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Installation And Operating Instructions
Model FCWB 6X8X16-CO_2-LTCO
CEXI Job No. X040221

I. Installation Instructions

A. Install the unit on a level concrete base as close as possible to the water source.

B. Connect the water supply to the inlet connection on the vaporizer – the 150 lb. flange connections on the water pump. Be sure that the piping does not introduce any external loads on the water flanges. Additional loading must be designed out of the system to be sure that the vaporizer inlet connection is not loaded. A flex line is strongly recommended on the water pump inlet.

C. Connect the return water from the outlet connection on the vaporizer to the water tank or return water connection.

D. Connect the main process liquid CO_2 connection to the inlet connection on the front of the vaporizer. Connect the main process CO_2 gas connection at the outlet connection of the vaporizer to the gas supply line for the system. It is advisable that pressure relief valves be installed wherever there is a possibility of trapping liquid CO_2. Be sure that the piping does not introduce any loads on the vaporizer piping. The liquid supply line must be designed to eliminate loads caused by expansion and contraction of the piping as it cools and warms.

E. Leak check all piping and tube connections at 1.25 times operating pressure with dry nitrogen gas. If any leaks are found repair and retest

F. Clean all carbon dioxide gas piping per the requirements of the system owners for carbon dioxide service. All oil and hydrocarbons must be removed from the piping prior to allowing carbon dioxide gas to flow in the piping.

G. Fill the system with water and open all water valves. The system should be turned on and the pump rotation checked.

II. Operation

A. General Description - The unit is designed to allow the CO_2 to flow only when all of the control devices and sensors are satisfied. The system requires that water be flowing through the vaporizer shell at all times when CO_2 is flowing. The system has the following safety devices.

1.) Water Flow Sensor – This is a heavy-duty type paddle switch that is installed in the water outlet of the vaporizer. The switch must be activated for the control circuit to operate. If water flowing past the paddle does not operate the switch, the valves will not open.

2.) Low Water Temp Sensor - senses the water temp exiting the vaporizer. If the water temp exiting the vaporizer is below the set point, the temp sensor will shut off the liquid valve supplying CO_2 to the vaporizer. The set point should be 45 degrees F.

3.) Low Gas Temp Sensor - senses the CO_2 gas temp exiting the vaporizer. If the gas temp exiting the vaporizer is below the set point, the temp sensor will shut off the liquid valve supplying CO_2 to the vaporizer. The set point should be 20^0F.

B. Turn on the ON OFF switch to the unit.

C. Verify that water is flowing through the unit.

D. Open the liquid CO^2 valves supplying the unit.

E. In the event that the water flow, the water temperature or the outlet gas temperature drop below the set points on the controllers the CO_2 liquid supply valves will close and stop the flow of CO_2 through the unit.

F. If the tubes can be heard rattling in the shell, this indicates that too much water is flowing through the shell. If this condition is allowed to continue, there will be damage to the tubes and the system will leak carbon dioxide into the water or water into the carbon dioxide – pressure dependent.

G. If the tank pressure is below 285 psig, the solenoid valve on the pressure build coil will open and allow liquid to flow to the unit. This is only true if there is water flowing through the shell of the vaporizer.

III. Trouble Shooting

PROBLEM SOLUTION

1. Unit turns on and stays on.
   No response from potentiometer.
   Contact stuck shut on the Athena

   A. Bad thermocouple - broken leads or shorted leads.
   Replace thermocouple.

B. Bad potentiometer - replace

C. Broken wires on potentiometer - replace/re-solder

D. Replace Athena controller.

Connect a Thermocouple to monitor the outlet gas temperature of the unit the problem is corrected. This will allow the operator to "see" that the outlet gas temperature is within operating limits and to act if it is not.

2. Unit operates but does not seem to sense temperature or respond to changes in temperature

   A. Bad thermocouple - doesn't vary resistance with temperature. (Check with voltmeter meter - see chart).

   B. Thermocouple not touching process tubing.

   C. Dial set too high or low.

   Connect a Thermocouple to monitor the outlet gas temperature of the unit until the problem is corrected. This will allow the operator to "see" that the outlet gas temperature is within operating limits and to act if it is not.

3. Unit operates, but allows gas temperature to get too cold before turning off.

   A. See 2B & 2C.

   Connect a Thermocouple to monitor the outlet gas temperature of the unit until the problem is corrected. This will allow the operator to "see" that the outlet gas temperature is within operating limits and to act if it is not.

4. No dial control – thermocouple is OK

   A. Bad P.C. board.

   B. No 120 vac power to controller.

   C. Bad potentiometer

   Connect a Thermocouple to monitor the outlet gas temperature of the unit until the problem is corrected. This will allow the operator to "see" that the outlet gas temperature is within operating limits and to act if it is not.

5. Solenoid valve does not operate - voltage is supplied to the coil.

   A. Solenoid valve coil burned out

   B. Valve internals dirty – the valve is sticking

C. Water has entered the valve and it is frozen

No emergency action required

6. Water flow switch is malfunctioning

A. Paddle is broken off or the paddle is stuck
B. Micro switch in the unit is bad - replace
C. Electrical connections to the switch are broken/loose.

No emergency action is required

7. Valve is leaking through the body joints

A. Valve has been over pressurized and stretched. Replace valve
B. Valve seals are bad. Replace

Shut off the system and allow the valve to warm up. Isolate the system and remove the valve from the system. Inspect the valve and replace or repair per factory instructions. Be sure that all flammable materials are removed and open flames are extinguished.

8. Vaporizer is leaking between the tubes and the waterside

A. Tube has pinhole due to corrosion - remove tube bundle, pressurize tube side and locate the leaking tube. Plug the leaking tube.

B. Tube is cracked at the tube sheet - remove tube bundle, pressurize tube side and locate the leaking tube. Plug or repair the leaking tube/tube sheet joint.

C. Tube sheet is cracked between the ligaments of the holes - Replace the tube bundle

Turn off the liquid carbon dioxide supply to the vaporizer. Keep the water running through the unit to vaporize and warm up the tube bundle. Remove the tube bundle. The unit must be taken out of service immediately or the shell may be damaged. It is also possible that a severe carbon dioxide leak could occur.

9. Water vapor/droplets found in the gaseous carbon dioxide stream

A. The unit is leaking between the waterside and the carbon dioxide side - see 9A through 9C

B. Liquid carbon dioxide supplied to the unit is carrying entrained water vapor in the form of ice. Check CO_2 supply

C. This will happen when the water pressure is greater than the CO_2 pressure in the event of a leaky tube bundle.

Turn off the liquid carbon dioxide supply to the vaporizer. Keep the water running through the unit to vaporize and warm up the tube bundle. Remove the tube bundle. The unit must be taken out of service immediately or the shell may be damaged. It is also possible that a severe carbon dioxide leak could occur.

10. Excessive noise from the shell of the unit.

A. Water flow too high causing vibration of the tubing - Reduce water flow through the unit, damage to the tube bundle will occur if this problem is not corrected.

B. Carbon dioxide leaking into the water stream - Pressure check the tube bundle with nitrogen gas while the tube bundle is in place and observe for decay or stop the flow of carbon dioxide to see if the noise stops.

Turn off the liquid carbon dioxide supply to the vaporizer. Keep the water running through the unit to vaporize and warm up the tube bundle. Remove the tube bundle. The unit must be taken out of service immediately or the shell may be damaged. It is also possible that a severe carbon dioxide leak could occur.

11. Power Switch on but the unit does not operate

A. 120 power is not turned on to the unit - turn on the power to the unit
B. Control circuit fuse is blown – replace
C. The switch contact block is bad - replace

No emergency action required

12. Valve is leaking through from the upstream side to the downstream side.

A. Check the arrow on the body and be sure that the arrow is pointing downstream,

B. Valve seals are dirty or damaged

C. Valve is frozen it the open position

Shut off the system and allow the valve to warm up. Isolate the system and remove the valve from the system. Inspect the valve and replace or repair per factory instructions. Be sure that all flammable materials are removed and open flames are extinguished.

13. Outlet Gas Temperature is too low

A. Water flow is too low - Increase the water flow

B. Water temperature is too low - Live with the situation - be careful that the shell does not freeze up - keep a careful eye on the outlet gas temperature if it starts to drop stop the operation.

C. Water is by passing the baffles - not flowing through the tubes - Consult with the manufacturer - Keep a watchful eye on the outlet gas temperature - if it starts to drop stop the operation.

D. Gas flow rate too high - reduce the gas flow rate

E. No water flow in the unit

It is imperative that the water flow be checked. Without proper water flow, the unit will freeze up and catastrophic damage will occur.

14. High pressure drop on the water side of the unit

A. Too much water flowing through the unit

B. High level of ice build up in the shell indicating that there may have been a high draw condition or insufficient water flow through the unit that caused large amounts of ice to form on the tubing.

C. Debris has entered the unit blocking the water passages. Remove the water connections and inspect the interior of the shell. Remove the tube bundle if necessary.

D. Valves in the water piping are partially closed

E. Water piping is undersized

It is imperative that the water flow be checked. Without proper water flow, the unit will freeze up and catastrophic damage will occur.

15. Pressure relief valve is relieving on the shell

A. Water hammer is occurring due to system dynamics - valve closing suddenly

B. Water Pressure too high

C. Leaks in tube bundle causing pressure to build in the shell

Correct the problem as soon as possible - with regards to the leak it is imperative that the cryogen be stopped immediately and the unit checked.

16. Outlet water temperature too cold

    A. Too little water flow through the shell

    B. Water temperature entering the shell is too cold

    C. Liquid side of the tube bundle is leaking large amounts of cryogen into the water stream chilling the water.

Correct the problem as soon as possible - with regards to the leak it is imperative that the cryogen be stopped immediately and the unit checked.

17. Shell frosting on the outside

    A. Tube is touching the shell - not a problem. This is indicated by localized frosting on the shell.

    B. No water flowing through the shell - the water in the shell is freezing - imminent danger - shut off the flow of cryogen immediately and get the water flowing in the shell

    C. Leak in the tube bundle - Stop flow of cryogen and determine where the leak is. Repair as required.

    D. Baffle bypassing water - Determine the reason and repair

Correct the problem as soon as possible - with regards to the leak it is imperative that the cryogen be stopped immediately and the unit checked.

18. Shell leaking water

    A. Corrosion has eaten through the shell - repair or replace as necessary - necessitates removal of tube bundle to inspect interior of shell

    B. Shell has been over pressurized - Replace the shell

    C. Shell has been ruptured due to freeze up Replace the shell

In general this does not require immediate attention

Removal and Installation Of Tube Bundles Forced Convection Water Bath Vaporizers

I. Removal Of Tube Bundle

a. Turn off the carbon dioxide supply to the vaporizer

b. Turn off the power to the unit

c. De-pressurize the tube bundle.

d. Turn off water supply to the vaporizer

e. Turn off the instrument air to the vaporizer.

f. Drain the shell of the vaporizer

g. Remove all the connections from the vaporizer nozzles - Carbon dioxide side.

h. Disconnect the wiring to the low temperature control valve. Remove the instrument air connection from the actuator of the valve.

i. Remove the thermistor from the well in the outlet of the tube bundle

j. Remove all of the bolts from the big flange or tube sheet.

k. The tube bundle will be difficult to pull out of the shell because of the baffles and deposit formation inside the shell. The tube bundle will need to pulled using come-a-longs of the chain variety or hydraulic puller. The shell should be tied down or anchored to be prevent the shell from moving while pulling the tube bundle out of the shell. Be sure that when the tube bundle is being removed that the direction of pull is centered and in line with the long access of the tube bundle. As the tube bundle is removed, the tube sheet must be supported. The tubing must not be used to support the tube sheet or the tube bundle. Tubing will be damaged if used to support the weight of the bundle. As the tube bundle comes out of the shell, the back end of the tube bundle will need to be supported. This can be done with a nylon sling wrapped around the entire tube bundle. Once the tube bundle is removed, it can be set on a pallet or other support for the bundle. Be sure that the tube bundle weight is not supported directly on the tubing. The weight can be supported on the baffles and the tube sheet. A forklift can be used to pull and support the tube bundle if there is enough area to allow the forklift to operate. It may be helpful to lay a piece of 2x4 on the shell and strike the wood with a hammer to break the baffles loose from the shell.

II. Installation

a. Clean the gasket surfaces on the tube sheet and the shell. Place a new gasket on the tube sheet.

b. Start the tube bundle into the shell until the first two baffles are in the shell. At this point, remove the nylon sling from the far end of the tube bundle.

c. Using come-a-longs winch the tube bundle into the shell. As each baffle starts to enter the shell, make sure that the baffle does not catch or hang up on the shell.

d. Once the tube bundle is pulled into the shell, center the gasket and install the bolts.

e. Snug the bolts holding the shell to the tube bundle. Do not tighten. Snug the bolts to the point where the gasket is just becoming snug between the two flanges.

f. Tighten one of the bolts on the flange until the flange just starts to squeeze the gasket. Go to another bolt 180 degrees from the first bolt and tighten this bolt to f70% of full torque value. Tighten the first bolt to approximately 70% of the full torque value. Bring all of the other bolts to 70% of the torque value for the bolt size - be sure to use a pattern that shifts 180 degrees to keep the tightening pattern on the flange even. In other words tighten two bolts that are directly across the flange from each other to 70% of the recommenced torque value. Rotate approximately 90 degrees and tighten another pair of bolts that are directly across from each other. Continue with this tightening sequence until all of the bolts are at 70% then repeat the sequence at full torque.

g. Connect the inlet and outlet connections to the tube bundle. Bubble check the connections at 1.25 times the operating pressure. Relief valves may have to be removed to accomplish this.

h. Connect the electrical connections back up to the solenoid valves.

i. Install the thermistor on the outlet of the vaporizer

j. Close the waterside drain valve.

k. Open up the water valves for the water supply and return to the vaporizer

l. Turn on the water supply or water pump

m. Turn on the electrical to the unit.

n. The unit is now ready to be put back into service.

If tubes need to be plugged in order to stop leakage 316, 304, or brass plugs may be used to seal off the openings at the tube to tube sheet joint.