INSTALLING LIQUID-RING VACUUM PUMPS

The first lesson for operating liquid-ring vacuum pumps is installing them properly

The liquid-ring vacuum pump is a specific form of rotary positive-displacement pump utilizing liquid as the principal element in gas compression. The compression is performed by a ring of liquid formed as a result of the relative eccentricity between the pump's casing and a rotating multi-bladed impeller.

The eccentricity results in near-complete filling, and then partial emptying, of each rotor chamber during every revolution. The filling and emptying actions create a piston action within each set of rotor or impeller blades.

The pump's components are positioned in such a manner as to admit gas when the rotor chamber is emptying the liquid, and then allowing the gas to discharge once compression is completed. Sealing areas between the inlet and discharge ports are provided, to close the rotor areas, and to separate the inlet and discharge flows.

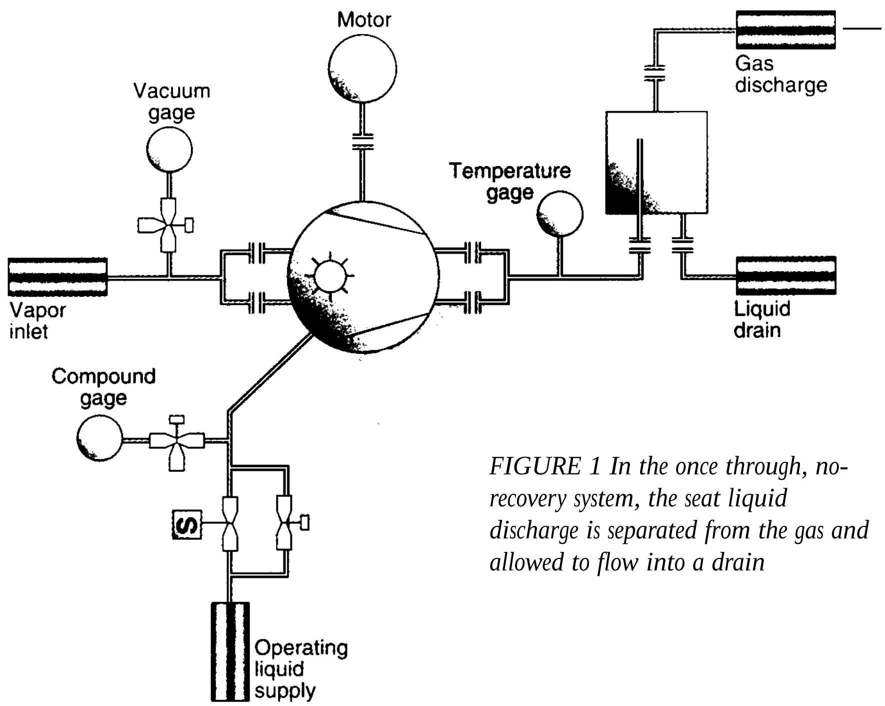

FIGURE 1 In the once through, no-recovery system, the seat liquid discharge is separated from the gas and allowed to flow into a drain

IN THE BEGINNING

The proper installation of a liquid-ring vacuum pump is critical to its subsequent operation and maintenance. The following installation guidelines are general recommendations that apply to nearly all types of liquid-ring vacuum pumps, but users should refer to the specific recommendations of each manufacturer to ensure the best performance.

As with any pump, care should be taken in unpacking the pump so as not to damage or misalign the assembly. For pump and motor units mounted on a baseplate, the unit should be lifted by the base only. Slings or hooks should not be attached to the pump or motor, since this can cause misalignment. Also, the pump should not be run until it is properly installed, nor should it be run without a sealing liquid.

Normally, a pump's components are protected with a water-soluble preservative, which should be flushed from the unit if any fluid other than water is utilized in a closed-loop system. Pumps made of stainless steel or other non-ferrous materials may be shipped without preservative, that is, "dry." Finally, the unit should be stored or installed such that any liquid present will not freeze.

SETTING UP

Liquid-ring vacuum pumps are basically slow-speed, smooth-operating rotating devices. Nonetheless, it is important to ensure that the pump's frame or baseplate is mounted level and firmly anchored.

Pumps that are about 50 hp and above are best placed on a concrete pad. Smaller units may be mounted on existing floors and skids. All joints in piping, whether flanged or screwed, should be free of strain and checked for leaks prior to start-up.

Normally, pumps that are supplied direct coupled to motors are aligned and test-run in the factory prior to shipment. However, because of unforeseen forces and moments imposed on the pump during shipment and installation, it is necessary to check the coupling's alignment prior to startup. To do this correctly, the guidelines of the coupling manufacturer should be followed as a minimum, and exceeded where possible.

For pumps utilizing V-belt drives, it is necessary to ensure that the sheaves are properly installed and aligned before attempting to tension the drive. The V-belts should be placed over the sheaves and in the grooves without forcing them over the sides of the grooves.

When all belts are in their grooves, the centers are adjusted to take up all slack and leave the belts fairly taut. When the pump is operating, the slack side should have a slight bow. After several days of operation, re-tension the belts if necessary. Slipping (squealing) at startup are indications of insufficient tension. Excessive tension can shorten bearing life. If the unit is idle for an extended period of time, the tension on the belts should be removed.

Excessive heat (140°F and higher) should be avoided, since this over-cures the rubber and shortens belt life. The belts should never be mixed or switched from one groove to another on the sheaves, and should be replaced only with a matched set. Belt dressing should never be applied, and the sheaves should remain free of oil and grease.

PIPING THE SEAL LIQUID

The working principle of the liquid-ring pump is dependent upon a continuous supply of clean seal liquid (normally water, but other suitable liquids can also be used). This liquid enters the pump through a connection on the casing and is discharged from the pump, along with the gas.

Three basic piping arrangements for the seal liquid can be used for vacuum pump applications: once through, partial recovery, and closed loop. All these arrangements have four elements:

- A source for the seal liquid (from a water main or reservoir)
- A regulating device, to control the flow of liquid, if required
- A means of stopping the flow when the pump is shut off
- A means of separating the gas-liquid exhaust mixture

Once-through, no recovery. In this design, seal liquid is taken directly from a main and supplied to the pump (Figure 1). The liquid discharge is separated from the gas and wasted to a drain. No recirculation or recovery takes place. This is a common arrangement where conservation or contamination of the seal liquid is not a concern.

An automatic solenoid valve ensures the flow of the seal liquid in conjunction with the pump-motor's operation (i.e., when the motor stops running, the valve closes to prevent the casing from filling with seal liquid). With a manual seal-liquid shut-off valve, care should be taken to flash *cautions* to open the valve immediately before turning the motor on, and shutting the

In general, it is not necessary to drain the pump if the incoming seal liquid is shut off simultaneously. An automatic valve can be used to control this procedure.

Many liquid-ring vacuum pumps that incorporate a standard packing or gland arrangement for shaft sealing are also fitted with lantern rings and a gland connection provided for cooling liquid. A suitable source of cooling liquid must be provided, at around 5 psig above the operating pressure. A common supply for both the seal liquid and the gland cooling is normally used.

If mechanical seals are employed, a supply of cooling and flush liquid is also required. It is recommended that a separate and clean source of seal liquid for mechanical seals is used. Double mechanical seals require a monitoring device to detect a leak on the inboard seal.

PIPING

To begin, the suction and discharge flanges on pumps are normally marked by arrows on the casing. The suction and discharge lines should be the same size as the pump connections.

Ideally, the discharge line from the pump to the separator should

ACCESSORIES

Liquid-ring pumps come with many accessories, supplied by the manufacturer or by other companies in the field. An application's particular requirements, mode of operation, and type of control scheme dictate the necessity of various items. The following covers some of the more commonly used items.

Isolation valves separate the pump from the system whenever it is shut down for extended

TROUBLESHOOTING
LIQUID-RING VACUUM PUMPS

Ike the proper installing of vacuum pumps, troubleshooting them is critical to their continued operation and maintenance. As a result, it is important that only qualified personnel, using proper equipment, be authorized to perform testing,

There are many factors that can influence the performance of a vacuum system. First, it is always good practice to inspect the equipment when it arrives at site, and then to make sure that the equipment is properly installed, and that all valves and flow switches are in correct direction as per the installation drawings. Verify that the pump rotates freely and in the proper direction, and that the system is properly primed before start-up. All these preliminary checks make troubleshooting of the system easier.

Malfunction of the vacuum system could be due to utility or process conditions, or both, or the equipment, and it is important to determine the cause. A malfunction due to external influences can be determined as follows:

1. The first step is to compare the original design conditions, especially gas composition and cooling water temperature to the existing condition.

   Any change in the design conditions and the gas's composition may have an effect on the vacuum system. For example, an increase in the condensable load will raise the effective seal-liquid temperature and effect the vacuum system. A change in the condensable or non-condensable gas composition may effect the seal-liquid composition and the vacuum. High seal-liquid temperatures will also affect the vacuum level.

2. Make sure that there is no excessive air leakage. Air leakage can be determined by a drop test per Heat Exchange Institute Standards for Steam Jet Vacuum Systems.

3. Back pressure on the system should be as per design conditions. Excessive back pressure increases the brake horsepower, and may have an effect on the capacity of the vacuum pump.