

INSTRUCTION PAMPHLET
FOR
FOSTER WHEELER TRIPLE EFFECT DISTILLING UNIT

This is a triple effect, low pressure, submerged tube distilling or evaporating plant and consists primarily of three boilers or shells containing in their lower sections a series of tubes, through steam passes and in passing gives up its heat to the sea water that covers them causing the water to boil. The steam thus created by this section is called vapor and, in its condensed form, distillate, rather than steam and condensate. This vapor rising to upper part of the shell in the 1st and 2nd effects comes in contact with another but smaller series of tubes, through which the feed water flows, pre-heating it before it enters the shell proper. In the 3rd Effect the rising vapor enters the Distilling Condenser, located in the upper part of the shell, where it is condensed into distillate.

In its condensed form this vapor becomes fresh water; the various minerals and impurities, originally contained in the sea water, having been left in the bottom of the shell from where they are pumped over the side in the form of brine.

The original source of heat is either live steam from the boilers or exhaust steam from the Low Pressure Turbine but in either case it is reduced to 5% psi before entering the 1st Effect Tube Nest Header. After passing through the tube nest the condensate is returned to the boiler feed water system through the DC Heater. Aside from the live steam used to operate the Air Ejector, this is the only place that boiler steam is used in the plant.

Instead of condensing this vapor from the 1st Effect Shell back into water and thereby wasting the BTU's that it contains, it is sent into the 2nd Effect Tube Nest Header where it gives up its heat to the sea water in the 2nd Effect Shell thereby creating enough vapor to operate the 3rd Effect in the same manner.

In its passage through the 2nd and 3rd Effect Tube Nests the vapor exchanges its heat causing the sea water to vaporize and itself to condense. It now passes through drain regulators, which are merely float operated steam traps, through the flash tanks, to the Distilling Condenser Condensate pump, to the Test Tanks and from there distributed to the various fresh water storage compartments by means of the Fresh Water Pump.

Sea water is put through the system by means of the Distilling Condenser Circulating Water Pump which discharges through the Distillate Cooler to the Distilling Condenser. After leaving the Condenser about 85% of this water is discharged over the side while the remaining 15% is picked up by the Evaporator Feed Pump.

The evaporator Feed pump discharges through the Air Ejector after Condenser to the 2nd and 1st Effect Vapor Feed Heaters, respectively, where, as the name implies, it is pre-heated by the vapor in the shell before entering the 1st Effect Shell.

When sufficient water has entered the 1st Effect Shell, instead of closing the feed check valve to this Effect, the surplus is allowed to enter the 2nd Effect Shell and then in turn, the 3rd Effect Shell.

The Feed Water having passed through each Effect, carrying with it the impurities remaining from the distilling process in the previous Effect, finally reaches the 3rd Effect Shell and from there it is pumped over the side by the Brine pump.

Do not assume that the 2nd and 3rd Effects are apparatus to further purify the vapor after it has left the 1st Effect. With the plant operating correctly each effect will produce fresh water. The additional Effects are for the purpose of utilizing the heat value contained in the vapor, produced in the preceding Effect, thereby bringing this type of Evaporator to a point of efficiency where it will produce approximately $2\frac{1}{2}$ pounds of distilled water per pound of steam as compared to a Single Effect Evaporator's average of slightly less than 1 pound of water per pound of steam.

FUNCTIONS OF THE VARIOUS PUMPS

1. DISTILLING CONDENSER CIRCULATING WATER PUMP.
Provides sea water to condense and cool the distillate and supplies feed water for the Evaporator Feed Pump.
2. EVAPORATOR FEED PUMP.
Takes sea water from the Distilling Condenser discharge line to feed the Evaporators.
3. BRINE PUMP.
Discharges the brine from the 3rd Effect Shell over the side. Also used when shocking tubes to drain the 1st and 2nd Effect Shells independently.
4. DISTILLING CONDENSER CONDENSATE PUMP.
Takes the distillate from the 3rd Effect Flash tank and the Distilling Condenser and discharges it into the Test Tanks.
5. FRESH WATER PUMP.
Distributes the distillate from the Test Tanks to the various storage compartments.
6. TUBE NEST DRAIN PUMP.
Returns the condensate from the 1st Effect Tube Nest to the boiler feed water system through the DC Heater.

TO START EVAPORATORS

1. Test all pumps to make sure they will operate when needed.
2. The following valves must be open before starting the plant:
 - a. Sea Suction.
 - b. Discharge from Distilling Condenser Circulating Water Pump.
 - c. Discharge from Distilling Condenser.
 - d. Overboard discharge.
 - e. Suction and Discharge from Evaporator Feed pump.
 - f. 3rd Effect Shell discharge to Brine pump.

- g. Vent to Brine pump from 3rd Effect Shell.
- h. All vents on Vapor Feed Heaters and Distilling Condenser heads.
- i. All vents on Tube Nest Headers.
- j. Both valves in the 1st Effect Tube Nest return line - one at the DC Heater, the other at the Drain Regulator.
- k. Feed stops on the 2nd and 3rd Effect Shells.
- l. Either drain to bilge or return to Double Bottoms from air Ejector Condenser.
- m. Brine pump discharge. Do not open until ready to start the pump.

3. Check 1st and 2nd effect Shell Drains to Brine pump and make sure they are closed.
4. Start Distilling Condenser Circulating Water Pump.
5. Start Evaporator Feed pump.
6. Close vents in Vapor Feed Heaters and Distilling Condenser Head so that there is only a trickle of water being discharged.
7. Open Feed valve to 1st Effect. When 5 inches of water shows in the glass, open 2nd Effect Check valve and allow water to rise to the same level, then open 3rd Effect Check valve. When water has come to 5 inches in this shell open Brine Overboard discharge valve and start Brine pump.
8. Adjust Brine pump overboard valve so that the water level in the 3rd Effect remains constant.
9. Notify Engine Room to open steam to Air Ejector.
10. Start the Air Ejector. Drain the steam line before putting pressure on it.
11. Start the Tube Nest Drain pump.
12. Put Steam on the plant by opening the Stop valve on whichever unit is to be operated.
13. When distillate appears in the 3rd Effect Drain Regulator glass, start the Distilling Condenser Condensate pump.
14. Close vents on Tube Nest Headers to a cracked open position.
15. The plant is now producing and the Distillate is entering the Test Tanks. Open the Test Tank Drain valve to the bilges and allow this water to flush out the tanks until such time as the Salinity Indicator indicates that the plant is producing water of the proper purity for which it is to be used. This will be 1/10 grain per gallon for Boiler Feed and up to 2 g.p.g. for Drinking purposes. Note that at the present time the Salinity Indicator readings are about 3/10 g.p.g. less than a chemical test.

OPERATING NOTES

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1. Maintain ~~150~~ psi on steam to Air Ejector.

2. If it becomes necessary to completely close the 1st Effect Feed valve open Air Ejector Condenser Leak-Off valve, located at the 2nd Effect Vapor Feed Heater Inlet, so as to insure sufficient circulation of water through the above-mentioned Condenser. This will prevent steam being blown to waste through the vent pipe. Under normal operating conditions this valve should be completely closed.
3. Open all vents on Vapor Feed Heaters and Distilling Condenser Head when starting up to prevent them from becoming air-bound. After air has been vented close valve so that only a trickle of water issues.
4. All vents on Tube Nest Headers should be opened wide on starting up. After plant is in operation for a short time close to a cracked open position. Adjust these vent valves so that the difference in temperature between the Supply Steam and the Drain return on each Tube Nest Header is as follows: 1st Effect 5° 2nd Effect 10° to 15° 3rd Effect 20° to 30°
5. Make sure that the 1st and 2nd Effect shell Drain valves are closed and the 3rd Effect Drain to Brine pump is open before starting up.
6. Keep $\frac{1}{2}$ glass of water in the 1st Effect Drain regulator in order to avoid blowing steam to waste. Desuperheater line will not work if this regulator is dry.
7. Keep 1st Effect Supply Steam below 240° and preferably at 230° by means of the desuperheater line, to prevent hard scale from forming on the tubes.
8. Vent to Brine pump, located in the center of the 3rd Effect Shell at the after end should remain open while pump is operating.
9. Brine Overboard valve should be closed as much as possible without allowing brine to reach a higher concentration than 1.5/32. Open the overboard valve to reduce concentration. Close to increase.
10. Vacuum in 3rd Effect Shell should be maintained at $26\frac{1}{2}$ ". Control this by means of the Distilling Condenser discharge valve. Open valve to increase vacuum.
11. Temperature of Feed Water entering the 1st Effect Vapor Feed Heater should be about 158°. Temperature will vary with the amount of water fed to the 1st Effect Shell. Slow feed, higher temperature - fast feed, lower temperature.
12. If Fresh Water pump does not show a discharge pressure upon starting up, it is probably air-bound. Stop the pump and open the pet cock in the top of the impeller casing. When air has discharged as a steady stream of water appears, close pet cock and start the pump. It is, of course, assumed that there is water in the Test Tank and that the various valves are lined up properly.
13. Do not open valves in Discharge line from Brine pump unless pump is operating. If check valve in this line fails to work while pump is cut out, sea water will flood the system.

14. For Drinking or Wash Water up to 5 grains of salt per gallon it is possible to carry the water at a considerably higher level. The higher the water level carried, the greater the capacity of the plant.

15. SALINITY INDICATOR.

If the #7 cell on #1 plant or #7 cell on #2 plant registers a high salt content, it will indicate a leaking tube in the Air Ejector Condenser and the condensate may be drained into the bilge rather than to the Double Bottoms without either affecting the operation of the plant or contaminating the Boiler Feed Water.

If #6 on #1 plant or #4 on #2 plant is too high there is a leak in the 1st Effect Tube Nest. Notify the Engineer on watch and, if, in his opinion the contamination is too much, the plant will have to be shut down.

If Distillate in Condenser and Tube Nest Drains in 2nd and 3rd Effects show a correct reading but Distillate to Cooler outlet reads high, there is a leaking tube in the Distillate Cooler. Send the Distillate direct to the Test Tank by by-passing the cooler.

If it becomes necessary to bypass the Distillate Cooler, the Salinity Indicator cell #1 will still be used to indicate the quality of the final distillate but the Compensator will have to be set to the temperature on the Cooler Inlet thermometer instead of the Cooler Outlet.

SECURING THE PLANT

1. Notify the Engineer on watch that plant is about to be secured.
2. Secure Air Ejector.
3. Close 12 lb. steam to 1st Effect.
4. Stop Tube Nest Drain Pump.
5. Open all Tube Nest Header vents wide.
6. Stop Distilling Condenser Condensate pump and Fresh Water pump.
7. Keep the following pumps running for about 15 minutes to cool off the plant: Distilling Condenser Circulating Water, Evaporator Feed and Brine pumps. Fill each glass full on each effect.
8. Close Sea Suction and Overboard Discharge valve.

SHOCKING AND SECURING

1. Open Air Ejector Condenser Leak-off Valve. (1" valve in the Feed Water line at the 2nd Effect Vapor Feed Heater inlet)
2. Close Feed Check valves to all 3 Effects.
3. Secure Air Ejector, both vapor and steam lines.
4. Shut down Evaporator Feed pump.

5. Pump out 1st Effect, allow tubes to thoroughly heat, pump out and repeat as necessary to free scale.
6. Notify Engineer on watch and secure Main Steam Supply to plant.
7. Stop Tube Nest Drain pump, Distilling Condenser Circulating Water and Distillate Condensate pumps.
8. Open all vents on Tube Nest Headers.
9. Secure Sea Suction and Overboard Discharge valves.
10. Remove clean out plates on all effects. Rake out scale that has cracked off the tubes and flush out Shells with fire hose.
11. Open up and clean out all strainers.

*W. A. Chamberlain
Ch. Eng'.*

USNS GENERAL JOHN POPE (TAF 110)

OPERATING INSTRUCTIONS: MAIN AIR CONDITIONING UNIT

STARTING

1A. Charge the Chill Water line by filling the same from the Auxiliary Condensate pump discharge until the line overflows from the overflow line. Use caution in filling so vacuum is not lost from the Auxiliary Condenser.

1. Line up the Condenser Salt Water Circulating System and start the pump. The discharge pressure should register 10 or 12 lbs.

2. Line up the Chill Water system and start the pump. Do not exceed 80 lbs. pressure.

3. Start the Auxiliary Oil pump on the panel board. Determine that the pressure registers 5 or 6 lbs. The Amber light on the board will go out. Push the start button and hold for several seconds until the Green light appears, then release the push button. The Green light should remain on.

4. Determine that the Steam Turbine Casing Drains are open. Drain all condensate from the steam and exhaust lines.

5. Set the turbine trip and regulator.

6. Set the manual throttle/or steam stop valve to minimum.

7. Open the throttle valve slowly until the turbine starts. Allow the turbine to idle slowly long enough to warm up, by using the speed regulator. When the unit is warm and all condensate has been removed from the steam lines, close all the drains and bring the unit up to speed. NOTE: The overspeed governor is set at 4400 R.P.M.

8. Do not exceed 4400 R.P.M. Use the governor control for this adjustment.

9. Do not allow the turbine to cycle in excess of 25 lb. differential on the nozzle block.

10. Adjust the speed control to control the cycling as instructed in item 9, but maintain adequate speed to continue lowering the Chill Water Temperature until the set limits are maintained.

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USNS GENERAL JOHN POPE (T-AP 110)

OPERATING INSTRUCTIONS: MAIN AIR CONDITIONING UNIT

RUNNING:

1. Do not allow the turbine to surge/or cycle. Control this with the governor control.
2. Watch the head pressure guage on the Control Board. This will vary with the load and temperature of the Condensor water ranging from inches of vacuum to 15 lbs pressure at which point the high head pressure limit switch will cut out and shut down the unit.
3. Watch the vacuum or low side pressure guage. This will range from 5 inches of vacuum to approximately 19 inches of vacuum depending on load conditions.
4. Watch the center oil pressure guage. This will rise to approximately 10 to 12 lbs., then the auxiliary oil pump will cut out automatically and the red light on the panel board will go out.
5. Watch the compressor line shaft bearing next to the coupling. The normal running temperature should be from 100° to 120° F. Normally excessive load conditions will raise the temperature higher. 140°F and above is a sign of trouble; locate and correct the trouble or secure the compressor.
6. Watch the compressor thrust bearing temperature; normal running temperature is 60°F to 80°F.
7. Maintain 10 to 15 lb. lube oil pressure on the turbine.
8. Maintain the lube oil temperature on the turbine between 110° and 120°F.
9. When the pin nears the red hand on the Bristor Recorder the turbine will start to throttle and in turn will surge/or cycle. Do not exceed 25 lb. nozzle steam pressure differential; use the speed control to accomplish this.
10. Maintain the hourly log as provided.

NOTE: When any limit switch cuts out, it will trip the turbine governor and the green light on the panel board will go out. It is not possible to get the unit started again until you push the start button on the panel board and the green light is lit again. If the green light will not stay on, locate the limit switch that is open and wait for the reset point. Do not attempt to start the turbine until the green light is lit.

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USNS GENERAL JOHN POPE (T-AP 110)

OPERATING INSTRUCTIONS: MAIN AIR CONDITIONING UNIT

SECURING:

1. Manually trip the turbine governor.
2. Secure the throttle valve.
3. Open all atmospheric casing and steam line drains.
4. Secure the water to the lube oil coolers.
5. As the compressor slows down the center oil pressure oil guage will drop to 5 or 8 lbs. pressure and the red light will appear. This will indicate that the auxiliary oil pump is back in circuit and will maintain oil pressure on the compressor until the unit stops.
6. When the unit has completely stopped, and ONLY THEN, turn off the on and off switch. The red light will go out and the seal on the compressor will close. The oil pressure guage will drop below zero.
7. Check the seal on the compressor to be sure it is closed. If the seal is not properly closed air will leak into the system.
8. When the unit has come to rest, stop the auxiliary oil pump.

PURGE UNIT:

1. This unit is fully automatic and will take care of itself.
2. The Purge Unit can be shut off and on by a switch marked Purger on the panel. The white light lit indicates that the Purger is on. It should operate all the time the unit is in operation.
3. When the unit is secure the oil heater will go into circuit and is indicated by an amber light on the panel.
4. Secure all sea valves.

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USNS GENERAL JOHN POPE (T-AP 110)

AIR CONDITIONING COMPRESSORS

OPERATING INSTRUCTIONS AND SAFETY PRECAUTIONS

The information furnished hereon was furnished by Mr. Jack Doyle, Worthington Corporation Service Representative:

1. TEST OF UNIT BEFORE STARTING: AFTER A PROLONGED SHUT DOWN.

a. If the chill water and the refrigerant temperatures are in close relation (one (1) degree maximum differential) this will indicate very little air in the system. If the air accumulation is excessive, check for leaks with the Halide Torch. If necessary, to get the unit running due to shaft seal leakage, first start the oil pump (this will seal the unit). Then start the circulator and compressor. Just crack the drain on the water leg of the purge unit, which will assist in removing the air and moisture from the system.

2. TO TEST FOR REFRIGERANT LEAKS IN THE SYSTEM WITH THE UNIT SHUT DOWN.

a. Run warm water thru the evaporator (water from an outside source). This will start the Freon 11 to gassify and build up a pressure in the evaporator. Do not exceed 5 lbs pressure in the evaporator, then test for leaks.

NOTE: Excessive air in the system will displace the gas and cause excessive heating of the compressor. This excess air, if in sufficient quantity, will displace the gas entirely; as air is lighter than freon 11.

3. Maintain 120 degrees F. maximum temperature on sump oil. Excessive oil temperatures will result in carbon deposits within the oil piping and filters.

4. Clean the lube oil filters once each week (minimum) by turning the plug cock to position "B", drain the filter casing and remove the filters.

NOTE: In replacing the filter cover, particular attention is directed to a perfect or undamaged cover plate gasket.

5. To add oil while the unit is running, remove the plug in the atmospheric side of the float trap.

6. SAFETY PRECAUTION: Do not allow the refrigerant temperature to go below 38°F.

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