

START-UP AND OPERATING INSTRUCTIONS  
MECHANICAL RECOMPRESSION STILLAGE EVAPORATOR  
DEDERT FILE 86-3959-E

These instructions are preliminary and should be revised after the unit is operational.

It is important that all vendor manuals be read before proceeding.

PROCESS DESCRIPTION

The stillage liquor at approximately 7% T.S. and 88°C in the evaporator feed tank is sent in series through two tubular preheaters EA-675XA and EA-675XB. The heating medium for the preheaters is evaporator condensate. The preheated stillage at approximately 100°F enters the Pass "B" circulating system of steam chest EA-676X where it is partially concentrated. The circulating system pumps the stillage with P-1 (GA-675X) through the upflow tubes where it is distributed at the top to the downflow tubes. The partially concentrated stillage from Pass "B" is transferred by pump P-1 (GA-675X) through level control valve LV-6703X to the Pass "A" circulating system of steam chest EA-676X where final concentration occurs. The circulating system pumps the stillage with P-2 (GA-676X) through the upflow tubes where it is distributed at the top to the downflow tubes. The final concentrated stillage product at approximately 30% T.S. and 103°C is transferred by product pump P-6 (GA-689) through level control valve LV-6704X to the concentrated liquor storage tank or back to the feed tank if the product liquor concentration is not in the specified range.

TESTING

The machinery should be tested for leaks: flanges which have been improperly bolted, improper field welds and damage which may have occurred during shipment. This testing may be done by first filling the shellside of the steam chest EA-676X and preheaters EA-675XA and EA-675XB with water and observing leaks. Particular attention must be paid to the circulating pipe and preheater drains for indication of a tube to tubesheet leak. Drain shellside water. Fill liquor side to operating level. Check for leaks in liquor piping, pumps, etc. Check to see that there is a relief valve in the steam piping and set it to protect the equipment against excessive

pressure. Admit steam to the unit at a pressure of approximately 5 psig. Care must be taken not to exceed the compressor casing pressure rating. Check for leaks. Caution personnel about steam pressure in the vessels.

NOTE: This test should be accomplished prior to insulating the unit.

After the compressor, drive and auxiliary components (GB-675X) have been properly installed, the lube oil system should be flushed and checked in accordance with the A-C Compressor Corporation Instruction Manual. It may be necessary to repeat the lube oil flush to remove all the scale and other foreign materials. This process is EXTREMELY important for long equipment life. It is recommended that an A-C Compressor Corporation serviceman be employed to supervise the installation inspection, lube oil flush and required preparatory procedures.

All pumps should be checked in accordance with the instruction manuals for things such as lubrication, alignment, direction of rotation and sealing. Install screens at the pumps' suction to prevent debris from entering the pump. Open seal water to pumps.

The instrumentation and flowsheet should be reviewed. The general control concept is outlined on Dedert Drawing 863959, Sheet 1A and 1B.

The control valves should be stroked and their movement observed.

The compressor and motor (GB-675X) should be checked against the A-C Compressor Corporation Instruction Manual to insure that they are ready for operation.

Water should be passed through the system from the feed tank and inlet piping through the product piping and product tank. Add start-up water to the condensate receiver FA-676X to allow water to be passed through the condensate system. At this time the pumps can be run; control valve actions checked; the various water sprays in separator DA-675X checked; desuperheating water to steam chest EA-676X set to a flow of 6 GPM; and water passed across the tray in separator DA-675X. Observe the water circulating in steam chest EA-676X through the chest sight glasses in the upper and lower liquor chambers. Open hand valves to the mesh and tray wash sprays and observe action through separator DA-675X sight glasses. Open the lowest manhole in separator DA-675X and observe the underside of the scrubber tray. These should be no leakage through the tray or over the risers with the

design water flow of 25 GPM to the scrubber tray. If necessary adjust outlet weir so water level is 1" below top of riser. Adjust inlet weir to provide an even distribution of water to the tray. The scrubber tray water removal pump P-4 (GA-678) should be operational.

Clean debris from system. Inspect compressor suction pipe VD-1 at manhole in horizontal run. Remove all foreign material.

At this point having made all adjustments and corrections, the evaporator can be operated on water or stillage.

NOTE: Pump inlet screens are to be removed if the evaporator is to be operated on stillage.

#### START-UP

The light stillage or water should be passed through the condensate preheaters and mechanical recompression evaporator.

- a. Open guide vanes to compressor GB-675X.
- b. Close all pump drain valves and start seal water to pumps.
- c. Introduce stillage or water to steam chest EA-676X Passes "A" and "B". Fill passes to a level above the upper sight glass in the lower liquor chamber.
- d. Start the circulating pumps P-1 (GA-675X) and P-2 (GA-676X) and maintain the operating levels in both passes between the sight glasses on the lower liquor chambers. When the circulating pumps are started, the level is decreased since the circulating piping LP-2 and LP-4 on the discharge side of the pumps; and upflow tubes now operate on full liquor. Experience dictates how much additional liquor is required to satisfy pump start-up.

A time delay is required between the start-up of pumps P-1 (GA-675X) and P-2 (GA-676X). This time delay depends on passes being filled initially in series or parallel.

- e. Separator DA-675X should be empty of liquor. Open the product valve or black valve and recycle back to the feed tank. When evaporator is running on stillage, it may be advantageous not to discharge material from the mechanical recompression evaporator until it reaches a higher concentration. At times the liquor becomes foamy

upon long periods of recirculating with no evaporation, and it may be necessary to pass liquor through the system. This is best determined in actual operation.

- f. The steam buffer (seal) and air buffer to the compressor should be set. Consult the A-C Compressor Corporation Instruction Manual for the proper settings of these buffers.
- g. Heat the evaporator to 100°C. Remove the air from the system by manually opening the vent valve PV-6703X 50% and admitting steam at 20 psig through the start-up connection in separator DA-675X. The progress of this heating and venting may be followed through the system. The thermometers in the liquor circulating piping indicate that the liquor is heated to atmospheric boiling. Next the vapor handling system is heated. When the entire system is heated and vented, steam leaves the process through the condensate tank FA-676X vent line. To hasten the heat-up, process steam may also be admitted through the make-up connection in steam chest EA-676X.
- h. Open the drain valves on the compressor GB-675X, suction piping VD-1 and condensate tank VP-1 to allow the condensate to drain. It is important to keep the suction trap system LS-6701X operating and level down at all times.
- i. Simultaneously, the compressor GB-675X should be readied for start-up in accordance with the A-C Compressor Corporation Instruction Manual.
- j. Blowdown the panelboard and other instrument air.
- k. The instruments should be set as follows:
  - 1. Chest EA-676X, Pass "A" and "B" Liquor Level Controls - Set controllers LIC-6703X and LIC-6704X to automatic. Maintain liquor levels as described above.
  - 2. Suction Pressure Control - Set controller PIC-6703 to automatic. Maintain pressure at 15 psia.
  - 3. Make-up Steam - Set controller FIC-6703 to manual. Admit a small amount of make-up steam. Observe separator pressure. This controller and start-up steam are used to maintain separator pressures at a slight positive pressure (15 to 15.5 psia).

4. Superheat Control - Set controller TDIC-6706 to automatic and control valve TV-6706X will fully open.
5. Compressor By-pass (HIC-6706) - Set control valve HV-6706X to fully open.
6. Guide Vanes (VCV-1) - Set HIC-6707 at 10% open when system is hot. This setting is almost fully closed.
7. Condensate Tank (FA-676X) Level Control - Set controller LIC-6701X to automatic. Maintain condensate level midway in tank.

NOTE: Vent valve PV-6703X to atmosphere should have minimum positioner. When the valve reaches the minimum set position, the make-up steam receives a signal to increase and maintains proper vent.

- l. Check the liquor levels in chest EA-676X.
- m. Check the compressor suction pressure. It should be at approximately 15 psia. If this value has been surpassed, decrease the start-up steam.
- n. When the compressor and motor (GB-675X) are ready to operate, that is when the lubrication system is checked. The evaporator is hot 100°C and 15 psia. The liquor and condensate levels are proper. The guide vanes VCV-1 are closed. The superheat (TV-6706X) and compressor by-pass (HV-6706X) valves are open. The compressor should be started.

Slowing open guide vanes VCV-1 to 20% or 25% to increase evaporation rate. Do not exceed rated motor amperage. During this period the vibration and temperature monitors should be checked against the A-C Compressor Corporation Instruction Manual.

NOTE: When the compressor GB-675X is started, the suction pressure decreases momentarily. It is important that this pressure does not fall below  $\pm$  15 psia as air may enter the system and cause surging. Experience dictates the proper setting for start-up. If the suction pressure falls below 15 psia, it is necessary to increase the start-up steam.

- o. Any changes to the suction pressure controller PIC-6703 should be made slowly since rapid changes not only affect the evaporator and compressor GB-675X, but the large

inventory of liquor may "flash" and result in excessive entrainment when the pressure is lowered. Similarly, increasing the suction pressure rapidly requires a large sensible heat load which may interrupt boiling and cause surging.

NOTE: Some remedies for surging are to introduce steam through start-up connections, increase make-up steam FIC-6703 or open compressor bypass valve HV-6706X.

- p. Make-up steam FIC-6703 should be switched to automatic.
- q. Slowly and stepwise, shut off start-up steam. An increase in liquor concentration should be observed.
- r. Slowly and stepwise close the compressor bypass valve HV-6706X. Evaporation and condensate may now be observed through the chest sight level glass LG-6707X.
- s. Review operation of separator DA-675X and chest EA-676X. There should be no liquor in separator DA-675X.
- t. Observe the compressor GB-675X lubrication and vibration systems and temperatures. If everything appears to be operating normally, continue to open the guide vanes VCV-1.
- u. Set the superheat controller TDIC-6706 set-point indicator to 3°C (5°F). This instrument may be tuned so that the superheat varies several degrees. It is important to maintain a superheated (dry) vapor to the compressor GB-675X. This can be observed by the sight glass in the compressor suction duct YD-1.

#### OPERATION

Continue observing the levels in the evaporator and the compressor monitoring equipment.

As the compressor guide vanes VCV-1 are opened, adjust feed rate to the desired value.

#### COMPRESSOR SUCTION PIPE VD-1

Use the sight glass to insure that this line is dry after the temperature differential recorder indicated that there is superheat.

When the suction pipe is dry, close the compressor GB-675X drain valve. Adjust suction trap system LS-6701X to keep the level below the sight glass.

#### BUBBLE CAP WASH IN SEPARATOR DA-675X

There are spray nozzles located beneath the scrubber systems to wash the accumulated suspended solids from the floor plate. It is necessary to periodically wash this accumulation to keep it from entering and plugging the mesh. These nozzles should be used individually for approximately one minute each and used every four hours during operation. Experience indicates how these intervals can be altered.

Observe bubble cap action. The water passing across the trays should appear clean and should not impinge upon the mesh.

The pressure drop across these trays should be approximately 2" H<sub>2</sub>O.

#### DEMISTER PADS IN SEPARATOR DA-675X

The pressure drop across these pads should be approximately 0.3" H<sub>2</sub>O. At a Delta P of 1" H<sub>2</sub>O, there is a danger of mechanically damaging the mesh. If the pressure drop exceed this value, the mesh was nozzles below the mesh can be used to wash out the foreign material during operation. Do not operate the mesh wash above the mesh when compressor GB-675X is in operation.

#### BOILOUT

Refer to Dedert Cleaning Procedures dated February 16, 1988 for the description of the boilout. Circulation of a cleaning solution such as water or chemicals removes fouling constituents which have been deposited on the product side of the tubes.

#### SHUTDOWN

- a. Shut down compressor GB-675X in accordance with the A-C Compressor Corporation Instruction Manual.
- b. Reduce the make-up steam FIC-6703.
- c. Open compressor bypass valve HV-6706X.

- d. Reduce feed rate and divert product in accordance with plant procedures.
- e. Shut down the condensate pump P-3A (GA-677) and tray water pump P-4 (GA-678) and open drains.
- f. Observe evaporator level. It should not be abnormally high.
- g. Shut down circulating pumps P-1 (GA-675X) and P-2 (GA-676X) only after circulating liquor is below normal operating concentration.
- h. If evaporator is to shut down for an extended period, drain and circulate weak liquor, water or clean out solution as dictated by plant procedures.

PRELIMINARY  
CAUSTIC CLEANING PROCEDURE

THE FOLLOWING CLEANING PROCEDURE IS PRELIMINARY IN NATURE AND IS INTENDED AS GENERAL INFORMATION FOR THE EVAPORATOR SYSTEM.

The assumption is made that a sufficient amount (approximately 7,000 to 8,000 gallons\*) of 4% to 5% caustic solution is available in Customer's caustic feed tank and that the solution is heated to approximately 180oF. It is also assumed that the unit is in full operation with the compressor in operation. Please refer to Dedert flow diagram (863959, Sheet 1A) and instrumentation diagram (863959, Sheet 1B) for references to pumps, instruments, control valves and manual valves.

Three important points should be noted and taken into account during the cleaning cycle:

1. Only a clean caustic solution should be put across the bubble cap tray and through the spray nozzles in Vessel DA-675X.
2. The use of the sump pump GA-679<sup>✓</sup> for removal of the spent caustic cleaning solution after cleaning will be susceptible to blockage from large pieces of caked solids. The inlet and outlet connections of this pump should be examined for their ability to accept solid material in an irregular form and an open impeller with large vane clearances is advisable.
3. In order to avoid foaming in the evaporator after caustic cleaning, it is advisable to follow with a water rinse across the bubble cap trays.

The following sequence is preliminary.

\*TO BE CONFIRMED AT LATER DATE

### EVAPORATOR SHUTDOWN

1. Stop compressor motor.
2. Observe final concentration on instrument DI-6701 and divert product to proper tank when final concentration is below acceptable concentration.
3. Close steam valve FV-6703X.
4. Observe level indication on instrument LIC-704 and condensate receiver FA-676X for stoppage of formation of condensate.
5. Close manual valves around FE-6704X and FE-6708X.
6. Once it is determined that new condensate is not being formed (evaporation has stopped), close the following valves: HIC-6707, TV-6706X, HV-6706X, and stop pumps GA-677 and GA-678.
7. It is advisable to reduce operating level in evaporator by lower level controls to their minimum. (This level must be determined at later date.)
8. Once lowest level has been reached, close valves FV-6705, LV-6703 and LV-6704X.
9. Stop pumps GA-675X and GA-676X.
10. Open manual valve that connects sump pump GA-679 to A-pass circulating system. Start sump pump and drain liquid and pump to proper feed, intermediate or product tank.
11. Open manual valve that connects sump pump to B-pass circulating system and divert liquid to proper feed or intermediate tank.
12. When evaporator system is completely drained, stop sump pump and close the two drain valves.
13. System should be completely drained of liquor and ready for caustic cleaning.

## CAUSTIC CLEANING

The evaporator system should be ready for the preheated caustic solution with the following valves closed: FV-6705, FV-6703X, LV-6703X, LV-6704X, HIC-6707X, TV-6706X and HV-6706X.

Also close manual valves around the flowmeters: FE-6704X and FE-6708X.

There are two separator cleaning loops involved: the liquor circulating loop and the tray wash system loop. The liquor circulating loop should be filled first.

### Liquor Circulating Loop

1. Open valves FV-6705 and FV-6703X.
2. Start caustic feed tank pump and introduce caustic into liquor circulating loops. Fill level to proper starting level and start pumps GA-675X and GA-676X. Continue to feed caustic solution until proper operating levels have been reached. Observe liquor distribution pattern in top of vessel EA-676X to insure that distribution reaches outside row of tubes.
3. Open FV-6703X if required to maintain proper temperature of solution.
4. Continue to maintain levels by introducing more caustic solution if levels drop.
5. Continue cleaning cycle for the required time.

After the cleaning cycle has been started on the liquor circulating loops, the cleaning of the bubble cap tray system should be started.

### Tray Wash System

1. Introduce clean caustic solution only from the caustic feed tank to the bubble cap trays by opening manual valves around FE-6708X and the four (4) manual block valves that isolate the bottom tray wash nozzles. Please note that only the bottom nozzles should be used.
2. Start pump GA-678 and send caustic solution back to caustic feed tank. This circulation loop should be run

for one to two hours or until observation through the bull's-eye sight glasses that tray and its underside are clean.

3. After it is determined that tray assembly is clean, caustic feed to tray assembly should be stopped and level in vessel FA-677X should be reduced to its lowest level. After draining of this tank, close manual valves to the bottom washes. Introduce fresh water to the suction side of pump GA-678 and circulate across tray through FE-6708X. This will remove any trace elements of caustic on tray and in bottom of mesh. This is important to eliminate potential for foam in start up of evaporator on stillage.

**REMOVAL OF CAUSTIC SOLUTION  
FROM CIRCULATING LOOPS**

After proper cleaning of circulation loops has occurred, it is time to remove caustic solution.

Close valve FV-6703X.

The circulation loops will contain both the caustic solution as well as solids that have been loosened during cleaning process. It is very important that solids be removed from system or else they will quickly be reapplied to the heat transfer surface. For this reason it is important that sump pump be capable of passing solids.

Most plants would have a spent caustic holding tank for storage. The plant would then meter this solution into the feed tank at approximately 5 GPM. This is an additional water load to the evaporator which should be taken into account in the plant material balance. It is also possible to send spent caustic solution to the evaporator product tank. The danger in this method is operator error which could lead to a product tank full of weak product and insufficient solids to the dryer.

No matter where spent caustic is sent, the circulating pumps GA-675X and GA-676X should be stopped. Both manual valves to sump pump GA-679 should be opened and the pump started. After complete draining the pump GA-679 should be stopped and both manual valves in suction line closed.

The evaporator can now be restarted on stillage using start-up procedure.

**CAUTION:** Heavy caustic solution is extremely corrosive and should be handled with care. Before starting the cleaning process, check the emergency shower and eye-wash equipment.