internal coil or a steam sparging line.

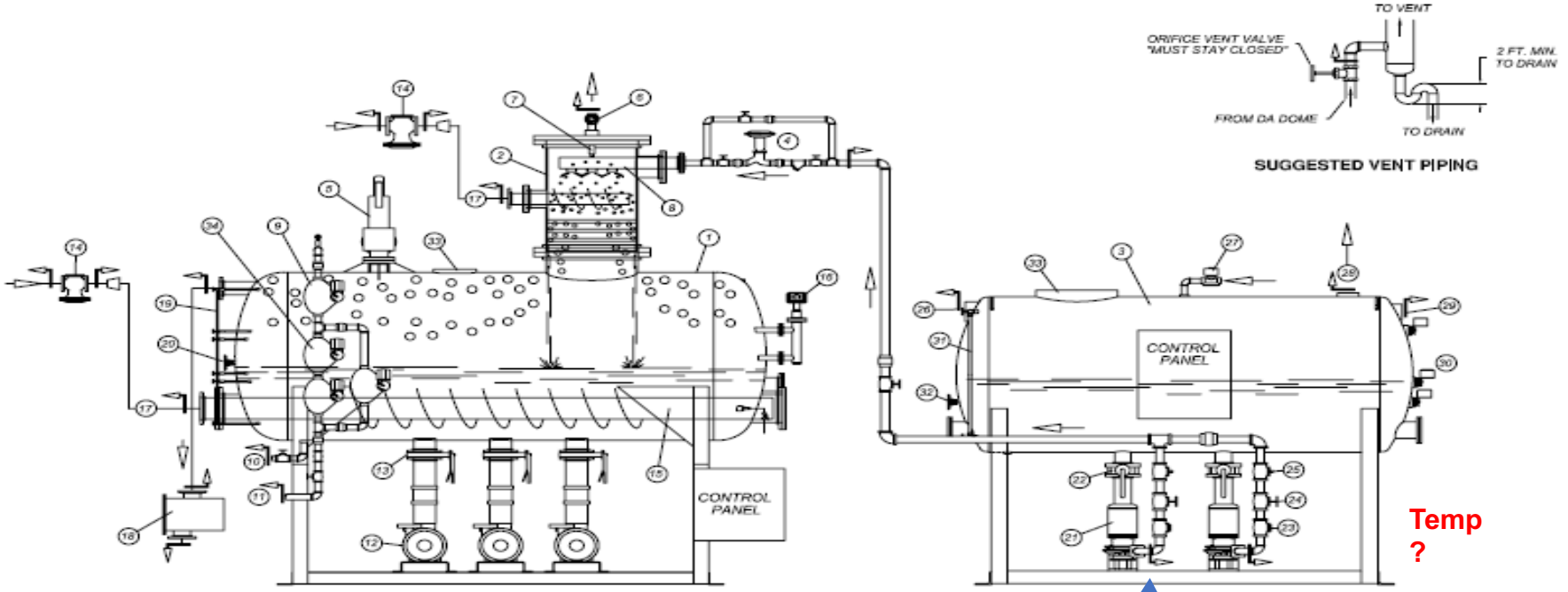
Surge Tank General Rule of Thumb

- Systems with 80% or more of make up do not require a surge tank

- Systems with more than 20% condensate returns, require a surge tank for effective uninterrupted deaeration.

Two Tank DA System

1. DEAERATOR STORAGE RECEIVER
2. DEAERATION DOME
3. SURGE STORAGE RECEIVER
4. DEAERATOR MODULATING INLET WATER
5. PRESSURE RELIEF VALVE
6. DEAERATOR ORIFICE VENT VALVE
7. DIAL THERMOMETER (DOME)
8. SPRAY NOZZLE MANIFOLD
9. EXTERNAL FLOAT CONTROLS
10. DEAERATOR RECEIVER DRAIN
11. EXTERNAL FLOAT CONTROL DRAIN
12. BOILER FEED PUMPS
13. BOILER FEED SUCTION VALVE - ONE PER PUMP
14. STEAM REGULATOR - SHIPPED LOOSE
15. SUBMERGED HEATER TUBE
16. MODULATING LEVEL CONTROLLER
17. PREHEAT TUBE/STEAM SUPPLY INLET
18. OVERFLOW DRAINER - SHIPPED LOOSE
19. SIGHT GLASS
20. DIAL THERMOMETER (DA RECEIVER)
21. SURGE TRANSFER PUMPS
22. TRANSFER PUMP SUCTION VALVE - ONE PER PUMP
23. NON SLAM CHECK VALVE - ONE PER B.F & TRANSFER PUMP
24. DISCHARGE SHUT-OFF VALVE - ONE PER B.F. & TRANSFER PUMP
25. DISCHARGE BALANCING VALVE - ONE PER B.F. & TRANSFER PUMP
26. CONDENSATE RETURN INLET
27. SURGE MAKE-UP WATER VALVE
28. SURGE RECEIVER VENT
29. SURGE RECEIVER OVERFLOW
30. FLOAT SWITCH CONTROLS
31. SIGHT GLASS
32. DIAL THERMOMETER (SURGE RECEIVER)
33. MANWAY
34. STAND-BY TRANSFER PUMP CONTROL



SUGGESTED VENT PIPING

INDICATES WHERE SHIPCO PIPING ENDS

Temp ?

On-Off operation causes any oxygen present to release suddenly when it comes on and causes pitting.

Transition Piping

Water Problems Two Tank System

- In a two tank system, the first tank receives the condensate and the make up water.
  - The first tank is the Transient section that buffers the system from causing a temperature drop in the DA section.
    - Water temperature can be as low as 140°F. You want the temperature to be 180º F or above to minimize oxygen content.
  - Oxygen content is based on water temperature, so this tank has to be treated for oxygen before the system can mechanically deaerate. At **150°F** Sodium Sulfite has limited effectiveness.
  - With low temperatures and high oxygen content, the corrosion rate on carbon steel can be excessive.
  - The first tank must be vented or the first tank and the transition piping will corrode.
- Chemical treatment potentially filming amines, molybdate or tannins
- Oxygen is the corrosion inhibitor for quality stainless steel (316L – low carbon), so the construction of the first tank and related piping should be stainless steel.
- Feed water pump should be continuous run with return line to the DA instead of on/off to prevent sudden oxygen release in the piping.

Dual Tank Systems DA

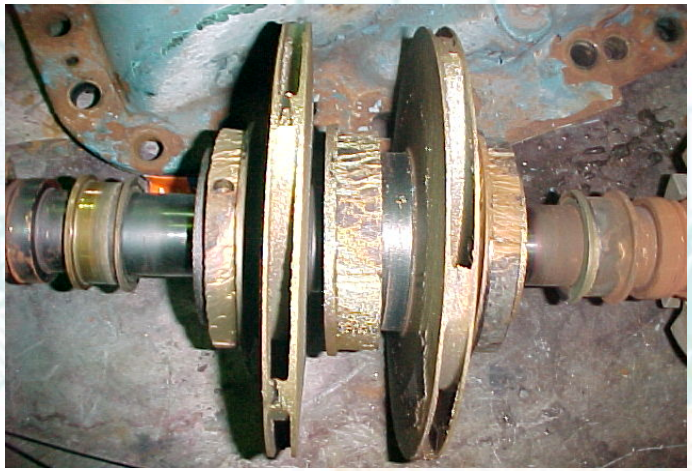
- Dual tank systems have the condensate and the make up water blend in the first tank. This tank is heated only from the condensate and may not be adequately vented
- The concept is to provide less thermal shock to the system

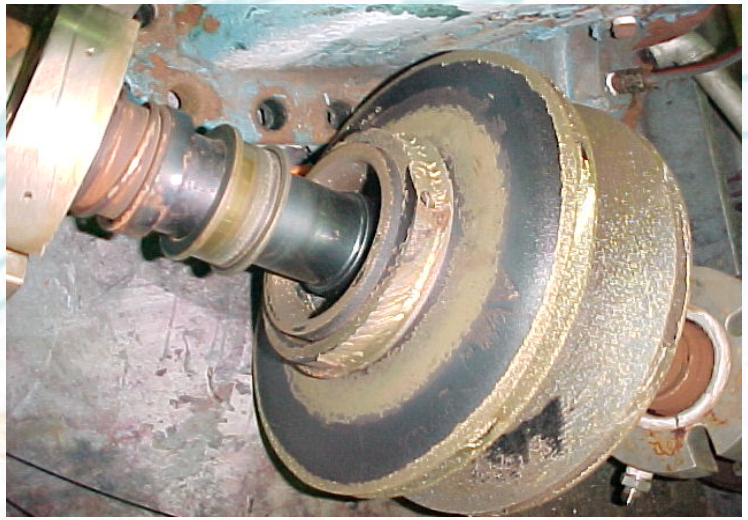
•Problem is that rapid corrosion occurs in the initial tank and in the transfer lines.
•This should be made out of Stainless Steel.

Cavitation Feed Water Explosion

Cavitation is caused when feed water reverts to steam in the feed water pump. Bubbles of steam form in an explosive manner which cause physical damage to the feed water pump internals.

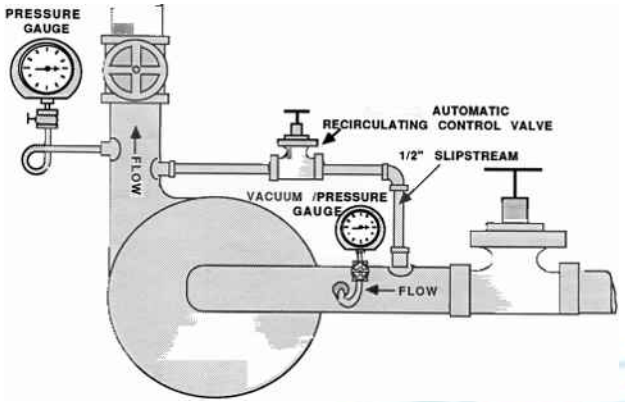
The Feed Water pump is designed to pump liquids, not steam, so it cavitates. This surging sound is distinctive.





Cure For Cavitation of Feed Water Pumps

- Cavitation is caused by the sudden release of steam in the feed water.
- A Deaerator is placed above the feed water pump, this creates head pressure over the pump. At 1 psi of head for every 2.3 feet of height, 30 feet ≈ 13 psi of head pressure.
- In a system with a feed water tank instead of a DA, maintain the temperature below 200ºF



The slip stream system uses a side stream to recirculate feed water back to the suction side of the pump, alleviating steam release (cavitation) in the feed water pump.

Quick Troubleshooting guide

Deaerator Troubleshooting		
Symptom	Possible Causes	Comments or Possible Solutions
High O^2	Air in-leakage	Loose fittings
	Insufficient stabilization period	Shut scavenger off
	Trays not installed properly and in place	Remove chemical interferences
	Not steady state conditions	Verify design conditions
	O^2 inlet not in accordance with specified designed conditions	
	Spray valves not installed correctly	
	Water inlet temperature too low	
	Improper venting	
	Incorrect testing	
	Operation outside of design conditions	
Excessive Pressure Fluctuation	Steam PRV improperly sized or calibrated	Check size and calibration
	Improperly sized downcomer and equalizer	Keep within design range
	Inlet steam pressure too high or too low	Check all valve and control settings
	Excessive inlet temperature variation	
	Heater flooding	
Low Outlet Temperature	Incorrect Thermometer reading	Check calibration
	Insufficient steam flow	Check steam supply
	Incorrect steam/water ratio	Check for restrictions
	Spray valves or internals malfunctioning	Check Pipe and valve sizing
	Heater flooding	Check heat and mass balances
	Inlet flow piped incorrectly	Check spray valves, trays, etc.
		Check all valve and control settings
		Check all inlet flows and temperatures

Quick Troubleshooting guide (cont.)

Deaerator Troubleshooting		
Symptom	Possible Causes	Comments or Possible Solutions
Water Hammer	Inlet flows mixing just prior to Deaerator inlet	Mix flows farther upstream of Deaerator
	Improper pipe design	Check and/or redesign
	High inlet velocities	Keep within HEI
High CO^2	High CO^2 at inlet	Verify CO^2 design condition
	High pH	Lower pH
	Improper venting	Review vent system
Tray Upsets	Tray hold down not secure	Install correctly
	Turbine trip	Gradual increase/decrease of controlled flows
	Flashing	
Unexpected Storage Tank Level Excursions	Malfunctioning level control system	Check setting and system operation
	Malfunctioning overflow or improper boiler feed pump operation	Check overflow level and boiler feed pump operation
	Pressure fluctuations	See pressure fluctuations above
Water Out of Vent	Cracked vent welds	Repair or redesign
	Improper vent piping	Should be as short and as vertical as possible
	Water carryover	Reset vent flow
Iron Oxide in Deaerator	Condensate or system corrosion	Keep positive pressure on Deaerator
	Frequent shutdowns	See High O^2 section above
	High O^2	

Questions?