

Background

Figure 1 illustrates a simple liquid absorbent system. For the purpose of description, the term "amine" is used to designate any liquid absorbent. The principles described hold equally true for any absorbent.

High pressure amine passes through the contactor where it absorbs carbon dioxide and hydrogen sulfide from the gas. The amine, now called "rich amine" passes through a pressure reduction (throttling) valve. The depressurized amine is admitted to a stripper where the contaminants are removed from the amine. The "lean" amine is then pumped back into the contactor thus completing the process.

The required flows and pressure differentials are often high enough to make pumping energy a major cost factor. Most of that pumping energy, however, is lost in the pressure reduction valve. A large savings is obtainable if the hydraulic energy normally lost in the reduction valve can be recovered and "recycled" in the process.

Figure 2 shows the TURBO™ acting as a pressure booster in the lean amine stream. The feed pump boosts the amine pressure to typically about 35-50% of the contactor pressure. The amine then passes through the pump section of the TURBO™ where it receives the final pressure boost. The rich amine passes through the turbine section where it converts hydraulic energy to mechanical energy to drive the pump section of the turbo.

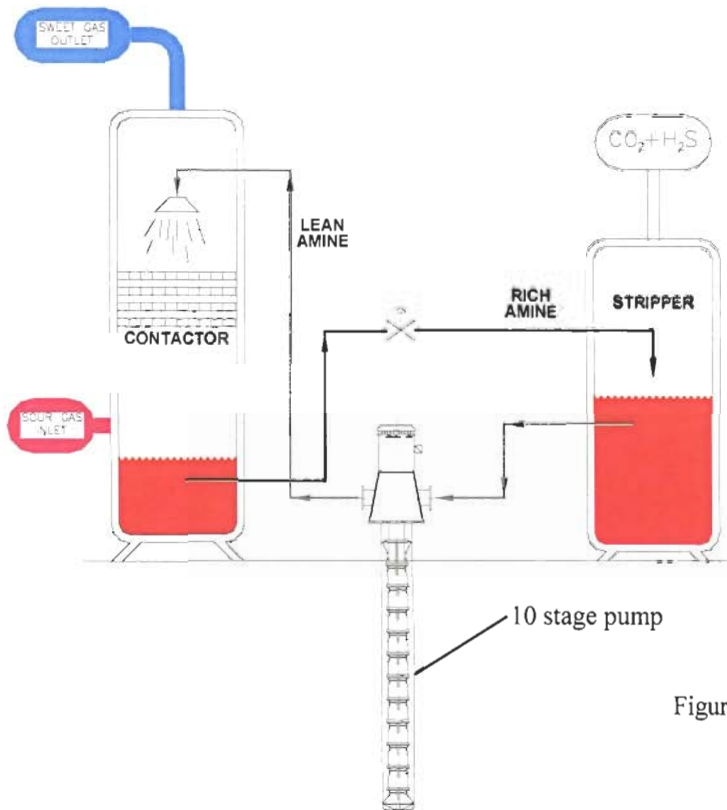


Figure 1

The TURBO™ is entirely energized by the high pressure rich amine. The pressure reduction valve has been eliminated, and the size of the high pressure feed pump has been reduced.

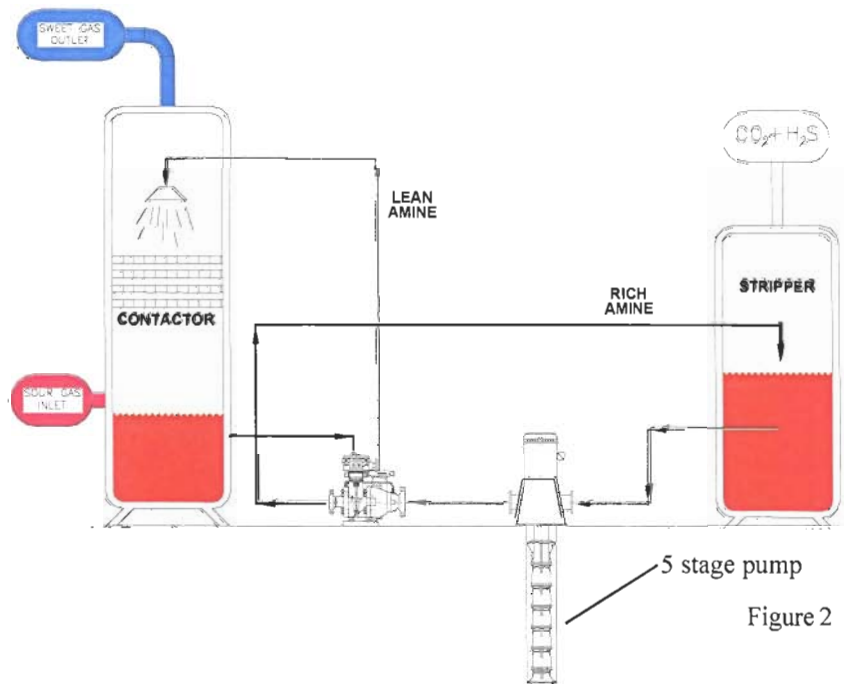


Figure 2

Features

The TURBO™ displays a number of features designed to insure simple operation and long operating life.

Low Maintenance

There are no mechanical seals in the unit. There is no oil or grease. The pumpage provides all required lubrication.

Easy Installation

The unit can be mounted in any orientation.

Brine Pressure Control

The unit can exhaust against a back pressure. Unlike impulse turbines, the TURBO™ never needs an exhaust repressurization pump.

The TURBO™ is equipped with two external tubes or pipes. One tube connects the rich amine inlet passage to the turbine body. This pipe contains a valve, called the auxiliary nozzle valve, allows the operator to adjust the rich amine flow and pressure. The auxiliary nozzle valve is described in the "Starting and Operating" section of this manual. See Figure 3.

The other tube connects the end cap to the feed outlet passage of the Turbo. This tube provides lean amine to lubricate the thrust bearing located in the turbine end cap.

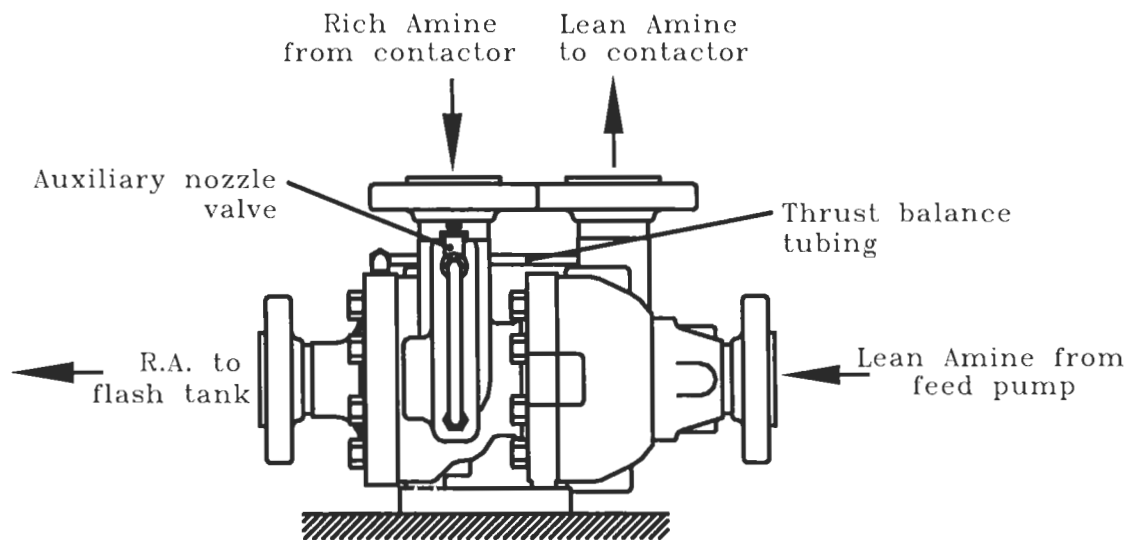


Figure 3

Preinstallation Requirements

Inspection of equipment

When the unit is received, inspect the shipping crate contents carefully for damage and check against the Packing Slip for completeness of order. Report any damage or shortage to:

Pump Engineering, Inc. Tel: (734)242-1772
ATTN: Shipping Dept Fax: (734)242-9777
1004 W. Hurd Rd.
Monroe, MI 48162 USA

Within the first week of receipt of the unit, it should be uncrated and checked for possible hidden damage. When uncrating, do not discard any accessories that are sometimes packed in the same crate. When removing from the crate, be careful not to damage the stainless steel tubing that may be attached to the unit.

Storage

When it is necessary to store the TURBO™ for a period of time before it can be installed, place it in a dry location. The unit must be protected from moisture, sand, grit and other foreign matter, and the protective covers on the pipe connections must not be removed.

Spare Rotating Assemblies

After inspection of any spare rotating assemblies that may have been provided, please repack in the original shipping containers to prevent damage.

Installation

Mounting

The TURBO™ may be bolted to any suitable mounting plate. The plate must be sufficiently rigid to withstand the weight of the Turbo and associated piping. For HPT size 600 and larger, the baseplate should be shimmed and leveled and grouted in place. Turbos smaller than HTC-600 can be mounted in any orientation.

Supply piping

!CAUTION!

It is very important that in making the pipe connections that the TURBO™ is not subjected to piping strains from any of the four connections. The TURBO™ is a precision machine with close internal clearances and any distortions in the casing caused by piping strains can shorten the life of the unit.

Feed inlet piping

The TURBO™ must be installed downstream to the high pressure feed pump discharge. The inlet pipe leading to the Turbo should be straight for at least a length equal to five times the pipe diameter.

Low pressure brine piping

The low pressure rich amine piping should be designed to provide low flow resistance in order to minimize back pressure. However, the exhaust back pressure should not be less than atmospheric pressure since this could cause cavitation that can result in erosion of the low pressure piping and turbine impeller. PEI recommends a minimum of 5 psi of back pressure at the turbine discharge.

A spool piece installed in the exhaust outlet will aid the installation and removal of the TURBO™. The spool piece should be about the length of the TURBO™.

Pressure Gauges

Pressure gauges installed on all the piping connected to the TURBO™ allows Turbo performance to be easily checked. Often, the TURBO™ is so quiet that the only way to verify operation is by noting the feed pressure boost.

!CAUTION!

It is extremely important that all piping be thoroughly flushed to remove all debris, such as welding slag, before installing the TURBO™. Such material can cause improper operation or even damage to the Turbo and may cause damage to other components in the system.

Pump Engineering, Inc. can provide bypass piping to be used in place of the TURBO™ during the flushing operation.

Starting and Operating

Before Starting the Turbo for the first time

After the TURBO™ is installed, inspect all four connections to confirm the proper liquid flow direction. The Gas Processing system should be charged with absorbant before starting. Insure that the auxiliary nozzle and bearing supply lines are properly installed. Sufficient measures should be taken to ensure the Gas Processing System is purged of all air. This will help ensure safe start-up of the Turbo as well as other components within the system.

Starting

The TURBO™ requires no special starting procedure. Simply start the feed pump and the TURBO™ will automatically generate a pressure boost as soon as amine begins to flow through the unit. In all cases, the manufacturer's recommended procedure for starting the feed pump should be used.

With centrifugal feed pumps set the auxiliary brine nozzle valve in the **closed** position before starting the feed pump.

With positive displacement pumps set the auxiliary nozzle valve in the **open** position before starting the feed pump.

Measure the feed pressure boost generated by the TURBO™. Also measure the lean and rich amine flows and the brine pressure. Verify that the Gas Processing system is operating as expected. Please refer to the instructions below on how to regulate contactor pressure and level.

Record the initial TURBO™ operating condition on the last page of this manual. Please fax this page to PEI, Attention: Field Service Dept. 734-242-9777

Flow and Pressure Control

To reduce Turbo discharge pressure, open the auxiliary nozzle valve until the desired contactor pressure and level are obtained.

To increase contactor pressure, close the auxiliary nozzle valve until the desired level and pressure are obtained.

If a feed throttle valve is used or if a variable speed pump drive is used then it may be necessary to adjust these items also to obtain the desired feed flow and pressure.

Troubleshooting

No Pressure Boost or a Negative Pressure Boost

If the pressure gages show that the TURBO™ is not producing a pressure boost in the feed stream then the TURO™ needs to be inspected.

Determine if the rotor is jammed and can not rotate freely. The rotor can be jammed by debris which usually comes from the feed piping such as welding slag, sand or loose parts from the feed pump. The rotor can also be jammed by debris from a damaged bearing caused by debris.

To determine if the rotor is jammed, remove either the inlet feed pipe or the outlet pipe. Using a socket wrench with an extension, engage the pump impeller retaining nut or use an Allen wrench to engage a vane on the turbine impeller through the brine outlet passage. The rotor should freely rotate.

If the rotor does not freely rotate then proceed to the inspection and overhaul section of this manual.

If the rotor does freely rotate, reinstall and try again. If the TURBO™ still does not produce a pressure boost then proceed to the inspection and overhaul section of this manual.

Inspection

Internal Inspection

A complete internal inspection will require measurements of shaft diameters and the inside diameter of the shaft journal bearing. Suitable measuring equipment such as a micrometer and telescoping bore guage should be available. A complete disassembly, inspection and reassembly can be done in just a few hours by following these instructions.

Disassembly

After shutting down the system and relieving all pressure, remove the drain and vent plugs and allow unit to drain. Disconnect all pipe connections. Cover the pipe openings to prevent entrance of foreign material.

Casing Removal

In a clean work area, place the unit in a horizontal position:

- A. Disconnect the thrust bearing tubing and save for later installation.
- B. Remove dowel pins in pump casing.
- C. Remove pump casing nuts (the studs should remain in the pump casing)
- D. Remove pump casing using jackscrews if needed. The casing must be moved straight out to prevent binding
- E. Remove turbine end cap nuts (the studs should remain in the turbine casing)
- F. Remove turbine end cap

Rotor Removal

Remove the rotor as follows:

- A. Using a socket with extension, remove the pump impeller retaining nut. A bar may be inserted in the pump impeller vane passage to prevent rotation
- B. Remove the retainer nut and washer from the shaft and save
- C. Remove the pump impeller from the turbine impeller and shaft being careful not to lose the key in the turbine shaft.

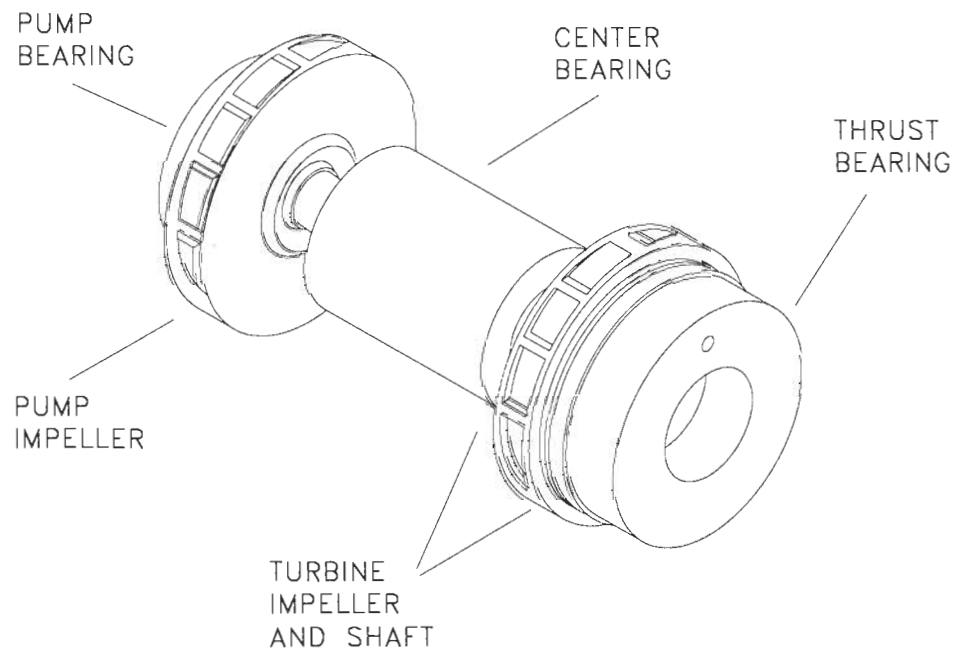
Remove the turbine impeller and attached shaft. The unit is now ready for inspection.

Inspection

With the TURBO™ ready for inspection remove any foreign debris from the unit. Inspect it to determine what the material is and possibly where it came from. This will help to determine where the origin of the problem is. i.e. pre-filtration, bearings, etc. Flush the parts with clean fresh water to remove contamination.

- ◆ Inspect the casings for corrosion and erosion damage
- ◆ Inspect the O-Ring grooves for damage that could prevent proper sealing

The turbine shaft and pump wear ring are either ground stainless steel or coated with a ceramic material that is black in color. The face of the turbine impeller may also be coated with ceramic. These surfaces are identified below.



Examine the ceramic coated surfaces for grooves, ridges or chips. Small chips are not a cause of concern. Also, check for chips or deep scratches in:

- ◆ Pump bearing
- ◆ Center bearing
- ◆ Turbine thrust bearing

If precision measuring equipment is available, measure the inside diameter of the pump and center bearings and the outer diameter of the pump wear ring and shaft in the bearing areas.

If the bearing clearance exceeds the values indicated in Table 1 or if the bearings or rotor have deep scratches or grooving then the bearings and the rotor should be replaced as a unit as described in the "Overhaul" section of this manual.

Overhaul

Overhauling can begin after the unit has been disassembled as described in the “Inspection” Section of this manual. **READ THE FOLLOWING PROCEDURE BEFORE STARTING.**

Removal and Installation of Bearings

The following parts must be available before proceeding:

- ◆ Pump bearing, Center bearing, and Thrust bearing
- ◆ Turbine impeller and attached shaft
- ◆ Pump impeller
- ◆ Pump impeller washer, retaining nut and shaft key
- ◆ Wrench sized for the casing bolts
- ◆ Socket with extension sized for the impeller retaining nut
- ◆ Small pry bar.

Pump Bearing Removal

Place the pump casing on a clean surface with the bearing side up and feed inlet side down. Remove the pump bearing retaining ring. Using a small pry bar, gently and evenly pry out the pump bearing until it is free of the bearing bore. Clean the bearing bore with a clean rag.

Pump Bearing Installation

Place an O-Ring into the O-Ring groove on the pump bearing. Lubricate the O-ring and bearing bore with white silicon grease, glycerin or other lubricant compatible with the O-Ring material and the RO process. Gently insert the bearing into the bearing bore until fully seated. Be sure that the O-Ring is not pinched during bearing insertion. Install the retaining ring.

Center Bearing Removal

Place the turbine casing horizontally on a clean surface. Remove the center bearing retaining rings on both sides of the bearing. Using a drift pin and hammer, gently tap the center bearing toward the pump end until it is free of the bearing bore. Clean the bearing bore with a clean rag.

Center Bearing Installation

Place an O-Ring into the O-Ring groove on the pump bearing. Lubricate the O-ring and bearing bore with white silicon grease, glycerin or other lubricant compatible with the O-Ring material and the RO process. Insert the snap ring on the turbine side of the center bearing bore. Gently insert the bearing into the bearing bore, from the pump side, until fully seated against the turbine side snap ring. Be sure that the notch in the bearing aligns with the anti-rotation pin at the bottom of the bore. Also be sure that the O-ring is not pinched during bearing insertion. Install the retaining ring.

Overhaul

Removal and Installation of Bearing (continued)

Thrust Bearing Removal

Place the turbine end cap on a clean surface with the bearing side down. Support the end cap on small blocks placed around the flanged edge of the bearing bore such that the bearing is free to drop out of the bore.

Using a drift pin and hammer, tap the visible edge of the bearing until it is free of the bearing bore. Clean the bearing bore with a clean rag.

Thrust Bearing Installation

Install the thrust bearing O-Ring into the O-Ring groove on the thrust bearing. Lubricate the O-ring and bearing bore with white silicon grease, glycerin or other lubricant compatible with the O-ring material and the RO process. Gently insert the bearing into the bearing bore until fully seated. Be sure that the notch in the bearing aligns with the anti-rotation pin at the bottom of the bore. This will ensure that the hole in the end cap and the hole in the thrust bearing, which supply lubrication, are in proper alignment. Also be sure that the O-Ring is not pinched during insertion.

Maximum allowable diametrical clearances (inches)

Table 1

MODEL	Pump Bearing	Center Bearing
HPT-150 & HPT-225	0.006-0.008	0.005-0.006
HPT-300 & HPT-450	0.006-0.008	0.005-0.006
HPT-600 & HPT-900	0.008-0.010	0.006-0.007
HPTI-1200 & HPT-1800	0.010-0.012	0.008-0.010

Assembly

Using either the original parts or new parts if necessary, reassemble the TURBO™ using the following procedure:

Insert the turbine impeller/shaft through the turbine end of the center bearing.

Install Pump Impeller

Install the key and pump impeller, install the retaining washer, screw in the impeller retaining nut and tighten to the torque value indicated in Table 2.

CAUTION! Make sure that the impeller retaining washer is seated evenly in its counterbore. Improper seating can result in impeller misalignment and loosening of the retaining nut.

Install Pump Casing

Place the turbine casing on a clean and flat surface. Place the O-Ring into the pump casing O-Ring groove. Carefully slide the pump casing on the turbine casing insuring that the pump casing is fully seated against the turbine casing. Install pump casing nuts and hand tighten. Align dowl pin holes, insert the dowel pins, and drive home. Be careful that the O-Ring is not pinched.

Rotate the rotor by hand. If it does not rotate freely then remove the pump casing. Check for burrs or rough spots on mating surfaces that might cause misalignment. Check for free rotation. If the rotor rotates freely then tighten the nuts to the torque values indicated in Table 2 and check for free rotation. If the rotor does not rotate freely, repeat the above step.

Install Turbine End Cap

1. Place the casing O-Ring on the end cap cylinder portion next to the flange.
2. Install the turbine end cap into the turbine casing. Install the nuts on the turbine casing studs and tighten to the torque values indicated in Table 2.
3. Reinstall thrust line piping and auxiliary brine valve piping.
4. Note that the rotor is free to move axially. This is normal and indicates that the rotor has been installed properly.
5. Install the TURBO™ in the RO system. Connect the feed and brine piping and prepare for operation as described in the Section "Startup".

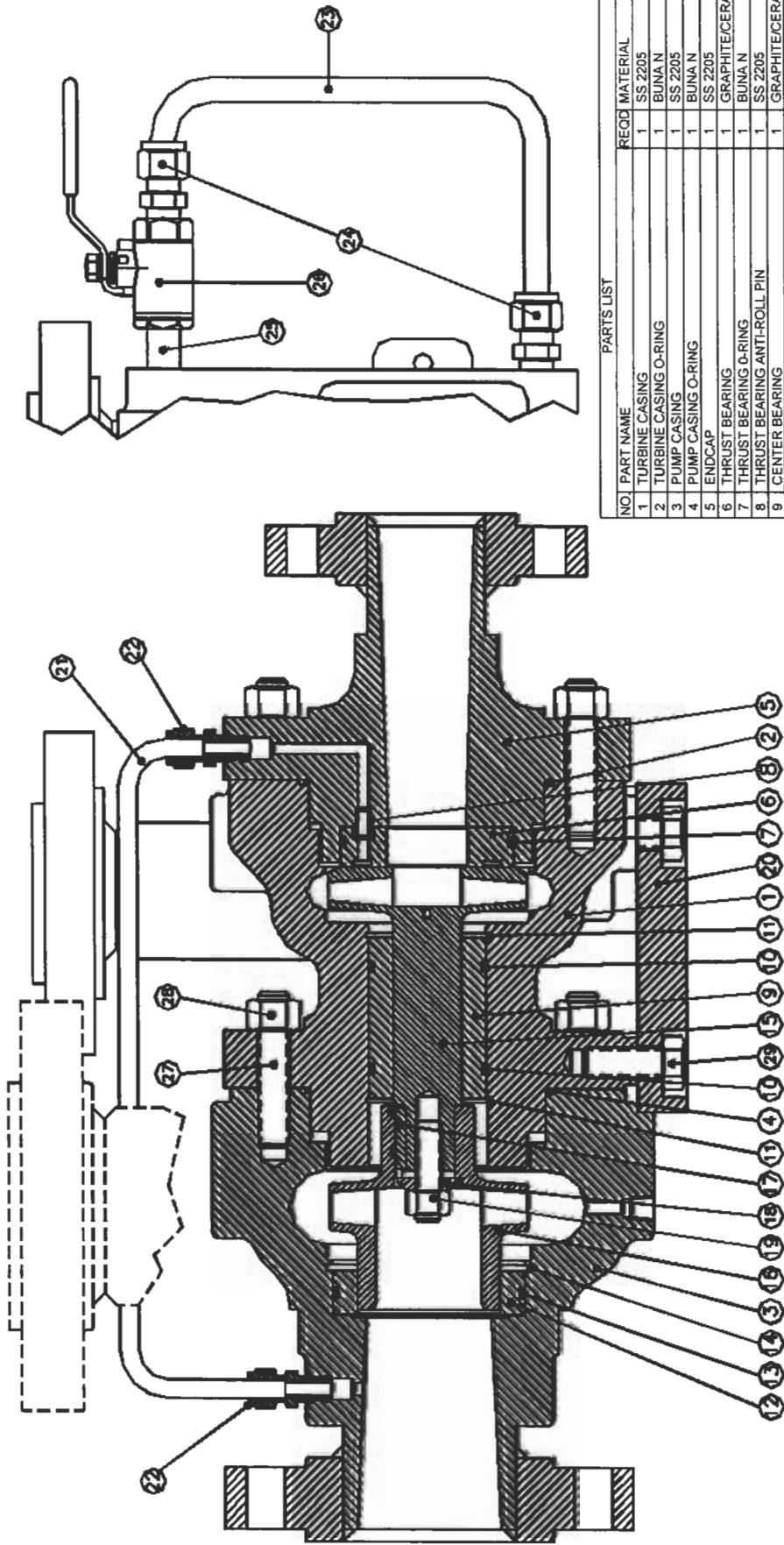
Please return all used parts to PEI along with any data on operating hours, comments, etc. This helps us to continue to provide the best energy recovery equipment available.

BOLT SIZE (inches)	TORQUE (foot-pounds)	BOLT SIZE (inches)	TORQUE (foot-pounds)
1/4	9	9/16	110
5/16	18	5/8	150
3/8	30	3/4	250
1/2	75		

Table 2

PUMP SIDE

TURBINE SIDE



PARTS LIST

NO.	PART NAME	REQD.	MATERIAL
1	TURBINE CASING	1	SS 2205
2	TURBINE CASING O-RING	1	BUNA N
3	PUMP CASING	1	SS 2205
4	PUMP CASING O-RING	1	BUNA N
5	ENDCAP	1	SS 2205
6	THRUST BEARING	1	GRAPHITE/CERAMIC
7	THRUST BEARING O-RING	1	BUNA N
8	THRUST BEARING ANTI-ROLL PIN	1	SS 2205
9	CENTER BEARING	1	GRAPHITE/CERAMIC
10	CENTER BEARING O-RING	2	BUNA N
11	CENTER BEARING SPIRAL RETAINING RING	2	SS 316 PAS
12	PUMP BEARING	1	GRAPHITE/CERAMIC
13	PUMP BEARING O-RING	1	BUNA N
14	PUMP BEARING SPIRAL RETAINING RING	1	SS 316 PAS
15	TURBINE IMPELLER	1	AL6XN
16	PUMP IMPELLER	1	AL6XN
17	ROTOR KEY 3/16"	1	SS 316 L
18	IMPELLER RETAINING WASHER	1	SS 2205
19	IMPELLER RETAINING NUT 3/8-18 UNC	1	SS 316
20	THRUST BEARING ANTI-ROLL PIN	1	SS 2205
21	THRUST LINE 3/8" X 17" X .035" SS-400	1	DELRON / SS 316
22	1/2" X 3/8"-NPT-M TUBING CONNECTOR	1	SS 316 L
23	AUX. LINE 1/2" X 15" X .035" TUBING	2	SS 316
24	3/8" X 1/4"-NPT-M TUBING CONNECTOR	2	SS 316
25	3/8" X 1 1/2" SCH. 80 NIPPLE	1	SS 316
26	3/8" SHARP FULL PORT BALL VALVE	1	SS 316
27	5/8-11 UNC X 3" STUD	16	SS 316
28	5/8-11 UNC HEAVY NUT	16	SS 316
29	5/8-11 UNC 1 1/4 HEX HEAD CAPSCREW	4	SS 316

Rotating Assemblies

The following items are part of a rotating element and must be changed as a full assembly.

Pump Impeller	Turbine Impeller and Shaft
Retaining Washer	Retaining Locknut
Impeller Key	Pump Bearing
Center Bearing	Thrust Bearing
Pump Bearing O- Ring	Center Bearing O-Ring (2)
Thrust Bearing O-Ring	Casing O-Ring
Pump Bearing Retaining Ring	Center Bearing Retaining Ring

When ordering rotating assemblies, please provide model number and serial number as well as operating data.

CONTACT PEI

Please contact Pump Engineering, Inc. if additional information is needed for the installation, operation, or maintenance of the TURBO™.

Please contact PEI before returning any equipment. This can prevent unnecessary returns as well as delays and expense. We will need the serial number of the equipment prior to return.

If equipment does need to be returned to PEI, use the following address:

ATTN: Service Department
Pump Engineering, Inc.
1004 W. Hurd Road
Monroe, MI 48162-9401
USA

Tel: (734)242-1772
Fax: (734)242-9777

Be sure to include a copy of the Maintenance Log in this manual. This will help ensure that the correct parts (if needed) are provided.

MAINTENANCE RECORD

INSTALLATION RECORD

Date unit installed: _____

Comments: _____

Date unit first started: _____

Model number: _____

Serial Number: _____

Feed Flow
Feed pressure at pump discharge
Feed pressure at contactor

Rich Amine Flow
Rich Amine pressure at Turbine Inlet
Rich Amine pressure at Turbine Exhaust

FIRST OVERHAUL RECORD

Date unit overhauled: _____

Estimated operating hours: _____

Before Overhaul

Feed Flow
Feed pressure at pump discharge
Feed pressure at contactor

Rich Amine Flow
Rich Amine pressure at Turbine Inlet
Rich Amine pressure at Turbine Exhaust

After Overhaul

Feed Flow
Feed pressure at pump discharge
Feed pressure at contactor

Rich Amine Flow
Rich Amine pressure at Turbine Inlet
Rich Amine pressure at Turbine Exhaust