

# **EQUIPMENT OPERATION AND MAINTENANCE MANUAL**

**FOR**

**Dairy Waste Solutions**

**LCI SALES ORDER NUMBER**

**LCI UNIT TYPE**

**18-072**

**SERIAL NUMBER**

**91229EA**

**PLANT LOCATION**

**Wichita, KS**

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**INSTRUCTIONS**

**PARTS LIST & PARTS DRAWINGS**

**REFER TO SECTION  
TITLED "PARTS LIST AND  
PARTS DRAWINGS" FOR  
IDENTIFICATION OF PARTS  
REFERRED TO BY NUMBERS  
IN THIS SECTION.**

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## 1. INTRODUCTION

This manual provides installation, operation, and maintenance instructions which are valid for most applications. If you have a particular problem or application requirement, please contact LCI Corporation's Process or Project Engineering Department (P.O. Box 16348, Charlotte, North Carolina 28297-8804, telephone 704/394-8341, telefax 704/392-8507).

Equipment supply by LCI Corporation is specified in the Bill of Material section of the plant manual.

### 1.1 Main Components

The LCI Unit consist of the following basic components:

#### Body Sections (101-102)

The upper section (101) with feed inlet and vapor outlet is located above the thermal zone.

Thermal section (102), one or more flanged shells with heating jackets.

#### Bottom Outlet Piece (103)

Conical Outlet (103)

Reducer below the thermal section with central bottoms product discharge nozzle.

#### Bearing (200)

Radial/axial bearing assembly for supporting and guiding the rotor.

#### Shaft Seal (300)

Double mechanical seal for the rotor shaft with coolant inlet and outlet connections.

#### Lower Bearing (400)

Lower rotor guide bearing.

#### Rotor (500)

Rotor with vertical blades rotates inside the machine with close clearance between the blade tips and the thermal section heating wall.



## 1. INTRODUCTION

### 1.2 How It Operates

The dilute feed material enters the LCI unit through the tangential feed inlet(s) above the thermal section.

The rotor spreads the feed material evenly around the circumference of the LCI unit.

As gravity draws the material downward, the rotor blades spread the material over the thermal surface and create effective film turbulence. Under favorable conditions of high heat flux, volatile components are rapidly evaporated. Heat is supplied by heating medium in the heating jacket.

The vapors travel upwards to the separator where entrained liquid is separated and returned to the thermal section. the vapors pass through the vapor outlet to a condenser or subsequent process operations.

Non-volatile material reaches the lower end of the thermal section in a few seconds and is discharged through the nozzle in the bottom outlet.

## 2. INSTALLATION

### 2.1 Location

When selecting the best location for the LCI unit, the following points should be considered:

- The unit is shipped completely assembled, excluding the rotor drive.
- The size and weight (flooded and empty).
- Weight of the rotor and top cover assembly.  
(For dimensions and weights see outline drawing).

-Sufficient clearance should be allowed for removal of the rotor from the top of the unit. It is suggested that a permanent hoist be provided to increase the ease of rotor removal.

- The need for rotor removal is generally an infrequent occurrence which is necessary for:
  - rotor and product area inspection
  - repair or adjustment
  - periodic cleaning
- For indoor installation, a hole in the roof with provisions on the roof to pull the rotor is adequate.
- Maintenance on bearings and seal does not require removal of the rotor.
- The immediate area around the LCI unit should be accessible for maintenance and operation.

### 2.2 Structure

The primary requirements of the support structure are that it be:

- Designed to have sufficient strength to support the flooded weight of the unit and sufficient rigidity to withstand vibrations. To ensure that the structure is adequately protected against the effects of vibrations. LCI recommends that a certified Civil Engineer design the structure for both dead (static) and vibration (dynamic) loading. All of the other equipment that is supported on the same structure must be considered in the same way.

## 2. INSTALLATION, CONTINUED

### 2.2 Structure, continued

-Designed with sufficient clearance between the beams to lower the unit down through the structure. If necessary, beams have to be removable to allow the heating nozzles , etc. to pass through when the unit is lifted into position.

### 2.3 Unpacking And Lifting

Make a copy of the packing list and check off each item as it is removed from the crate. Keep the checked packing list for future reference. The unit is packed horizontally in its shipping box and must be lifted out with two hoists and brought to a vertical position (see sketch below). Small units (up to 5 FT<sup>2</sup> of heat transfer area) can be lifted out of the box by simply attaching a rope around the upper part and lifting it with a hoist.

The larger units should be lifted by the lifting lugs on each side of the upper part above the support plate.

<b>NOTE:</b> DO NOT USE THE LUGS ON THE TOP COVER TO LIFT THE ENTIRE UNIT. THESE LUGS ARE TO BE USED <u>ONLY</u> FOR LIFTING THE TOP COVER AND ROTOR.
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The weight of the unit can be obtained from the outline dimensional drawing or the markings on the shipping box.

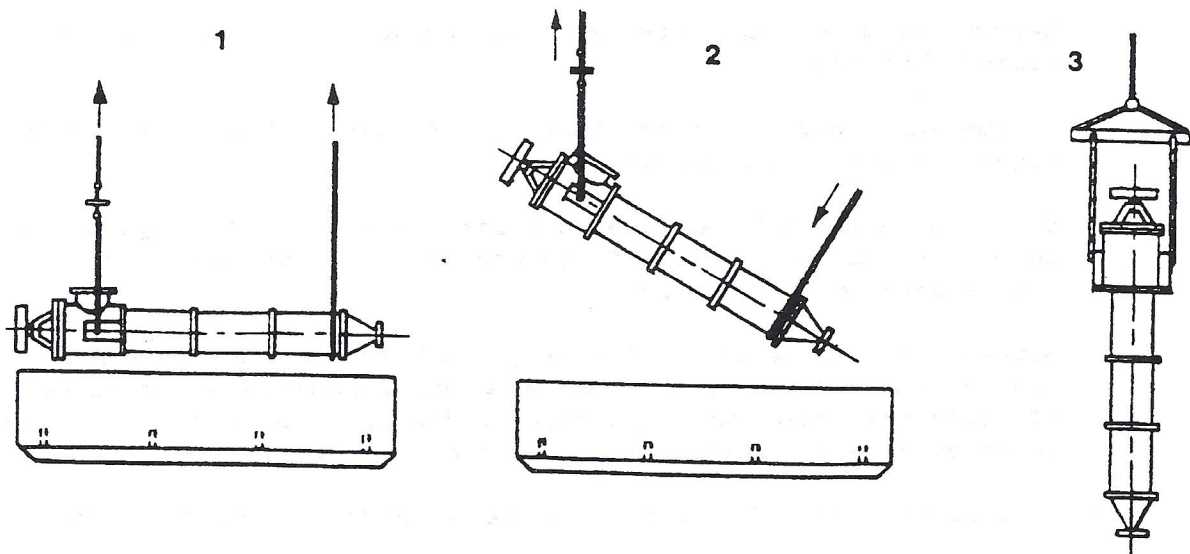
#### IMPORTANT:

Avoid sudden shocks while lifting the unit during installation.

<b>IMPORTANT!</b> If Evaporator is provided with an external Bottom Bearing, confirm that the Bottom Bearing has not shifted during shipment. See LCI Parts Drawing for the Lower Bearing set dimension and section on the Disassembly and Assembly of the Lower Bearing.
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## 2. INSTALLATION, CONTINUED

### 2.3 Unpacking And Lifting



### 2.3 Unpacking And Lifting, continued

Note: Tools and spare parts are normally shipped in the box with the LCI unit. They must be removed and stored in the proper place so they will be readily available when needed.

### 2.4 Leveling The Unit

-The unit is to be initially placed on its supporting structure.

-Before the unit is bolted down, it should be checked to ensure that the axis is reasonably vertical (A level placed on the outlet flange is adequate). If the axis is not vertical, suitable shims must be installed. LCI units designed with support brackets to rest on horizontal structural beams or a floor are provided with leveling bolts in the bottom plate of the support brackets to assist in leveling the unit only. Use shims under the bolts for final leveling.

### 3. PIPING

#### 3.1 Piping (General)

- Remove all discs that were installed between the flanges for protection during shipping.
- Tongue and groove or raised face type flanges are recommended to assure tightness for vacuum service.
- Stresses on the LCI unit due to piping or auxiliary equipment connected to the unit must be reviewed because of the close clearance between the unit's heating wall and rotor.
- Stresses in excess of the limits given below must be eliminated in both the hot and cold condition. Process and utility lines connected to the LCI unit must have expansion joints, flexible hoses, or piping designed to compensate for forces exceeding these limits.

Table of maximum bending moment referred to the support level:

Heat Transfer Area, Square Feet	Maximum Allowable Moment, Ft.-Lb. (M)
1 to 4	950
4 to 9	750
9 to 15	1,300
16 to 28	1,800
28 to 40	4,300
40 to 60	4,600
60 to 80	7,000
80 to 120	8,000
120 to 160	14,000
160 to 200	22,900
200 to 260	49,400
260 to 360	57,500
360 to 400	88,500

NOTE: For determining maximum forces, see bending moment table below.



### 3.1 Piping (General) continued

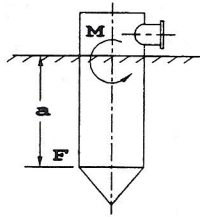
NOTE: Opposing forces must not be subtracted.

Calculation of force F:

The maximum allowable force F is calculated with the following equation:

$$F = \frac{M}{a}$$

a: Distance between support level and Force F.



-Compensation must also be made for the vertical thermal expansion of the LCI unit at operating temperature. Also, any piping below the unit must be included when considering the total vertical expansion.

-In most cases, the product piping is fabricated from stainless steel.

-When the melting point of the product is above ambient temperature, the product piping, instruments, and pumps must be heated to prevent plugging. According to the requirements, this can be done either by tracing or jacketing.

-The overall performance of the LCI system is greatly improved when automatic controls are used on all important process variables. Use of automatic controls will:

- Improve uniformity and quality of the overhead and/or bottoms streams.

- Minimize supervision of operating personnel.

- Protect the LCI unit from damage.

The degree of automatic control required depends on the product, process requirements, and availability of operating personnel.

### 3.2 Feed Piping

To ensure trouble-free continuous feeding of product, the following requirements must be met:

- Feed rate and composition should be as constant as possible.
- The temperature of the feed material should not be more than a few degrees C below its boiling point at operating pressure to best utilize the LCI unit's heat transfer area. If the feed temperature is substantially below the boiling point, a preheater should be considered.
- Avoid flashing of the feed material into the LCI unit. If flashing is unavoidable, a back pressure valve should be installed, as close as possible to the LCI feed inlet nozzle, to assure a steady feed rate. Excessive flashing may necessitate an external entrainment separator to assure complete separation of vapor from entrained liquid.
- Install drain valves at the lowest points of the piping system.
- Install a manual positive shut-off valve in the feed line to prevent leaking of feed material into the unit during down time.
- If pulsating feed pumps are to be used a pulsation dampener must be provided to assure steady feed flow.
- For continuous operation, installation of a stand-by pump is recommended.
- Variations of the feed variables, such as temperature, rate, and composition, will result in fluctuations of the overhead to bottoms ratio and therefore their composition. The degree of control of these variables is dictated by the required product quality and by the physical characteristics, mainly of the bottoms stream (over-concentration, degradation, freeze point, etc.)
- If large fluctuations in the feed composition cannot be avoided and would produce off-spec product, the predominant measurable physical property of the product must be monitored continuously and controlled by automatically regulating one of the process variables (example: feed temperature, feed rate, operating pressure, heating temperature).



### 3.2 Feed Piping, continued

-Some LCI units are supplied with two feed nozzles as standard equipment. Both nozzles are used on some applications to recycle material from an entrainment separator or other equipment in the system or for feeding a cleaning solution. If you have questions concerning the use of the feed nozzles, please contact LCI Corporation.

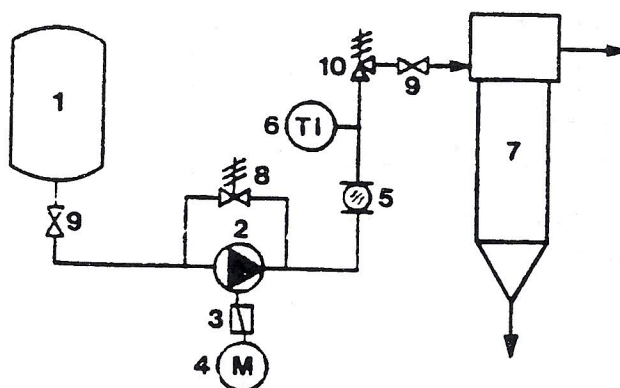
Examples of typical feed systems are given below:

#### EXAMPLES:

##### Volumetric feed pump

The feed rate is determined by the speed of the pump. The speed can be adjusted by a variable speed drive.

#### 1. Feed Tank



- 2. Volumetric Pump
- 3. Variable Speed Drive
- 4. Drive Motor
- 5. Sight Glass or Flow Meter
- 6. Temperature Indicator
- 7. LCI Unit
- 8. Safety Relief Valve
- 9. Block Valve
- 10. Back Pressure Valve

### 3.3 Bottoms Product Piping

Proper design of the discharge system is extremely important. The design must assure continuous discharge from vacuum to atmospheric conditions and prevent product back-up (flooding) into the LCI unit. (NOTE: Product back-up into the unit during operation will cause vibration which can result in mechanical failure.)

The following items should be considered in the design of the discharge system:

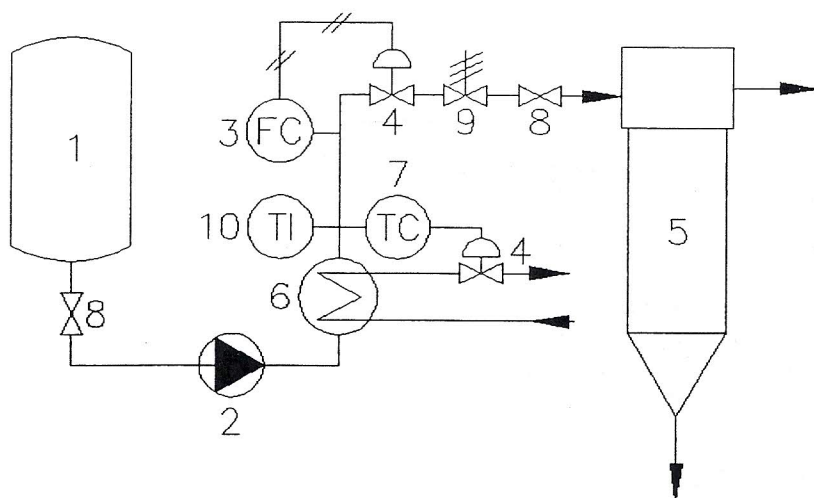
- Choose the proper pump for the required job (Rate, viscosity, temperature, discharge pressure, etc.). For pumping from a vacuum, a double mechanical seal on the pump shaft has been found to be the most reliable seal to prevent air leaks into the pump.
- Once the proper pump is chosen, be sure that the pump is installed properly.
- Maintain the required suction head on the pump. An automatic level control system is recommended to maintain the required minimum suction head on the pump and to prevent dry operation of the pump.
- To prevent vapor locking, or plugging due to viscous or solid materials, keep the pump suction lines as large as practical. If pipe size reduction is required, it should be reduced at the connection to the pump suction. The pump suction lines should run vertically from the LCI unit outlet to the pump suction. If the line must be inclined, the angle must not be more than 45 degrees to the vertical.
- Volumetric pumps should be protected by a pressure relief by-pass valve. When shut off valves are used in the suction line they must be of the full port design to minimize pressure drop.
- Standby pumps are recommended for continuous service as they significantly increase operational reliability of the whole plant.
- For temperature sensitive products, a cooler should be installed downstream from the pump (effectiveness may be improved with recirculation to the pump suction).
- For products with a melting temperature higher than ambient or with high viscosity, the discharge piping including fittings and pumps must be heated.
- Drain valves should be provided at the lowest points of the piping.

### 3.2 Feed Piping, continued

#### Centrifugal feed pump

The feed rate is best regulated by an automatic control system.

1. Feed Tank
2. Centrifugal Pump
3. Flow Meter or Controller
4. Control Valve
5. LCI Unit
6. Preheater (if required)
7. Temperature Controller
8. Block Valve
9. Back Pressure valve
10. Temperature Indicator



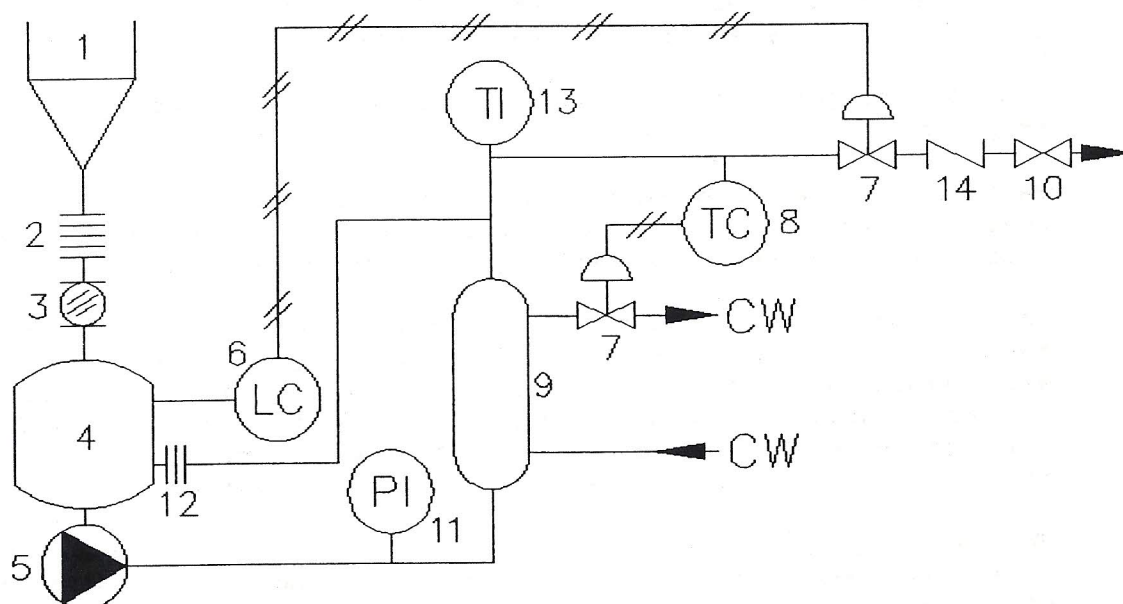
### 3.3 Bottoms Product Piping, continued

-A check valve should be installed after the pump to assist in maintaining a vacuum tight system before the pump is started.

-Installation of a compound pressure gauge on the pump discharge will aid in trouble shooting pump problems.

#### EXAMPLES: Of liquid discharge systems

#### SYSTEM FOR: Low viscosity liquids and high rates

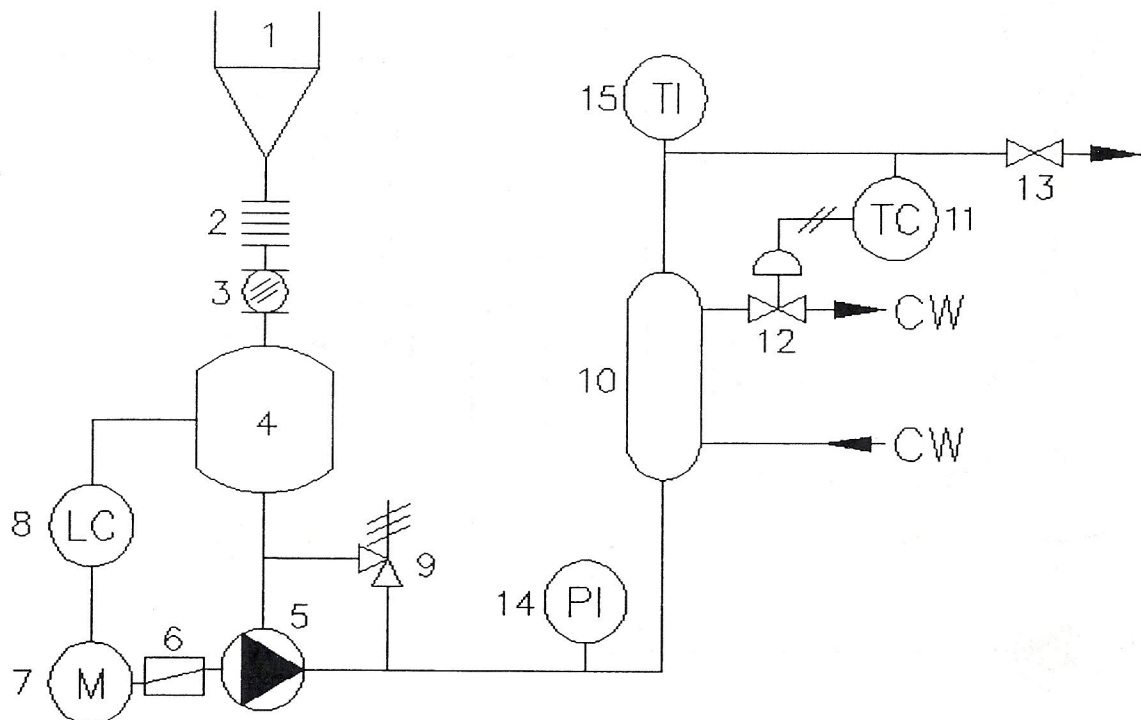


1. LCI Unit (or condenser)
2. Expansion Joint
3. Sight Glass
4. Level Tank
5. Centrifugal Pump
6. Level Control
7. Control Valve
8. Temperature Control
9. Cooler (for heat sensitive products)
10. Block Valve
11. Pressure Gauge
12. Orifice
13. Temperature Indicator
14. Check Valve

### 3.3 Bottoms Product Piping, continued

EXAMPLES: Of liquid discharge systems, continued

SYSTEM FOR: Medium to high viscosity liquids or high discharge head requirements

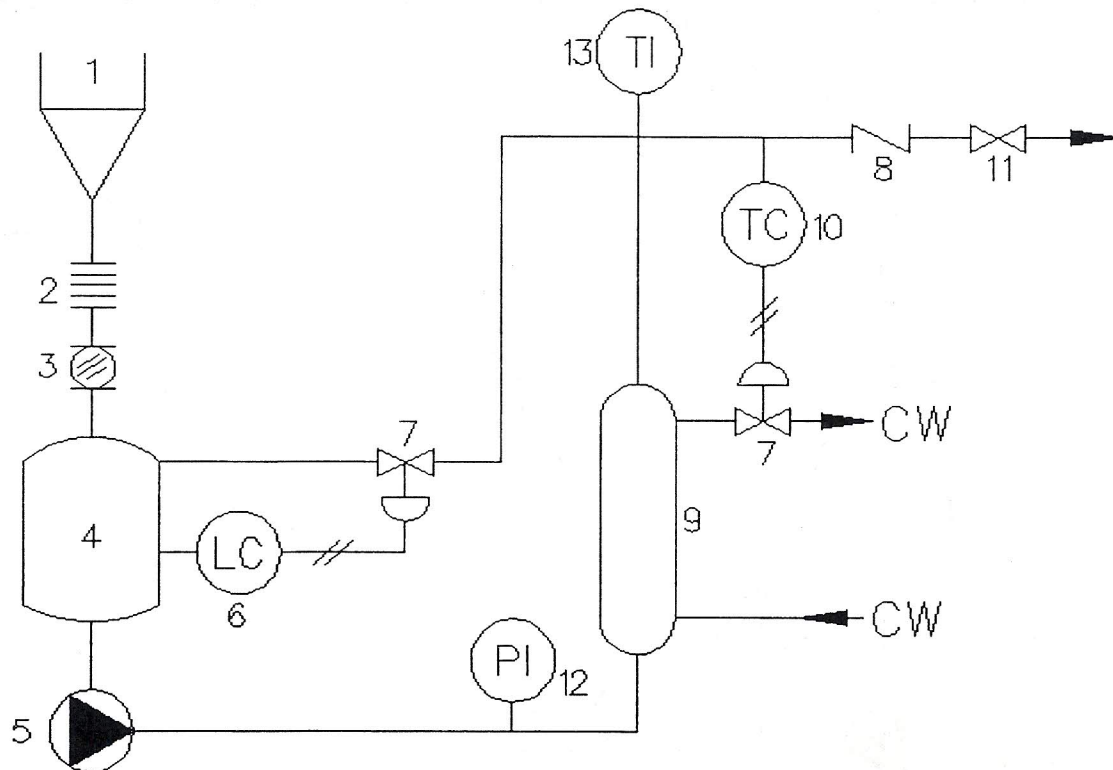


1. LCI Unit (or condenser)
2. Expansion Joint
3. Sight Glass
4. Level Tank
5. Volumetric Pump
6. Variable Speed Drive
7. Drive Motor
8. Level Control
9. Relief Valve
10. Cooler (for heat sensitive products)
11. Temperature Control
12. Control Valve
13. Block Valve
14. Pressure Gauge
15. Temperature Indicator

### 3.3 Bottoms Product Piping, continued

EXAMPLES: Of liquid discharge systems, continued

SYSTEM FOR: Low discharge rates or required cooling of pumped liquid



1. LCI Unit (or condenser)
2. Expansion Joint
3. Sight Glass
4. Level Tank
5. Volumetric or Centrifugal Pump
6. Level Control
7. Control Valve
8. Check Valve
9. Cooler (for heat sensitive products)
10. Temperature Control
11. Block Valve
12. Pressure Gauge
13. Temperature Indicator



### 3.4 Distillate Piping

Design of the liquid distillate discharge system requires the same considerations as previously listed for the bottoms product piping, refer to Section 3.3.

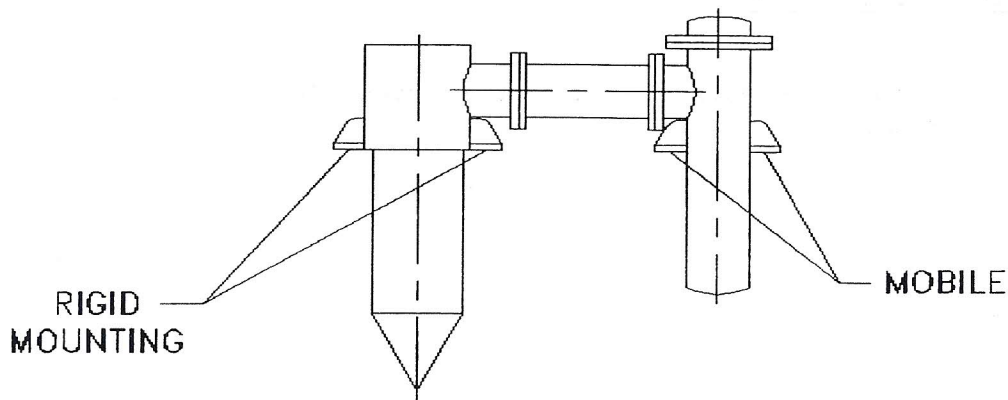
Recommendations for the distillate vapor line are given below:

- The allowable horizontal forces acting on the LCI unit's upper section should not be exceeded. The maximum allowable forces can be calculated from the maximum bending moments (See Section 3.1).
- The supporting structure must be sufficiently rigid to prevent deformation under these forces, otherwise the unit could be pushed out of its vertical position.
- Examples of typical vapor lines are given below:

#### EXAMPLES:

##### Vapor pipe rigid, condenser sliding

With this design the condenser is displaced in line with the thermal expansion of the vapor line. Pipes connected to the condenser must allow its movement.

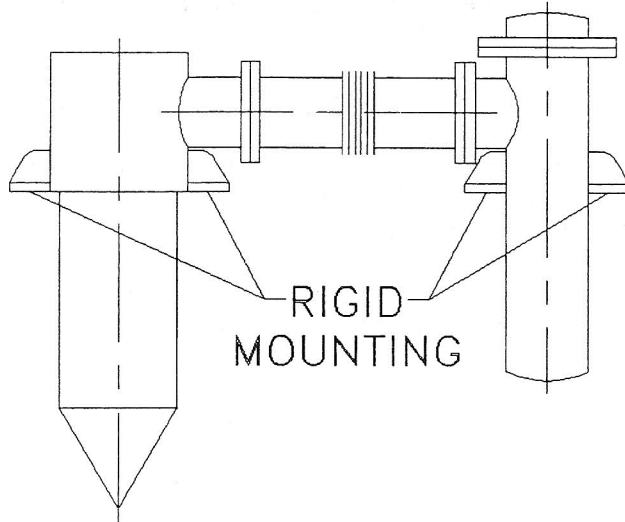




### 3.4 Distillate Piping, continued

#### EXAMPLES, continued

##### Vapor line horizontal with expansion bellows



With this design, the forces acting on the rigidly mounted equipment must be considered since they have to be absorbed by the supporting structure.

##### Multi-directional vapor line

With this design, compensation must be provided for the horizontal and vertical forces.

### 3.5 Vacuum System Piping

The type of vacuum system to be used depends on the operating pressure, the utilities, and the available space.

#### Operating Range

Steam jet ejectors: Down to 1 mm Hg Absolute.

Water ring pumps: Down to 25 mm Hg Absolute (depending on water temperature).

#### SIZING OF VACUUM PLANT

##### CAPACITY:

The total gas rate to be handled depends on the size and tightness of the plant as well as on the amount of noncondensables in the product.

##### LEAK RATE:

The table below gives a practical range of leak rate for various size system.

Plant Volume (Ft <sup>3</sup> )	7	35	100	175	350	900	1800	3500	7000	18000
Air Leak Rate lb/hr										
Mainly Flanged	0.3-0.6	1-2	2-4	3-6	4-8	8-17	13-26	22-44	35-70	60-113
Partly Flanged, Partly Welded	0.2-0.4	0.5-1	1	1.5-3	2-4	4-8	6-13	11-22	17-35	30-60
Mainly Welded	<0.2	0.3-0.5	0.5-1	0.8-1.5	1.3-2.6	2-4	3-6	5.5-11	17-30	17-30

For large standard flange connections (>40 inches) with flat gaskets, the air leak rate is approximately 0.14-0.27 lb/hr/ft (ft = circumferential distance around outside diameter of flange facing in feet).

For tongue and groove and O-ring connections, the leak rate can be reduced to 0.034-0.067 lb/hr/ft.

## Vacuum System Piping, continued

### Inert Gas:

The quantity depends entirely on the product.

### Air and Gases From Cooling Water

If spray condensers are used, the amount of air dissolved in the water ( $6.2 \times 10^{-4}$  to  $1.2 \times 10^{-3}$  lb air/ft<sup>3</sup> water) must be taken into consideration.

Water from cooling towers can contain as much as  $6.2 \times 10^{-3}$  lb/air /ft<sup>3</sup> water.

### Product Vapor:

The air leak is saturated with product vapor, which has to be considered when sizing the vacuum unit. The proportion of product in this vapor mixture increases as its temperature increases.

### Suction Pressure:

Depends on the specified operating conditions.

### Steam Pressure and Cooling Water:

If steam ejectors are used, the dryness of the steam as well as the required cooling water rate and temperature must be considered.

### Control:

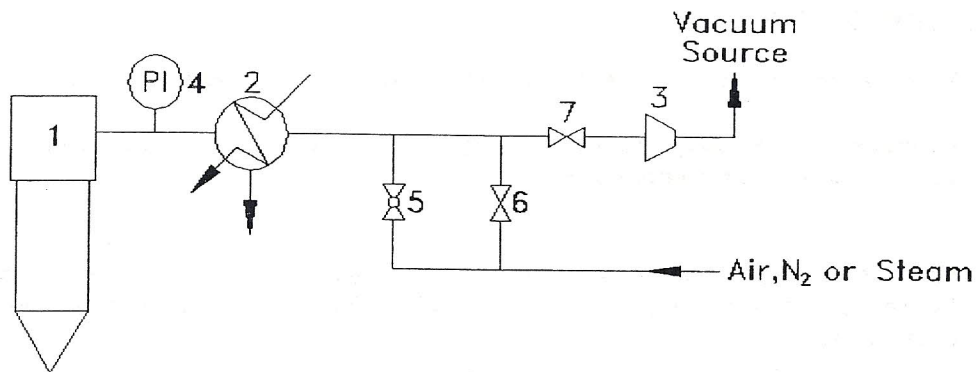
The most commonly used method for controlling the operating pressure is to bleed air, nitrogen, or steam into the vacuum producing equipment until the required vacuum is obtained. This can be accomplished either manually with a needle valve and rotameter, or it can be automatically controlled using an absolute pressure transmitter, a controller and a pneumatic control valve. Note that the bleed valve must be designed for the system's total leak rate so that control can be maintained when the system is absolutely tight. The choice of the bleed medium is determined by the product and the type of vacuum system used. (For additional information we recommend consulting the vacuum equipment manufacturer.)

### 3.5 Vacuum System Piping, continued

Examples of typical manual and automatic controlled vacuum systems are given below.

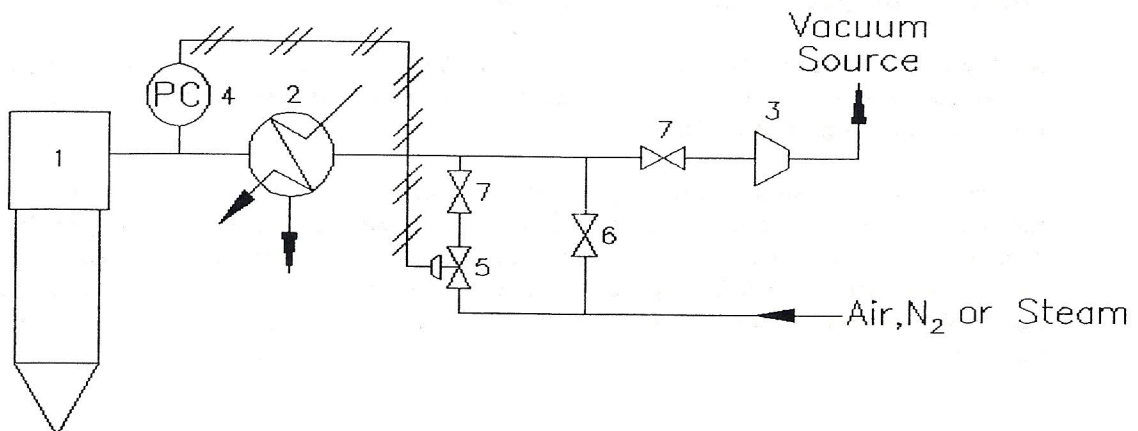
#### EXAMPLES

##### Manual Vacuum Control



1. LCI Unit
2. Condenser
3. Vacuum Unit
4. Vacuum Gauge
5. Regulating Valve
6. Vacuum Break Valve
7. Block Valve

##### Automatic Vacuum Control



1. LCI Unit
2. Condenser
3. Vacuum Unit
4. Vacuum Control
5. Regulating Valve
6. Vacuum Break Valve
7. Block Valve

### 3.6 Heating System Piping

Design of the Heating System is extremely important. Improper design can result in inconsistent or fluctuating bottoms and distillate product streams and/or temporary thermal distortion of the thermal sections. The design of the system and control method depends on the heating medium to be used. (See Section 3.1 for General Piping Recommendations)

#### -Steam Heating

When using steam for heating, the following items must be considered:

- Provide generously sized supply lines. For large multisection units, a steam header is recommended.

- When the steam supply pressure is greater than the thermal section design pressure, a pressure reducing station and safety relief valve is required.

- Steam is placed in the top of each thermal section and the steam condensate is removed from the bottom of each jacket.

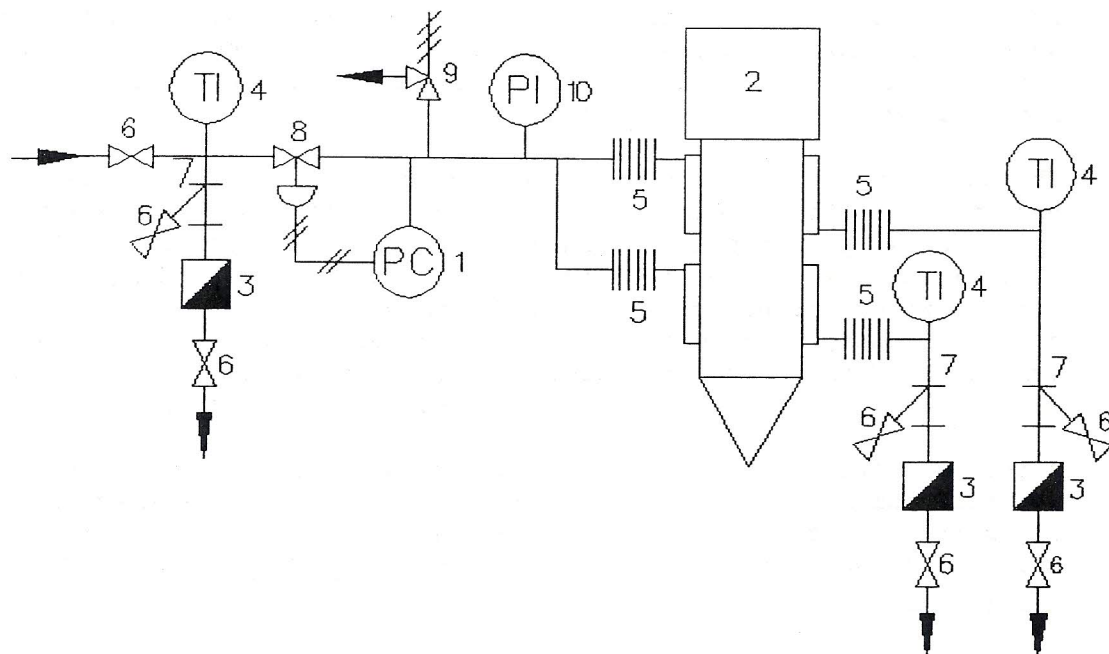
- Separate steam traps should be provided for each thermal section. Each trap should have a good gas handling capacity and a bypass of the trap should be provided. A steam trap must also be placed on the steam supply header to prevent the accumulation of condensate in the header. Temperature indicators should be placed just before each steam trap to indicate proper functioning of the trap.

- A tight shut-off valve must be provided in the steam supply lines to prevent steam leaks from causing thermal distortion of the thermal section during down time.

- Control of steam flow to the thermal section may be by rate, temperature or pressure. Of these, pressure control is preferred as steam rate control under some conditions can cause uneven heating of the sections, resulting in thermal distortion. A typical pressure control system for steam heating medium is shown in the following example.

### 3.6 Heating System Piping, continued

#### EXAMPLE - Steam Heating



1. Steam Pressure Control
2. LCI Unit
3. Steam Trap
4. Thermometer
5. Flex Hose (or piping designed to allow expansion)

6. Block Valve
7. Strainer
8. Regulating Valve
9. Relief valve
10. Pressure Indicator



## ROTOR DRIVE AND ROTOR PROTECTION

### 4.1 ROTOR DRIVE

The standard drive for the LCI unit is a V-belt drive which is driven by an electric motor. This electric motor is normally equipped for across the line full voltage starting. AC variable frequency drives and Hydraulic drives are also used on occasion.

The operating load on the rotor during operation indicates what is happening in the process area. Over concentration of bottoms product or liquid back-up into the process area is quickly indicated by the rotor drive motor load. To protect the rotor from extreme loading conditions due to process upset or mechanical breakdown, a method for quick shutdown must be provided. The minimum requirement is an indicating ammeter. For this type of protection, a manual rotor shutdown system must be provided that is readily accessible to the operator.

A better system is obtained by using an indicating or recording wattmeter with two set points. The first point for a warning alarm and the second point actuating an automatic shutdown of the rotor and the LCI unit's feed system. (NOTE: NEVER FEED THE LCI UNIT WITH THE ROTOR STATIONARY.)

In cases where the product tends to bake on or degrades at higher temperature, it is also recommended to interlock the heating system so that the heating control valve shuts off when the motor stops.

For additional protection against liquid back-up into the LCI unit, a high level alarm system can be placed in the bottoms discharge line. This can be interlocked with the rotor drive and feed system for automatic shutdown if the upset is not corrected.

NOTE: Refer to Section 4.2 for Recommended Interlocks.



## 4.2 RECOMMENDED INTERLOCKS

NOTE: The following interlock points are recommended:

1. Verification of mechanical seal coolant/ lubricant flow before heating the LCI unit or starting rotor.
2. Verification of lubricant flow to the lower bearing (internal lower bearing units) or lower mechanical seal (external lower bearing units) before starting rotor.
3. Verification of rotor rotation before starting feed.
4. High-high rotor power shutdown also shuts off feed and heat.
5. High-high bottoms level shuts off heat, after time delay shuts off feed and rotor.

## 5. OPERATION

### 5.1 Testing

After the equipment and piping is installed, it should be tested before the introduction of product.

-Flush all pipes and vessels with water or another suitable cleaning material. Note: Disconnect mechanical seal piping at the inlet to the seal, flush with at least 5 times the line volume ahead of inlet before reconnecting. Do not flush material through the seal.

-Use temporary in-line screens during flushing or disconnect the suction lines of the pumps prior to flushing.

-Vacuum test.

Leaking flanges, screwed connections, or welding seams can cause severe problems during operation. Therefore, it is important to perform a thorough vacuum test on the system to eliminate problems prior to start-up.

1. Drain all low points in the system making sure that pockets of water (or flush fluid) are not trapped via valves or seal loops. (don't forget the check valves)
2. Isolate the plant from the parts which are not under vacuum when the plant is operating by shutting the necessary valves.
3. Start-up the vacuum system according to the manufacturer's instructions. Verify the vacuum system performance while isolated from the LCI plant before opening the vacuum isolation valve.
4. After approximately 30 minutes shut the vacuum isolation valve.
5. Check the loss of vacuum over a period of two (2) hours. If the vacuum loss is greater than 20 mm Hg/hr, the leaks must be located and eliminated.

Leaks can be detected by subjecting the plant to a pneumatic pressure of 3-6 psig (maximum 8 psig) and then applying soap solution to suspected parts with a brush. A bubble formation can be observed where the plant is leaking. An alternate method would be to inject a halogen laden gas into the system and locate leaks with a halogen detector.

## 5.1 Testing, continued

-Prepare the various parts of the plant (gear boxes, pumps, etc.) for operation according to the manufacturer's instructions.

-Align all shafts and couplings.

Check electrical circuits.

-Rotate shafts by hand, if possible before checking direction of rotation of all motors by briefly jogging the switches. Disconnect coupling for this test wherever possible.

NOTE: Direction of rotation for the LCI unit rotor is clockwise looking down on the top of the unit.

-Check to make sure that all utilities such as air, water, steam, etc. are available to the system.

-Check all valving to ensure it is installed properly:

1. Stroke automatic valves via controllers, checking that they fail open/closed as required for safe plant operation and have their full range of travel.
2. Ensure that all hand valves can be opened by the operator as required.
3. Ensure that all back pressure, relief and check valves have proper orientation.

-Rotate the LCI unit rotor by hand to confirm that it turns freely.

## 5.2 Start-Up

- Refer to Section 4.2 for Recommended Interlocks.
- UPPER SEAL-Open valve in the coolant line to the mechanical seal and set necessary flow rate.
- LOWER MECHANICAL SEAL (If so configured)-Open valve in the coolant line to the mechanical seal and set necessary flow rate.
- set necessary flow rate.
- LOWER INTERNAL BUSHING (If so configured)-Open valve in lubricant line to the bottom bearing and set necessary flow rate.
- Rotate the LCI unit rotor 360 degree by hand to confirm that it turns freely.
- Switch on rotor drive.
- Apply vacuum the system until the required operating pressure is achieved.
- Preheat the LCI unit. Proper preheating requires uniform heating medium distribution and a gradual temperature rise to prevent thermal shock and temporary thermal distortion. (rotor may touch the wall if distortion is extreme).

The method used depends on the heating medium.

<u>Heating Medium</u>	<u>Procedure</u>
Steam	Place 5 psig steam on the thermal section. Open steam trap by-pass until clean, dry steam flows through. Close by-pass. Increase steam pressure gradually to preheat temperature.
Liquid	Start the circulation of heating liquid through the thermal sections at ambient temperatures. Heat to 10 deg. C (18 deg F) per minute.

The preheat temperature depends on the physical properties of the feed and bottoms streams. Generally the LCI unit's heating jackets are preheated to within 10 degree C (18 degree F) of the boiling temperature of the feed material at the unit operating pressure. If flashing could occur at the feed inlet, the jackets should be preheated to approximately 10 degree C (18 degree F) above the melting temperature of the bottoms product.

## 5.2 Start-Up, continued

- Start the feed flow into the LCI unit at design rate.
- Switch on the bottoms and distillate product pumps when flow appears in the sight glasses (or is indicated by level controls). Do not allow the liquid to back up into either the LCI unit or condenser.
- Increase the heating medium temperature gradually until the desired product quality is obtained.

### NOTES:

1. This procedure can be modified to the requirements for special products or processes. For the best method contact LCI Corporation.
2. Never feed liquid into the LCI unit without the rotor turning.

In order to ensure consistent product quality, the following process conditions must remain constant:

- Temperature of feed product.
- Composition of feed product.
- Flow rate of feed product.
- Heating temperature.
- Internal operating pressure.

These process conditions must be checked periodically and recorded in a process log book.

In addition, the following data should also be noted periodically:

- Power draw of the rotor drive motor.
- Vapor temperature.
- Concentrate temperature.
- Distillate temperature.
- Temperature of condensate, measured before the steam traps or, in case of liquid heating, the inlet and outlet temperatures of the liquid.

This data is essential for troubleshooting in case of operational difficulties.

### 5.3 Shutdown

A typical shutdown procedure for the LCI unit is as follows:

- Turn off heating medium supply. (For liquid heating, circulation through the jacket can be continued to ensure uniform cool-down.) Except for high melting products.
- If possible, continue to feed product for several minutes or switch to a suitable flushing medium.
- Turn off feed supply (do not depend on control valve, use positive block valve).
- When the liquid flow in the bottoms and distillate lines stops, shut off removal pumps and close isolation valves.
- Break the vacuum on the system. (For safety consideration--inert gas may be required on some applications.)
- Switch off the LCI unit's rotor.
- Turn off the coolant supply to the mechanical seal and lubricant to the lower guide bearing.
- Drain all process and utility lines, if required.

<p><b>NOTE:</b> When there is risk of freezing, all water and condensate lines must be drained completely or heat traced.</p>
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#### 5.4 Cleaning

The high turbulence of the liquid film keeps the heating wall clean in most applications. However, in extreme cases or due to repeated process upsets, deposits may accumulate on the wall which will reduce the heat transfer efficiency.

If capacity loss becomes intolerable, clean the unit in one of the following ways:

- Flush with cleaning agent while the rotor is turning. A small amount of heat on the LCI unit's heating sections may help in the cleaning operation.
- Fill the unit to the vapor outlet with cleaning agent and leave as long as practical.

CAUTION: DO NOT TURN THE ROTOR WHILE THE LCI UNIT IS FILLED WITH CLEANING AGENT. ALSO, THE UNIT MUST BE VENTED WHEN FILLED WITH CLEANING AGENT.

- Pull the rotor and clean the heating wall mechanically.



## 5.5 Troubleshooting

### A. Loss of Capacity

If loss of capacity occurs, check:

- Steam traps for proper operation (condensate temperature near the trap should be very close to inlet steam temperature).
- Heating medium supply for loss of pressure, temperature, rate, etc.
- Vacuum system for action of controller, causes for pressure drop, performance of vacuum producing equipment.
- Feed supply for changes in rate, composition, temperature.

If the above checks do not produce a cause for capacity loss, check the LCI unit for accumulations on the heating walls and clean if required. (See instructions in section on cleaning.)

### B. Vacuum Leaks

If distillate quality is poor, concentrate pump cavitates, or the required process vacuum cannot be obtained, a systematic check should be made of the following:

- Proper operation of vacuum producing equipment.
- Leaking flanges and fittings.
- Leaking control valves.
- Leaking mechanical seal.
- Non-condensable gases in the feed material.

To check for leaks, one of the following methods can be used:

- Leaks can be detected by subjecting the plant to a pneumatic pressure of 3-6 psig (maximum 8 psig) and then applying soap solution to suspected parts with a brush.
- Fill system to a slight pressure with a halogen containing gas and check suspected joints with a halogen detector.

NOTE: The LCI unit is normally designed for vacuum or atmospheric pressure in the process area. Do not exceed 8 psig pressure in the process area at any time without contacting LCI Corporation for recommendations.

## 5.5 Troubleshooting, continued

### C. Rotor Interference

If the rotor touches the wall or is locked, the following possible causes must be checked and corrected if necessary.

-Uneven heat distribution to the heating jacket due to:

Steam Heating: undersized or inoperable condensate traps;  
noncondensables trapped in jackets; leaking control valve during shutdown.

Liquid Heating: low circulation rate; vapor or airlock in heating system or jackets.

- Unit improperly preheated e.g. heating with rotor off.
- Leaking feed shutoff valve during shutdown or preheat.
- Air leak in bottoms discharge system.
- Inadequate compensation for thermal expansion in the piping to the LCI unit.
- Forces acting on the LCI unit in excess of the acceptable limits (See Section 3.1).

### D. Vibration

If the LCI unit begins to vibrate during operation, the cause should be determined as quickly as possible and must be eliminated to prevent damage to the rotor, bearings, thermal bodies and mechanical seal. Should vibrations continue, the LCI unit must be shut down and the cause determined and corrected before starting again. The most common causes of vibrations in the LCI unit are listed below:

Vibration has high amplitude and low frequency:

- Backup of bottoms product into the process area.
- Overconcentration of product in the process area.
- Air leaks in bottoms discharge system.
- Improper installation of the LCI unit.
- Inadequate support structure.
- Undersized or inoperable condensate traps or noncondensables trapped in jackets

## 5.5 Troubleshooting, continued

### D. Vibration, continued

Vibration has low amplitude and high frequency:

- Heavy deposits on heating jacket wall.
- Heavy deposits on rotor.
- Worn lower guide or roller bearing.
- Worn upper roller bearing.
- Loose V-belts on rotor drive motor.
- Improper installation of the LCI unit.
- Inadequate support structure.

If an external cause cannot be determined as the source of vibration, the balance of the rotor must be checked.

### E. Mechanical Seal Leak

An outboard seal leak on a radial seal (e.g. Crane Type 8 or 9 seal) is detected by flow of seal coolant from the drip pipe located in the upper bearing housing.

An outboard seal leak on a concentric seal (e.g. Crane Type 151 seal) is detected by flow of seal coolant from around the outer circumference of the seal.

An inboard seal leak is indicated by loss of vacuum or contamination of bottoms or distillate product with seal coolant.

If either of the leaks are detected, the LCI unit should be shut down and the worn or damaged parts replaced to prevent further damage.

### F. Increase in Drive Motor Power Draw

An increase in drive motor power draw can be caused by:

- Overconcentration of bottoms product.
- Backup of bottoms product into the process area.
- Process variable change.
- Malfunction of bottoms removal system.
- Malfunction of drive motor.
- Rotor interference.
- Worn or damaged upper roller bearing or lower guide or roller bearing.

## 5.5 Troubleshooting, continued

### G. Unusual Noises

Unusual noises can be caused by:

- Improper lubrication to bottom guide bearing.
- Worn or damaged bottom guide or roller bearing.
- Improper lubrication to the upper roller bearing.
- Worn or damaged upper roller bearing.
- Rotor interference.
- Improper lubrication of the upper or lower (if present) mechanical seals.

6. DISASSEMBLY, ASSEMBLY, AND MAINTENANCE6.1 UPPER BEARING AND MECHANICAL SEAL, DISASSEMBLY

Reference drawing 17927PD2 and 17457PD3A

Preparation for disassembly

-Secure the drive to prevent accidental starting of the unit during this procedure.

-Remove the belt guard, the rotor sheave, sheave bushing, and key for belt driven units. For units that are directly driven, remove drive, coupling, and key from the rotor shaft. Units that are directly driven may be equipped with a drive support mounted to the top head. The drive support should be removed if it hinders access to the bearing and seal housing.

-Shut off the buffer gas supply to the mechanical seal. Remove the buffer gas connections to the bearing and seal housing.

Installation of the jack screw

-Before removing the upper mechanical seal and bearing(s), the rotor must be supported by a jackscrew installed in the bottom bearing housing cap. Using a piece of all-thread rod, or a stud, and a couple of hex nuts can easily make a jackscrew. The jackscrew should be approximately 6" long and free of dirt, grit, or anything else that may contaminate the grease in the lower bearing. On the smaller units the bearing housing cap is tapped for 3/4"-10 UNC and on the larger units for 1"-8 UNC.

-Remove the plug and gasket located in the lower bearing housing cap. With the top bearing housing cap removed, insert the jackscrew in the lower bearing housing cap and raise the rotor approximately 1/8". This will remove the axial load on the bearing retainer (item 8) due to the rotor's weight and allow the disassembly of the bearing. On the smaller units the bearing retainer is a spiral wound retainer clip.

**NOTE:** Precautions must be made to prevent the jackscrew from backing out during this procedure. This can be accomplished by using a jam nut, on the jackscrew, tightened against the lower bearing housing cap.



## 6. DISASSEMBLY, ASSEMBLY, AND MAINTENANCE

### 6.1 UPPER BEARING AND MECHANICAL SEAL, DISASSEMBLY

#### Removing the upper bearing(s)

-After raising and securing the rotor remove the bearing retainer. In the small units, the spiral wound retainer clip (item 8) can be removed with a small pocket screwdriver. Pry the relieved end of the spiral radially away from the shaft and "un-wind" the clip from the groove and discard. *LCI does not recommend re-using the spiral wound retainer after its removal.*

-The bearing on this size unit is held rigidly to the shaft by a tapered bore adapter sleeve. The sleeve is tightened by a locknut and washer combination. In order to remove the bearing from the rotor shaft, the adapter sleeve must be loosened.

-Wipe as much grease away from the bearing as possible. Bend the lockwasher tab out of the slot on the locknut. A spanner wrench or spanner socket should be used to loosen the locknut. *Do not use a hammer and chisel (or screwdriver) to remove the locknut.* Remove the lockwasher and thread locknut back on the adapter until there are several threads of engagement. Using a rawhide mallet, or other appropriate tool, strike the nut in order to drive the adapter down into the bearing bore. This will relax the tapered bore adapter's grip on the shaft.

-In most instances, it is easier to let the bearing remain in the housing and remove the housing from the top head and rotor shaft first. The housing is fastened to the top head by socket head cap screws. The socket head cap screws can be removed and the bearing and seal housing can be pulled from the top head and rotor shaft. The bearing and seal housings were supplied with tapped holes in the mounting flange to be used for jackscrews. Remove the socket head cap screws that attach the housing to the top head and use them as jack screws to lift the housing from the rabbet fit.



## 6. DISASSEMBLY, ASSEMBLY, AND MAINTENANCE

### 6.1 UPPER BEARING AND MECHANICAL SEAL, DISASSEMBLY

-Care should be exercised when removing the housing. The mechanical seal can be damaged if the housing is handled too roughly during removal. The housing should be lifted straight up to prevent chipping the primary seal face or scratching the seal seats. Take special care if your unit has ceramic seal seats, as this material does not tolerate mechanical shock. After removing the housing, the bearing can now be extracted from the housing.

#### Removing the upper mechanical seal

-The outboard seat is retained in the seal housing and is held in place by the O-ring sealing element. The seal retainer (the component that contains the inboard and outboard primary rings, springs, and the rotor shaft sealing elements) is driven by a dog-point set screw. This setscrew is installed so that the dog-point is positioned in the milled slot on the rotor shaft. Remove the setscrew from the seal retainer to prevent scoring the rotor shaft and slide the seal retainer off the rotor shaft. The inboard seal seat can now be removed.

## 6. DISASSEMBLY, ASSEMBLY, AND MAINTENANCE

### 6.2 LOWER BEARING AND MECHANICAL SEAL, DISASSEMBLY

#### Preparation for disassembly

-Secure the drive to prevent accidental starting of the unit during this procedure.

-Shut off the buffer gas supply to the mechanical seal. Remove the buffer gas connections to the bearing and seal housing.

-Since the weight of the rotor is supported by the upper bearing, no special procedures are required for supporting the rotor i.e., no need for a jackscrew.

#### -Removing the lower bearing

-The lower bearing is held rigidly to the shaft by a tapered bore adapter sleeve. The sleeve is tightened by a locknut and washer combination. In order to remove the bearing from the rotor shaft, the adapter sleeve must be loosened.

-Wipe as much grease away from the bearing as possible. Bend the lockwasher tab out of the slot on the locknut. A spanner wrench or spanner socket should be used to loosen the locknut. *Do not use a hammer and chisel (or screwdriver) to remove the locknut.* Remove the lockwasher but thread the locknut back on the adapter until there are several threads of engagement. Using a rawhide mallet, or other appropriate tool, strike the nut in order to drive the adapter down into the bearing bore. This will relax the tapered bore adapter's grip on the shaft.

-In most instances, it is easier to let the bearing remain in the housing and remove the housing from the bottom head and rotor shaft first. The housing is fastened to the bottom head by socket head cap screws. The bearing and seal housings are supplied with tapped holes in the mounting flange to be used for jackscrews. Remove the socket head cap screws that attach the housing to the bottom head and use them as jack screws to drop the housing from the rabbet fit.

6. DISASSEMBLY, ASSEMBLY, AND MAINTENANCE6.2 LOWER BEARING AND MECHANICAL SEAL, DISASSEMBLY

-Care should be exercised when removing the housing(s). The mechanical seal can be damaged if the housing is handled too roughly during removal. The housing should be dropped straight down to prevent chipping the primary seal face or scratching the seal seats. Take special care if your unit has ceramic seal seats, as this material does not tolerate mechanical shock. After removing the housing, the bearing can now be extracted from the housing.

Removing the lower mechanical seal

-The outboard seat is retained in the seal housing and is held in place by the O-ring sealing element. The seal retainer (the component that contains the inboard and outboard primary rings, springs, and the rotor shaft sealing elements) is driven by a dog-point set screw. This setscrew is installed so that the dog-point is positioned in the milled slot on the rotor shaft. Remove the setscrew from the seal retainer to prevent scoring the rotor shaft and slide the seal retainer off the rotor shaft. The inboard seal seat can now be removed.

6. DISASSEMBLY, ASSEMBLY, AND MAINTENANCE6.3 UPPER BEARING AND MECHANICAL SEAL, ASSEMBLY

Reference Drawing 17927PD2 AND 17457PD3A

-Before installing the upper mechanical seal and bearing(s) install the jack screw in the bottom bearing housing cap as described in the disassembly instructions. This will insure the rotor is at the proper position for installation of the mechanical seal and bearing(s).

Inspection of the rotor shaft

-Inspect the upper rotor shaft for wear, scratches, evidence of abuse or anything that may prevent an O-ring or the Teflon wedges from sealing properly on the shaft. Replace or repair the shaft as necessary.

-Inspect the mechanical seal drive slot for any sharp edge or burr that may cut an O-ring or Teflon wedge during installation of the new seal.

Installation of housing components

-Clean housing thoroughly.

-Inspect for damage/wear. Pay close attention to the O-ring sealing bores and the bearing fit area. Replace or repair as necessary. Remove any/all residual grease from the bearing area and clean thoroughly.

- Prior to installing the mechanical seal, study drawing 17457PD3A (top mechanical seal) and 17457PD3B (bottom mechanical seal). Notice all the seal seats are etched with a volute pattern. The correct orientation of the volute pattern is critical for the seal to operate as designed. The inboard and outboard seats are different sizes however; the outboard seal seat on the top mechanical seal is the same size as the outboard seat on the bottom mechanical seal. The volute patterns for these seats are different. Care must be taken to insure the correct seal seats are being installed in the top and bottom seal housings for the seal to operate properly.

6. DISASSEMBLY, ASSEMBLY, AND MAINTENANCE6.5 MAINTENANCEGREASE RECOMMENDATIONS FOR LCI TURBA-FILM®

While there are numerous types and brands of grease that will perform satisfactorily in our thin film evaporators, we have reviewed and approved the following greases for lubrication of ball and roller bearings used in LCI Turba-Film® units.

GREASE BRAND	BASE	MANUFACTURED BY	TEMPERATURE RANGE °F	NLGI GRADE	USDA APPROVAL
Energrease HTB	Bentonite	BP	5° to 500°	1	none
Mobiltemp	Non-soap	Mobil	30° to 500°	1	none
Darina	Non-soap	Shell	-30° to 325°	2	H2
Alvania	Lithium	Shell	-20° to 265°	2	H2
Barrierta L 55/2	PTFE	Kluber Lubrication	-22° to 500°	2	H2
Aquaplex 524	Non-soap	Specialty Lubricants	-10° to 400°	2	H1
Aquaplex 985	Non-soap	Specialty Lubricants	0° to 425°	2	H1
Lubriplate FGL-2	Aluminum Complex	Kar Products	10° to 515°	2	H1
G.I. Lube (bearings originally packed with this grease at factory)	Calcium	Ricmar Industries	0° to 180°	2	H1



## 6. DISASSEMBLY, ASSEMBLY, AND MAINTENANCE

### 6.5 MAINTENANCE

Care must be taken when selecting the proper grease. Consideration should be given to actual operating temperature of the bearings. This can easily be determined by measuring the temperature of the bearing housing during operation. When measuring bearing housing temperatures, the unit should be running for a minimum of 2 to 3 hours under normal operating conditions to insure the bearing temperatures have stabilized.

The NLGI grade is a measure of the stiffness of the grease. The higher the NLGI grade the thicker the grease. The NLGI grade is determined by an ASTM test referred to as the worked penetration. Lower NLGI grades such as grade 1 grease are commonly used in central lubricating systems because they are easier to pump than a grade 2 or 3. Lower NLGI grades are also more susceptible to being washed off when exposed to high-pressure liquid streams than the higher grades. Most grease formulations are available in more than one grade. LCI recommends an NLGI grade 1 or 2 for use in Turba-Film® equipment.

Grease is actually a semisolid lubricant consisting of two main components, a thickener and a liquid lubricator. The thickener acts like a sponge to retain the low viscosity lubricator and release it at a controlled rate. The thickener also provides the grease with its stiff and tacky nature. The two most common types of thickeners are referred to as either soap or non-soap. Lithium, calcium, and aluminum complexes are examples of soap based greases. Most soap-based greases use a mineral oil as the liquid lubricator and are normally limited to lower operating temperature ranges. Bentonite, polyurea, PTFE and other synthetics are examples of non-soap type greases. Most greases are referenced by their thickener, i.e. a lithium base grease or a calcium base grease. However, many times a non-soap thickener is considered proprietary by its manufacturer and referred to only as non-soap grease. Many non-soap based greases use synthetic liquid lubricators and can achieve higher operating temperatures.

Many Turba-Film® thin film evaporators are used in the food processing industry and require the use of USDA approved greases. There are two lubricant groups approved by the USDA, H1 and H2. USDA-H1 approved lubricants may be used in applications where incidental contact with food is possible. Lubricants approved as USDA-H1 are referred to as food grade lubricants. USDA-H2 approved lubricants are generally suitable for use in the food industry where contact with the food product is considered not possible.



6. DISASSEMBLY, ASSEMBLY, AND MAINTENANCE6.5 MAINTENANCE

These are referred to as special lubricants for use in the food processing industry. The USDA publishes a list of lubricant names and manufacturers that meet H1 or H2 approval. This list is available through the U.S. Government Publishing Office as Miscellaneous Publication 1419 (List of Proprietary Substances and Non-Food Compounds Authorized for Use Under USDA Inspection and Grading Program).

In most applications, a high temperature grease should only be used for higher operating temperatures. The high temperature greases normally have higher lubrication viscosity's in the lower range of their temperature rating. Because of this, using a high temperature grease in the low range of its temperature rating can increase power consumption of the drive.

It is extremely important when changing greases that the bearings and bearing housing be thoroughly cleaned so that all residual grease has been removed. It is a fact that some greases, when mixed, will form an abrasive that will damage the bearings and quite possibly the equipment.

When changing greases or installing new bearings it is important to thoroughly grease (pack) the bearings by hand before installation. Care must be taken to ensure that no dirt, grit, or other abrasives contaminate the grease. One method to insure this is to place the bearing in a clean, dry re-sealable plastic bag. Grease can then be added, excess air removed, and the bag sealed. The grease can now easily be worked into the bearing without the risk of contaminants entering the grease. The bearing should be left in the bag until ready to install in the housing. Refer to the bearing installation instructions for complete details on proper bearing installation and lubrication practices.

6. DISASSEMBLY, ASSEMBLY, AND MAINTENANCE6.3 UPPER BEARING AND MECHANICAL SEAL, ASSEMBLY

-Before installing the outboard mechanical seal seat into the bearing and seal housing, sparingly lubricate the O-ring with a light silicone grease or oil. Extreme care must be taken to prevent the lapped sealing surface from being damaged. Take note of the pin located in the housing and the slot in the seal seat. The seat is to be installed so that the slot in the seat accommodates the pin in the housing. It may be necessary to pull the seat into the housing from the bearing end. After the seat is installed, make sure no oil, grease or liquid of any kind is left on the seal face. It is imperative that the seal faces are installed clean and dry.

-The grease seal, installed between the bearing area and the mechanical seal area, should be a light press fit. Reference the assembly drawing of the lower bearing and seal for the correct orientation of the lip. Use a light silicone grease or oil to lubricate the grease seal lip. This will help to prevent wearing the shaft.

Installation of the mechanical seal

-Use a light silicone oil to coat the entire rotor shaft. This will allow the O-rings in the primary rings of the mechanical seal (or the sleeve), to seat properly and ease installation of the seal retainer assembly on the shaft.

-Lubricate the O-ring for the inboard seal seat with either silicone oil or light silicone grease. The sealing surface of the seat must be clean and dry. Check the volute pattern of the seal seat with the drawing to verify that the correct seat is being installed. Once the seat is lubricated properly, slide the seat over the rotor shaft with the lapped side of the seat up and locate the slot in the seat over the pin in the head.

-Before installing the seal retainer assembly on the rotor shaft. Make sure the dog point set screw (in the seal retainer) has been backed out so as not to score the shaft during assembly. The seal retainer should slide on the shaft with a little resistance i.e., it should not slide along the shaft without assistance.

## 6. DISASSEMBLY, ASSEMBLY, AND MAINTENANCE

### 6.3 UPPER BEARING AND MECHANICAL SEAL, ASSEMBLY

-The seal may have to be compressed slightly before the dog point set screw can be properly installed. Special attention should be paid to the installation of the setscrew. The screw should not be "bottomed-out" in the drive slot. The seal is designed to "float" on the shaft. Proper installation can be verified by checking to see if the seal retainer assembly can slide along the axis of the shaft a short distance. Check to make sure the seal retainer cannot rotate about the shaft.

#### Installation of the bearing and seal housing

- Apply a light silicone grease or oil to the inboard end of the housing where the inboard seat O-ring will seal. The bearing and seal housing O-ring must also be lubricated to insure a good seal and proper installation. Check to make sure the surface of the top head, where the housing will mount, is clean and free of nicks or burrs.

-Installation of the housing may require two (2) people. Great care must be taken when lowering the housing over the rotor shaft so as not to damage the fragile mechanical seal faces. After bolting down the bearing and seal housing, check to make sure the grease seal is still properly installed in the housing.

#### Installation of the top bearing

-The bearing should be packed by hand with appropriate grease. (Refer to LCI's grease recommendations.) One way to do this is to place the clean and dry bearing in a clean and dry plastic bag. Put enough grease in the bag for properly lubricating the bearing and knead the grease into the bearing. This can prevent dirt or other abrasives from getting in the grease and causing premature bearing failure.

-The rotor shaft should now be wiped clean of any lubrication that may be in the bearing area. Do not use an anti-seize lubricant on the shaft or the bearing housing. The tapered bore adapter should be installed in the bore of the bearing. Put the lock washer and lock nut on the tapered bore adapter loosely so as to prevent the adapter from slipping out of the bearing during assembly on the rotor shaft. The bearing and taper bore adapter can now be installed on the rotor shaft.



## 6. DISASSEMBLY, ASSEMBLY, AND MAINTENANCE

### 6.3 UPPER BEARING AND MECHANICAL SEAL, ASSEMBLY

-After putting the bearing and taper bore adapter on the shaft install the spiral wound retainer ring on the rotor shaft. The retainer ring will insure proper position of the bearing on the rotor shaft and prevent the rotor from dropping in the event that the taper bore adapter nut should loosen.

-The taper bore adapter should be resting against the spiral wound retainer ring. Tightening of the locknut should be done with an appropriate tool such as a spanner wrench and not with a hammer and screwdriver. During the tightening of the lock nut the tapered bore adapter may want to turn on the rotor shaft. If this is the case, lightly tapping on the outer race of the bearing with a non-metallic dowel will drive the bearing onto the adapter and tighten it to the rotor shaft.

-Once the locknut is tight; one of the tabs on the lock washer should be secured in one of the locknut grooves.

Note: Over-tightening the taper bore adapter will cause the bearing to generate excess heat. This will be evident by a higher than normal temperature of the bearing housing during normal operation. If left unresolved, this may cause premature bearing wear or degradation of the grease.

-The bearing cap should be clean and dry before installation. Install the grease seal in the cap after noting the orientation shown on the bearing and seal assembly drawing. Fill the cap with the bearing grease. Use a new gasket and attach the cap to the housing. Bearing manufacturers agree that one of the common causes of bearing failure is over-lubrication. Care should be taken to insure the bearings are not over-greased. Grease will expand upon being heated and can cause the bearing to generate excessive heat from churning the excess grease, ultimately causing premature bearing failure.

-Remember to remove the jackscrew and install the plug with gasket in the lower bearing and seal housing cap. Buffer gas service to the upper and lower mechanical seals must be returned before operating the unit.

6. DISASSEMBLY, ASSEMBLY, AND MAINTENANCE6.4 LOWER BEARING AND MECHANICAL SEAL, ASSEMBLY

Reference Drawing 17927PD4 AND 17457PD3B

Inspection of the rotor shaft

- Insure the drive motor has been shut off and secured.
- Inspect the lower rotor shaft for wear, scratches, evidence of abuse or anything that may prevent an O-ring from sealing properly on the shaft. Replace the shaft if necessary.
- Inspect the mechanical seal drive slot for any sharp edge or burr that may cut an O-ring during installation of the new seal.

Installation of housing components

- Clean housing thoroughly.
- Inspect for damage/wear. Pay close attention to the O-ring sealing bores and the bearing fit area. Replace or repair as necessary. Remove any/all residual grease from the bearing area and clean thoroughly.
- Prior to installing the mechanical seal, study drawing 17457PD3A (top mechanical seal) and 17457PD3B (bottom mechanical seal). Notice all the seal seats are etched with a volute pattern. The correct orientation of the volute pattern is critical for the seal to operate as designed. The inboard and outboard seats are different sizes however; the outboard seal seat on the top mechanical seal is the same size as the outboard seat on the bottom mechanical seal. The volute patterns for these seats are different. Care must be taken to insure the correct seal seats are being installed in the top and bottom seal housings for the seal to operate properly.

6. DISASSEMBLY, ASSEMBLY, AND MAINTENANCE6.4 LOWER BEARING AND MECHANICAL SEAL, ASSEMBLY

-Before installing the outboard mechanical seal seat into the bearing and seal housing, sparingly lubricate the O-ring with a light silicone grease or oil. Extreme care must be taken to prevent the lapped sealing surface from being damaged. Take note of the pin located in the housing and the slot in the seal seat. The seat is to be installed so that the slot in the seat accommodates the pin in the housing. It may be necessary to pull the seat into the housing from the bearing end. After the seat is installed, make sure no oil; grease or liquid of any kind is left on the seal face. It is imperative that the seal faces are installed clean and dry.

-The grease seal, installed between the bearing area and the mechanical area, should be a light press fit. Reference the assembly drawing of the lower bearing and seal for the correct orientation of the lip. Use a light silicone grease or oil to lubricate the grease seal lip. This will help to prevent wearing the shaft.

Installation of the mechanical seal

-Use a light silicone oil to coat the entire rotor shaft. This will allow the O-rings, in the primary rings of the mechanical seal (or sleeve), to seat properly and ease installation of the seal retainer assembly on the shaft.

- Lubricate the O-ring for the inboard seal seat with either silicone oil or light silicone grease. The sealing surface of the seat must be clean and dry. Check the volute pattern of the seal seat with the drawing to verify that the correct seat is being installed. Once the seat is lubricated properly, slide the seat over the rotor shaft with the lapped side of the seat up and locate the slot in the seat over the pin in the head. If vacuum is available to the Turba-Film®, it can be used to hold the inboard seal seat against the bottom head.

- Before installing the seal retainer assembly on the rotor shaft. , Make sure the dog point set screw (in the seal retainer) has been backed out so as not to score the shaft during assembly. The seal retainer should slide on the shaft with a little resistance i.e., it should not slide along the shaft without assistance.



## 6. DISASSEMBLY, ASSEMBLY, AND MAINTENANCE

### 6.4 LOWER BEARING AND MECHANICAL SEAL, ASSEMBLY

-The seal may have to be compressed slightly before the dog point set screw can be properly installed. Special attention should be paid to the installation of the setscrew. The screw should not be "bottomed-out" in the drive slot. The seal is designed to "float" on the shaft in order to accommodate thermal expansion during startup and shutdown. Proper installation can be verified by checking to see if the seal can slide on the shaft. Check to make sure the seal retainer cannot rotate about the shaft.

#### -Installation of the seal and bearing housing

-Apply a light silicone grease or oil to the inboard end of the housing where the inboard seat O-ring will seal. The bearing and seal housing O-ring must also be lubricated to insure a good seal and proper installation. Check to make sure the surface of the bottom head, where the housing will mount, is clean and free of nicks or burrs.

-Installation of the housing may require two (2) people. Great care must be taken when raising the housing over the rotor shaft so as not to damage the fragile mechanical seal faces. The housing should be raised far enough to start the inboard seat O-ring into the housing before using the mounting screws to pull the housing up to the bottom outlet. After bolting down the bearing and seal housing, check to make sure the grease seal is still properly installed in the housing.

#### -Installation of the lower bearing

-The bearing should be packed by hand with appropriate grease. (Refer to LCI's grease recommendations.) One way to do this is to place the clean and dry bearing in a clean and dry plastic bag. Put enough grease in the bag for properly lubricating the bearing and knead the grease into the bearing. This can prevent dirt or other abrasives from getting in the grease and causing premature bearing failure.

-The rotor shaft should now be wiped clean of any lubrication that may be in the bearing area. Do not use an anti-seize lubricant on the shaft or the bearing housing. The tapered bore adapter should be installed in the bore of the bearing. Put the lock washer and lock nut on the tapered bore adapter loosely so as to prevent the adapter from slipping out of the bearing during assembly on the rotor shaft.

6. DISASSEMBLY, ASSEMBLY, AND MAINTENANCE6.4 LOWER BEARING AND MECHANICAL SEAL, ASSEMBLY

-It is very important to reference the lower bearing and seal assembly drawing at this time (17927PD4). There is a "set" dimension noted on this drawing that will locate the bearing in the housing. The location of the bearing in the housing is engineered to compensate for thermal expansion during startup and shutdown.

-Tightening of the locknut should be done with an appropriate tool and not with a hammer and screwdriver. During the tightening of the lock nut the tapered bore adapter may want to turn on the rotor shaft. If this is the case, lightly tapping on the outer race of the bearing with a non-metallic dowel will drive the bearing onto the adapter and tighten it to the rotor shaft. It may also be necessary to have someone hold the sheave on the driven end of the rotor to prevent the rotor from turning.

-Once the locknut is tight; the location of the bearing should be verified. One of the tabs on the lock washer should be secured in one of the locknut grooves.

**NOTE:** Over-tightening the taper bore adapter will cause the bearing to generate excess heat. This will be evident by a higher than normal temperature of the bearing housing during normal operation. If left unresolved, this may cause premature bearing wear or degradation of the grease.

-The bearing cap should be clean and dry before installation. Fill the cap with the bearing grease. Use a new gasket and attach the cap to the housing. Bearing manufacturers agree that one of the common causes of bearing failure is over-lubrication. Care should be taken to insure the bearings are not over-greased. Grease will expand upon being heated and can cause the bearing to generate excessive heat from churning the excess grease, ultimately causing premature bearing failure.

-Remember to remove the jackscrew and install the plug with gasket in the lower bearing and seal housing cap. Buffer gas service to the upper and lower mechanical seals must be returned before operating the unit.

## 6. DISASSEMBLY, ASSEMBLY, AND MAINTENANCE

### 6.5 MAINTENANCE

-The only components requiring routine maintenance are the bearings and mechanical seals.

-The John Crane type 28LD seal is a non-contact dry running seal. Once the unit is brought up to operating speed (minimum of 750 RPM), the seal faces no longer make contact and as a result there is no wear. Frequent starting and stopping of the unit will be the main contributor to wearing of the mechanical seal parts.

-The proper maintenance of the bearings is the key to this piece of equipment. The health of the bearings can be monitored by many high tech methods. If the equipment is not available for this, perhaps the easiest method is monitoring the temperature of the bearing housing and listening to the bearings.

-The bearing housing temperature should be checked periodically when the unit is first installed to establish a baseline temperature. The bearings will heat up to an equilibrium temperature after a couple of hours of normal operation. It is difficult to predict this temperature for all units because it will vary on the type of drive, operating temperature of the heating jackets, ambient conditions, vapor temperatures, etc. Normally, the bearing temperatures will be in a range of 100-180°F.

-The baseline temperature taken when the unit is first installed and operated under normal conditions can be used to determine the bearing health in the future. After installing new bearings, during routine maintenance, it is a good idea to monitor the bearing temperatures. A bearing housing temperature considerably higher than the baseline may indicate over-greasing of the bearing or over-tightening of the taper bore adapter sleeve.

-It is also important to verify that the bearing temperature is within an acceptable range for the grease being used. See the grease recommendations.

-Since thin-film evaporators operate at relatively slow speed, problems with the bearings can be heard rather easily with the assistance of a mechanic's stethoscope. A healthy bearing sounds very smooth. Chirping is indicative of imminent bearing failure and the unit should be shut down as quickly as possible to prevent seriously damaging the mechanical seals or other Turba-Film® components.





**PARTS LIST**  
91229EA:  
General Assembly:

Ref  
Drawing  
601136F06

??/??/??

Item	Part No.	Qty	Description	
C01	909031	1	Electric Motor, 25HP, 1200 RPM	
C02	909032	1	V Belt Pulley Motor	
C03	909033	1	V Belt Pulley Rotor	
C04	711325	3	V Belt	
C05	710267	4	HHC Screw	
C06	710011	4	Hex Nut	
C07	302035	4	HHC Screw	
C08	710030	4	Spring Washer	
C09	712049	2	Roll pin, Self lok	
C11	710112	6	Hex Nut	
C12	712051	4	Spherical Washer	
C13	908635	2	O-ring	
C14	908634	1	O-ring	
C15	710403	16	HHC Screw	
C16	710011	16	Hex Nut	
C17	710125	24	Hex Nut	
C21	901777	6	Threaded Taper Pin	
C21 a	300207	6	Hex Nut	
C22	713036	35	Insulation Type TIW	
C23	711669	18	Tape Spectape	



**PARTS LIST**  
91229EA :  
General Assembly:

Ref  
Drawing  
601136F06

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Item	Part No.	Qty	Description	
001	601132F05	1	Vapor Section	
002	401172F02	1	Thermal Section	
003	401145H02	1	Bottom Outlet	
004	401143B01	1	Top Head	
005	301115D03	1	Top Bearing & Seal	
006	34550B03	1	Bottom Bearing & Seal	
008		1	Rotor	
009	401146A01	1	Seperator	
010	501101S01	1	Motor Mount	
011	44991S01	1	Motor Hinge Plate	
012	113871C01	1	Hinge Bar	
013	113872	1	Shaft Collar	
015	403206A10	1	Belt Guard	
016		2	Threaded Rod	
017	112264B4	24	Stud	
018		1	Insulation Cover	



**PARTS LIST**  
*Upper Bearing & Seal Assembly:*

Ref  
Drawing  
301115D03

??/??/??

Item	Part No.	Qty	Description	
C01	9017722	2	Threaded Taper Pin	
C01A	901771	2	Hex Nut	
C02	300729	8	SHC Screw	
C03	711341	1	Lubrication Fitting	
C04	711252	6	SHC Screw	
C05	700030A07	1	Shaft Seal	
C08	700030A02	1	Shaft Seal	
C10	700015C70	1	Countersunk Plug	
C12	726070	1	O-ring	
C14	700001A95	1	Thrust Bearing	
C14A	700001A96	1	Thrust Washer	
C15	700003A37	1	Roller Bearing	
C16	106259	1	Key	
001	301117A01	1	Top Bearing & Seal Housing	
002	201104A02	1	Bearing Cap	
003	113857A	1	Gasket	
004	726069	1	Mechanical Seal	
005	116002A03	1	Spacer	
006	201105A03	1	Sleeve	
007	119222C	1	Split Ring	





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[illegible]



**PARTS LIST**  
*Bottom Bearing & Seal Assembly*

Ref  
Drawing  
34550B03

??/??/??

Item	Part No.	Qty	Description	
C02	302056	8	SHC Screw	
C03	711341	1	Lubrication Fitting	
C04	710544	8	SHC Screw	
C06	700003A03	1	Roller Bearing	
C06A	700003A25	1	Roller Bearing Adapter	
C07	700015C60	2	Countersunk Plug	
C08	700030A02	1	Shaft Seal	
C09	726070	1	O-ring	
C10	700015A01	1	Countersunk Plug	
C11	909139	1	Lubrication Fitting	
001	34585A	1	Bottom Bearing & Seal Housing	
002	23998	1	Bearing Cap	
003	113857B	1	Gasket	
004	726069	1	Mechanical Seal	
005	113855A02	1	Gasket	
006	113942A	1	Plug	



**PARTS LIST**  
*Rotor Assembly*

Ref  
Drawing  
909404

??/??/??

Item	Part No.	Qty	Description	
010	201114A	1	Bottom Stub Shaft	
011	122887D01	8	Safety Screws	
012	712662	3	Safety Wire	