TUTHILL
Vacuum & Blower Systems

KINNEY®
Booster Systems

Instruction Manual
1816

ISO 9001
CERTIFIED
QUALITY SYSTEM

MANUAL 1816-1

DESCRIPTION

General

Booster vacuum pumping systems are a combinations of two (or more) positive displacement pumps; a high capacity mechanical booster and a lower capacity backing pump.

Vapor handling systems are a combination of a rotary piston pump with a backing pump to maintain the vacuum pump oil free of contamination.

This manual should be accompanied by separate manuals which contain more information about the component pumps.

Booster Pumps

Mechanical booster pumps have lobe type rotors driven by timing gears. The rotors counter-rotate with very close clearances between each other and the pump cylinder. The rotors trap a volume of air between each rotor and the pump cylinder. This is then carried to the exhaust side of the pump and discharged.

Booster/Rotary Piston Systems and Compact Booster Systems

The two pumps operate in series, with the operation of the booster pump automatically controlled by a pressure switch. In operation, the backing pump makes the initial pressure reduction to the cut-in pressure of the booster pump. At this point, the booster pump starts and both pumps function in series.

The backing pump is an oil sealed, rotary piston type vacuum pump. The pump functions by drawing air in at the pump inlet for almost one full revolution and then compressing it for almost another revolution until adequate pressure is reached to discharge it from the pump. Both cycles are performed simultaneously; one side of the piston draws in air while the other side compresses air drawn in on a previous cycle. The pump can be either a single stage or compound pump.

Close-Coupled Systems

Close-coupled systems are the same as piston pump systems except that the booster is mounted directly on the backing pump suction elbow, and both pumps are driven by a single motor. The booster runs at all pressures from atmosphere down and there is no pressure switch. It is necessary to avoid prolonged operation at high pressure which will result in overheating of the blower. Close-coupled systems are most suitable for rapid pump-down of small volumes.

Booster/Liquid Ring Pump Systems

Booster/liquid ring pump systems consist of a booster with a liquid ring backing pump. The booster is controlled by a pressure switch. The booster increases the capacity and ability to reach low pressures, and the system is suitable for high vapor loads and wet applications.

Bypass Line

The bypass line is a valved arrangement used to bypass the booster when the backing pump is making the initial pressure reduction. It can be furnished as an optional item on any booster system to considerably shorten the time required to reach the cut-in pressure of the booster pump. In systems without the bypass line, roughing is done directly through the booster pump.

Pressure Switch

Various types of pressure switches are used to control starting of the booster pump. The most common are the diaphragm type and bellows type. They function by sensing the pressure at the booster pump inlet. When this pressure drops below the cut-in pressure setting on the switch, the booster pump is started.

Interstage Manifold

The interstage manifold is usually constructed of mild steel and fitted with standard ANSI type flanges or threaded connections. Flat gaskets are normally used to seal flange connections, but O-rings may be used on some applications. Sealing compound is used to seal threaded connection. Most systems have flexible connectors (bellows) at the backing pump inlet. Where necessary, some systems may have interstage baffles or heat exchanger.

INSTALLATION

General

When installing this booster pumping system it is recommended that certain items be incorporated in the overall system for ease of maintenance and operation. These include (1) a high vacuum valve between the booster pumping system and the connected equipment to allow isolation for testing, (2) a vent valve to vent the pumping system to atmospheric pressure, (3) a cooling water shut off valve, and (4) a separate switch for the booster so that it can be switched off even when the suction pressure is low.

1. Check the contents of each crate against the packing list and check that all parts are in good condition.

2. Position the equipment and secure it to a level, rigid, and flat foundation (grouting may be used). Locate pumps to allow easy access to working parts. Check that connecting manifolding is free of all foreign matter.

   Install gaskets between flanges, and tighten opposite pairs of fasteners to distribute the load evenly. Use "Tite Seal" (Radiator Specialty Co., North Carolina) compound for sealing threaded connections over 1-inch in diameter.

   Note that if threaded connections are used, such as at gauge, pressure switch, or temperature switch connections, the threads should be coated with Kinseal when making up the connection to prevent vacuum leaks. An alternative sealing technique is to wrap a layer of PTFE tape on the threads. Make connections carefully to prevent sealing compound or tape from blocking the opening of the connection.

4. Check pump drive.

   On V-belt driven boosters, check that the tightest belt does not depress more than its own thickness under normal thumb pressure.

   On direct drive coupling pumps, check alignment of coupling. Total indicator runout should be 0.005 inches or less. The inside coupling faces should be parallel within 0.0015 inches. Backing pump V-belts should be checked as directed in the pump instruction manual.

5. Connect tubing from vacuum manifold to pressure switch, if removed for shipping.

6. Connect water inlet and discharge lines to pump connections as shown on outline drawing. Note that some model booster pumps have two water inlets and outlets. These are marked on the pumps. Use an open drain or a visual flow indicator to check discharge water flow and temperature. Check that pump water drain plugs are in position.

7. Fill backing and booster pumps with oil, per component instruction.

8. Complete electrical wiring. Typical wiring diagrams are shown on Figures 1, 2, and 3 on the opposite page, and in the manual for the backing pump. Consult Kinney Vacuum for further assistance if required. Check each electrical device for correct wiring voltage.

   When a Bristol pressure switch has been provided for cut-in pressures below 25, torr the switch must be protected by a solid state relay. The Bristol switch will fail if it is used to control the booster contactor directly.

When this booster pump system is first installed, the blank-off pressure of the pumping system only (as well as that obtained when the process equipment is connected) should be checked. This should be done before starting process work to eliminate the possibility of process vapors causing system contamination. If the desired pressure can be reached in the time required, the booster pumping system is functioning properly. In general, a pumping system need not obtain a pressure lower than 10% of that required for the particular process.

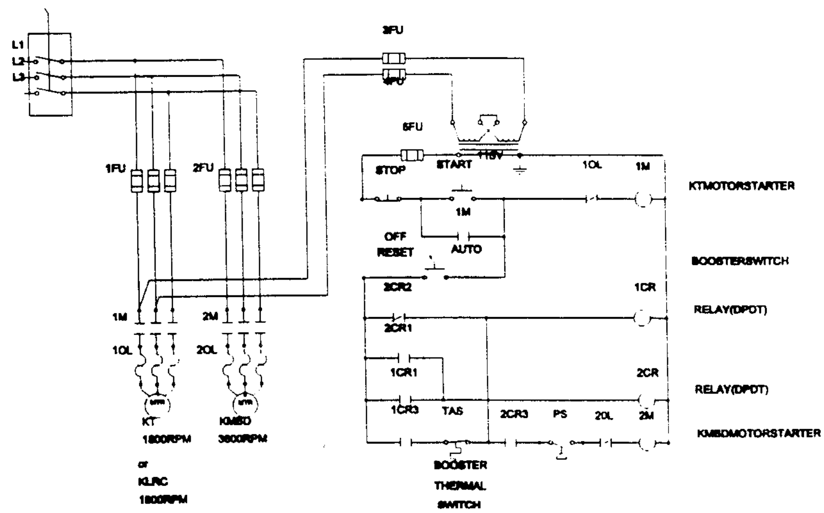

Figure 1 Typical wiring diagram, KMBD/KT, CB & KMBD/LR

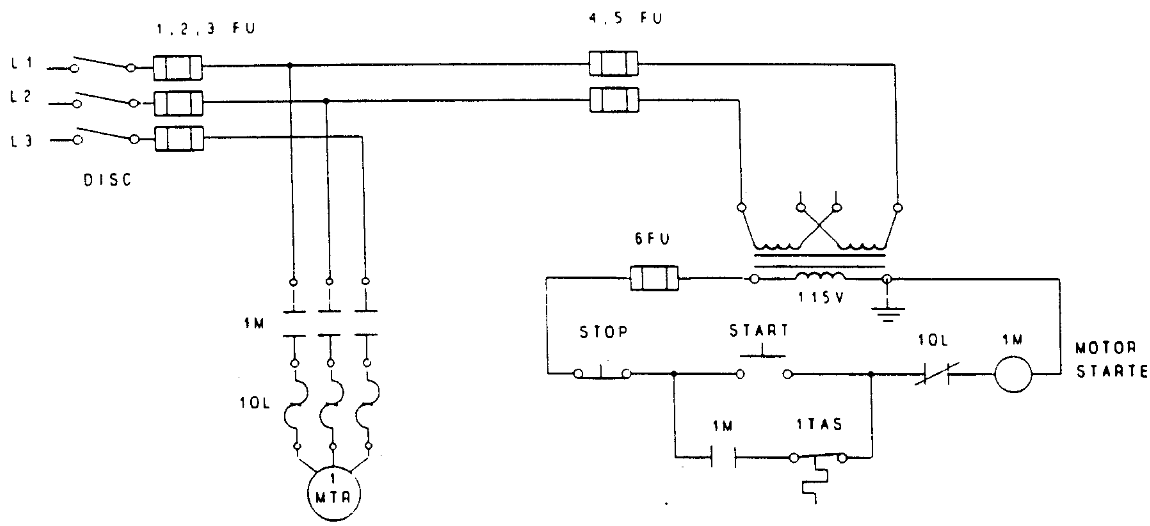

Figure 2 Typical wiring diagram Close-Coupled Booster System

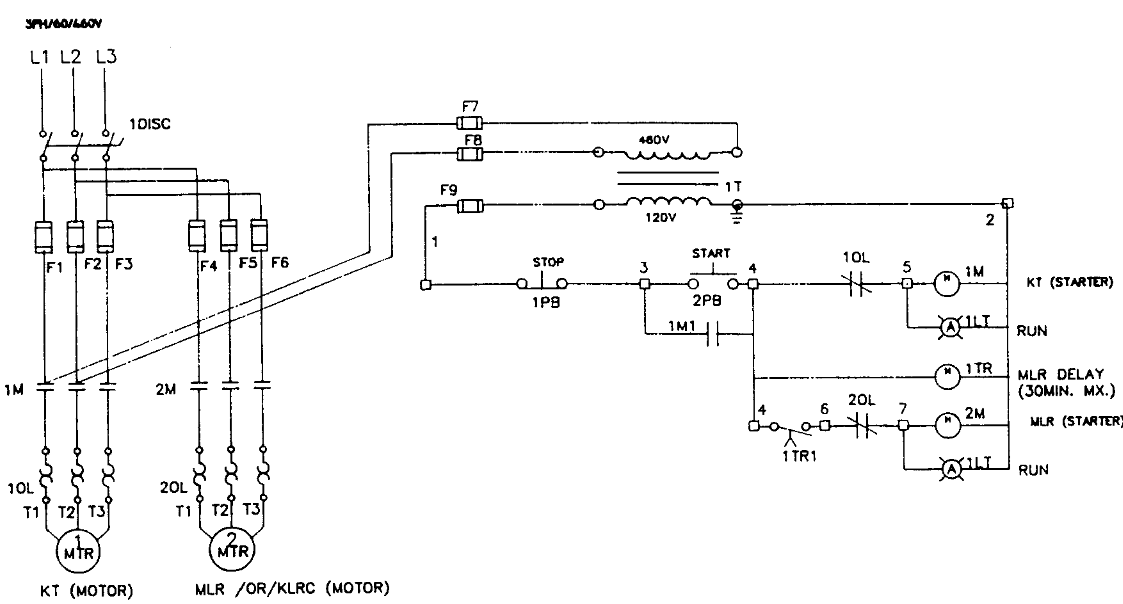

Figure 3 Typical wiring diagram, Vapor Handling System

OPERATION

General

Each booster pumping system is thoroughly tested and is ready for operation as soon as it is connected to the system, lubricated, and wired to the proper power source. The rated blank off pressure should be attained if the system is tight, including the connections to the booster pump inlet.

Prestart Checks

1. Check that all vacuum lines are completed and tight. Check that all wiring is completed and correct.

2. Check for proper oil and/or sealant levels on booster and backing pumps as directed in the component instruction bulletin.

   Note that the backing pump oil level should change when operating normally. At high pressures, or when using gas ballast, the oil level should be near the top of the sight glass. When operating at low pressures, the level should drop noticeable to indicate that the oil passages are clear and pump is receiving proper flow of oil.

3. Check that tubing is connected from vacuum manifold to pressure switch.

4. Turn booster and backing pumps over by hand to ascertain that they turn without binding. Note that when turning the backing pump over, the inlet must be open to atmosphere and that additional force is required to turn the pump at the end of the stroke when the pump discharges.

5. Check that shaft rotation is correct by momentarily starting pumps and then checking rotation against arrow cast on pumps.

6. Check V-belt tension of backing pump per component instruction bulletin. Close gas ballast valve.

7. On Booster/Liquid Ring Pump systems with mechanical seals, check the setting of seal flush throttling valves as directed in the liquid ring pump manual.

CAUTION: Do not vent booster pumping system to atmospheric pressure while the booster pump is operating. The abrupt pressure change which occurs may disrupt booster pump rotor timing.

Starting Booster/Rotary Piston & Close-Coupled Systems

1. Start the backing pump by placing power switch in ON position. Note that minimum pump starting temperature is 50°F. In extreme cold, pump may have to be heated to allow starting.

   If the booster pumping system can be isolated from the connected process equipment by means of a high vacuum valve, warm up of the backing pump before starting process cycle is recommended. About a 10 minute warm up period, with the inlet high vacuum valve closed and the booster switch off is sufficient.

2. Start cooling water flow to backing pump, once pump is up to normal operating temperature.

3. If the system is equipped with a high vacuum valve between booster pumping unit and process equipment, place this valve in open position.

4. Place booster switch in AUTO or ON position (except Close-Coupled systems). Open water supply valve which controls cooling water flow to booster pump.

5. When backing pump has reduced system pressure to cut-in pressure setting of booster's pressure switch, booster will start automatically.

6. Adjust water flow rate so that discharge water temperature of both pumps is not more that 70° - 80° F, (lukewarm).

Stopping Booster/Rotary Piston & Close-Coupled Systems

1. Close high vacuum valve, if system is equipped with one.

CAUTION: Do not stop booster by increasing pressure (venting to atmosphere) to open pressure switch contacts, since this causes an overload on the booster pump motor.

3. Vent pumping equipment to atmospheric pressure to prevent backing pump oil from being drawn into system.

   Note that if backing pump is equipped with a solenoid vent valve which opens when motor is de-energized, the valve is sized for venting only booster and backing pumps to atmospheric pressure and is not adequate for venting large volumes.

4. Stop backing pump by placing power switch in OFF position.

5. If desired, turn off cooling water flow.

Starting Booster/Liquid Ring Pump Systems

1. Start cooling water flow to heat exchanger if so equipped.

2. Open the sealant line throttling valve to liquid ring pump. Immediately start the pump, and adjust flow if necessary according to instructions in liquid ring pump manual.
   If booster pumping system can be isolated from the connected system by means of a high vacuum valve, run the liquid ring pump alone (with the booster switched off) for ten minutes before opening the system valve. Make sure that either a vacuum relief valve is installed and correctly set, or that the liquid ring pump attenuation valve is open.

3. If the system is equipped with a high vacuum valve between booster pumping unit and process equipment, place this valve in the open position. Close the liquid ring pump attenuation valve, if this has been opened.

4. Switch the booster on. Open the water supply valve, which controls water flow to the booster.

5. When backing pump has reduced system pressure to cut-in pressure setting of booster's pressure switch, booster will start automatically.

6. Adjust cooling water flow rate so that discharge water temperature of both pumps is not more than 70° to 80° F, lukewarm or as individually specified.

Stopping Booster/Liquid Ring Systems

1. Close high vacuum valve, if system is equipped with one.

2. Switch booster off. CAUTION: Do not stop booster by increasing pressure (venting to atmosphere) to open pressure switch contacts, since this causes an overload on the booster pump motor.

3. Vent pumping equipment to atmospheric pressure to prevent backing pump sealant from being drawn into system. Systems equipped with interstage check valves will help prevent sealant transport upstream.

   Note that if backing pump is equipped with a solenoid vent valve which opens when motor is de-energized, the valve is sized for venting only booster and backing pumps to atmospheric pressure and is not adequate for venting large volumes. A separate valve large enough to vent the entire system should be used if the booster unit cannot be isolated from the process equipment.

4. Close sealant throttling valve to liquid ring pump.

5. Immediately stop liquid ring pump by placing power switch in off position.

6. If desired, turn off cooling water flow.

TROUBLESHOOTING

General

When troubleshooting a booster vacuum pumping system and connected process equipment, it is best to isolate and test each portion of the system separately and systematically. Use the procedures outlined in this section to aid in localizing the trouble. Refer to page 8 for a listing of common vacuum system difficulties.

Vacuum Gauges

Two general types of vacuum gauges are used for testing vacuum equipment; total pressure reading types such as the Thermistor or Thermocouple gauges and the partial pressure McLeod gauge. The McLeod gauge indicates the partial pressure of permanent gases. It is not greatly affected by vapor contamination unless the vapor pressure is quite high. It is most useful in confirming the performance of pumps and for determining the absence or presence of real leaks. The thermistor or thermocouple gauge is preferable for leak checking and indicating the degree of contamination.

Isolating Troubles

First, isolate the trouble to either the process equipment or the booster pumping system by performing the following test:

a. Close the high vacuum valve or isolate the booster pumping system from the process equipment by means of a blank-off plate. Start the booster pumping system.

b. Read the lowest pressure attainable at the booster pump inlet with a McLeod gauge. This should be about one micron Hg. absolute (or 10% lower than the pressure required for the process). This depends upon the type of gauge used. (Portable units often do not indicate pressures below 10 microns with any accuracy.) If the blank-off pressure is below one micron Hg., absolute, the booster pumping system is functioning properly. The process equipment is at fault. Proceed as directed in Checking Process Equipment.

If the blank-off pressure is above one micron, (or above a pressure 10% lower than that required for the process) the booster pumping unit is at fault. Proceed as directed in Checking Booster Pumping System.

Checking Process Equipment

If the blank-off test shows that the booster pumping system is functioning properly but that the process equipment is faulty, the trouble can be isolated further by applying the following procedures:

a. Pump down each segment of the process equipment individually, starting at the segment closest to the booster pumping system.

b. Check the lowest pressure attainable when each segment is added. If the pressure is close to that obtained previously, add the next segment. If the pressure is not, leak test the last segment.

When leak checking the process chamber, start at the air and gas inlet valves, doors, sight ports, electrical and mechanical feedthroughs, gauge tube fittings, and any other penetrations into the vacuum portion of the process equipment. Check especially gasketed and O-ring connections. After a suspected leak has been found, cover it with plastic sealing compound, such as Apiezon Q, and check the equipment performance before sealing the leak permanently. Thus, all permanent repairs can be made at the same time.

Leak Checking Techniques

If a leak detector is not available, use the following methods to locate leaks:

a. Cover suspected leaks with a low vapor pressure sealing compound (such as Apiezon Q, James Biddle company or Shell Company; Ductseal, Johns Mansville Company. Do this while pumping on the equipment and monitoring the pressure. A sudden decrease in pressure indicates that a leak has been covered. Repair leaks permanently as directed in Repairing Leaks.

b. If the leak is large, causing pressures in the Torr range, pressurize the process equipment with one psig of clean compressed air and use a soap solution to check suspected leak areas. De-energize and isolate the booster pumping unit during the leak checking. Repair leaks as directed in Repairing Leaks.

c. If the leak is small causing pressures in the sub-Torr range, use a fast acting thermocouple or thermistor gauge in conjunction with a probing medium such as acetone, alcohol or helium. Position the vacuum gauge head downstream from the suspected leak area, between the leak and pumping equipment, and when the pressure has been reduced so that the gauge may be used, applying probing medium to suspected leak areas. (A squirt gun or brush may be used for applying liquid probing media). If the probing fluid is directed at the leak or an area close to it, a sudden change in pressure will occur. Cover suspected leak with plastic sealing compound and continue leak checking until desired pressure is obtained. Repair leaks per Repairing Leaks.

d. If leak checking fails, disassemble and remake all demountable joints and connections using new gaskets or vacuum sealing compound such as Kinseal. Temporary gaskets may be fabricated from plastic sealing compound, but these should not be made too thickly since the material may be squeezed into the equipment.

Checking Booster Pumping System

If the results of the blank off pressure test indicate that the booster pumping system is at fault, the trouble can be further isolated to the booster or the backing pump or a section of manifolding before leak checking the equipment.

1. With both the booster and mechanical pumps operating, check the pressure with a McLeod gauge at the inlet to the booster pump (P1) and in the interstage manifolding (P2). Divide P2 by P1 (P2/P1).

2. Divide the booster pump displacement by the backing pump displacement to get a ratio of booster pump cfm/backing pump cfm for example, the ratio of a KMBD-1600 backed by a KT-300 is 1600/300 or 5/1 approximately.

If P2/P1 is 30/1 or more, or greatly different than the pumping speeds ratio, the trouble is on the discharge side of the booster. Check for proper blank off pressure on the backing pump as directed in Checking Backing Pump. If this is acceptable, check the interstage manifolding for leaks, using the methods outlined in Leak Checking Techniques. Also check the booster discharge connections for leaks per Booster and Backing Pump Leaks.

If P2/P1 is equal to the pumping speeds ratio, the trouble is on the inlet side of the booster. Check the booster pump inlet flange gaskets and inlet manifolding for leaks and for proper sealing of the booster inlet by either a high vacuum valve or blank off plate. Inspect the booster pump bypass valve for proper sealing. Clean if necessary. If the trouble still persists, proceed as directed in Booster and Backing Pump Leaks.

Checking Backing Pump

To check the condition of the backing pump, measure the pump's blank off pressure as directed below using a McLeod gauge. If possible, also read the blank off pressure with a thermistor or thermocouple gauge to check the condition of the pump oil. To read the blank off pressure:

a. Close off the pump inlet by means of a high vacuum valve or blank off plate.

b. Connect a vacuum gauge to the pump side of valve or blank off plate. Position it so that it will not become flooded by pump oil, preferably in the blank off plate facing into the pump suction.

c. Operate the pump for a short period, about 15 minutes, until the lowest pressure is reached. Note the reading obtained.

The reading obtained should be between the pump's specification blank off pressure (low end) and the pressure needed for the process (high end).

For single stage duplex (KD and KDH) and triplex (KT) pumps, average blank off readings are 5 to 50 microns, McLeod, and 10 to 100 microns, thermocouple. The specification pressure is 10 Microns, McLeod.

If the McLeod gauge reading is low and the thermocouple gauge reading is high, the pump oil is contaminated. Change the oil as directed in the pump bulletin and recheck the pump blank off pressure. (In some instances it is necessary to change the oil several times to flush all traces of contamination from the pump). Note that if a thermocouple gauge is not available, and the pump oil has been in service for an appreciable period, it is best to change the pump oil several times to eliminate pump oil contamination as a possible cause of poor pump performance. After changing the oil, recheck the blank off pressure.

If both the McLeod and thermocouple gauge readings are high, indicating that the oil is not contaminated, the pump is leaking. Proceed as directed in Booster and Backing Pump Leaks.

Booster and Backing Pump Leaks

If either the booster or mechanical pump are suspected of leaking (after eliminating backing pump oil contamination as the cause of poor performance), use plastic sealing compound to seal over suspected areas, and check pump blank off performance before making permanent repairs with Kinseal. If gasketed connections are suspected, remake the connection. (Plastic sealing compound may be used to make temporary gaskets, these should not be made too thickly since the material may be squeezed into the pump).

On the backing pump, check carefully around the head to cylinder joints, securing bolts, oil lines, plugs, bearing set screws, and generally any penetration into the vacuum pumping portion of the pump. Check the inlet connection for proper sealing. If these checks fail, disassemble the pump and examine the discharge valves. Also check the shaft seal for mechanical defects, such as cracked carbon washer or hardened rubber components. Refer to the pump instruction bulletin for details on disassembly and overhaul.

TROUBLESHOOTING

Symptom	Possible cause	Remedy
Required system operating pressure not attainable	Process equipment faulty or Booster system malfunctioning	See Isolating trouble
	Process equipment contaminated	1. Clean equipment with Acetone, Alcohol or Ether. 2. Pump down with Mechanical pump overnight for cleaning low vapor contamination.
	Process equipment leaks	See Checking Process Equipment
	Booster pump system malfunctioning	See Checking Backing Pump
	Backing pump malfunctioning	See ……Checking Backing Pump
	Booster or backing pump leaking	See ……Booster and Backing Pump Leaks
Booster pump starts after short time regardless of pressure	Pressure switch malfunctioning (loose or broken wire, frozen relay contacts.)	

MAINTENANCE

General

Normal maintenance for this system consists of cleaning and lubrication. Recommended procedures for this preventative maintenance as well as corrective maintenance are given in the following paragraphs. Although maintenance procedures for the backing pump and any accessory equipment are given in the component instruction bulletins, some general maintenance steps for the backing pump are outlined in the following paragraphs for ready reference.

Because of different operating conditions, and applications, a rigid maintenance schedule for this equipment cannot be stipulated. When possible, required maintenance is given on an operating hour basis. Where this is not possible, experience or poor performance will dictate the need for maintenance. A careful record of booster pumping system blank off readings and process chamber pumpdown times should be kept to aid in maintaining and troubleshooting this system.

Booster Periodic Maintenance

Check the oil level(s) of the booster pump daily during the first week of operation and at least weekly thereafter. Also check the oil pressure per the component instruction bulletin, if the pump is so equipped. Frequency of oil changes varies according to the specific operating conditions, but the average interval for changing the oil is usually every 2000 hours of operation or 6 months. Refer to component instruction bulletin for details.
When operating the booster pumping system, listen for excessive or unusual pump or equipment noises which may indicate a malfunction. If any develop, stop the equipment and investigate. The trouble may also be that the rotors are out of time. Refer to the component instruction manual for information on repair of these difficulties.

Backing Pump Periodic Maintenance

Check the oil level daily for the first week of operation, and weekly thereafter. The oil level should be about midway on the sight gauge. However, this changes when the pump is operating normally. At high pressures, or with a gas ballast flow, the oil level should be noticeably higher than it is when operating at low pressures, near blank off. If there are no changes in the oil level, the pump may not be receiving a proper flow of oil. Check for obstructed oil passages or other difficulties.
Check the condition of the oil periodically by draining a small quantity of oil into a clean container and visually inspecting it for solid or liquid contaminants. Change the oil when contaminated.

There is no fixed interval for changing pump oil, since applications vary widely. This can be determined only by experience and/or by deterioration of pump performance. As a minimum, change pump oil after every three month operating period.

Blank Off Test

To check the performance of the booster pumping system by means of a blank off test, proceed as follows:

a. Close high vacuum valve or isolate booster pumping unit from process equipment by means of a blank off plate sealed to booster pump inlet. Connect a McLeod vacuum gauge to booster inlet. On threaded connections seal with Kinseal or by winding a layer of PTFE tape on the threads before making connection. Use caution so that Kinseal or PTFE tape will not block connection opening.

b. Start booster pumping system per operation section and read lowest pressure attainable with a McLeod gauge at the booster inlet. This should be about 1 micron Hg. absolute (or 10% lower than the pressure required for the particular process); this depends on the type of gauge used. (Portable gauges often do not indicate pressures below 10 microns with any accuracy). If this pressure is not attainable refer to Troubleshooting section.

Cleaning Contaminated Process Equipment

Process equipment contamination which may result in poor chamber pressures is often caused by condensable vapors such as water vapor and can readily be removed. An extremely long pumping cycle indicates severe contamination; a moderately longer than normal cycle indicates slight contamination. Operating experience is usually the best guide to determine the proper cleaning method to use.

If the contamination is heavy, operate the pumping equipment on process equipment overnight. Open the vacuum pump gas ballast valve to prevent pump oil contamination.

If contamination is slight, operate for a few hours with gas ballast. Application of gas ballast during processing will eliminate or reduce pump oil contamination.

If the process equipment is heavily contaminated, wipe down the chamber walls with cloths soaked in ethyl alcohol, acetone, or other solvent. When starting the pumping equipment, open the gas ballast valve to avoid backing pump oil contamination.

Note that the initial pumpdown cycle will be longer than usual due to the evaporation of the cleaning fluid. Once the working pressure is reached, subsequent pumpdown cycles should be normal.

Repairing Leaks

Leaks may be temporarily repaired by covering the leak with a plastic sealing compound such as Apezion Q when under vacuum. More permanent repairs can be made by using a vacuum sealer such as Kinseal over the leak areas when under vacuum.

Permanent repairs on manifolding or process chambers or equipment require either welding, silver soldering, or use of any epoxy resin. If the leak is in a demountable joint, remake the joint with new seals.

Leaking at gasketed and O-ring sealed flanges may be due to a number of difficulties. A few of these and their remedies are listed below.

Bypass Valve

When supplied, the optional bypass valve functions to automatically bypass the booster when the backing pump is making the initial pressure reduction. If the valve fails to open or close, fails to seal properly, or develops a leak, poor booster pumping system performance will result. If leaks are suspected, use Kinseal to cover the suspected areas. If improper valve closing is suspected, disassemble the valve and clean the internal mechanisms.

Shaft Seals

Shaft seals are used to form a vacuum tight seal between the rotating shafts and the booster housing. if the shaft seals are faulty, they may cause oil to leak. If the shaft seals are suspected, refer to the pump instruction manual for directions on pump overhaul. Check the shaft seals for mechanical defects such as a cracked carbon washer, hardened rubber components, or foreign matter on the sealing surfaces. Some boosters have slinger type seals on the rotor shafts which require minimal maintenance.

VAPOR HANDLING SYSTEMS

Description

Kinney vapor handling systems are designed to maintain the sealing oil of the rotary piston vacuum pump free from contamination. Typical contaminants are water vapor and oil insoluble or soluble solvents. The method is particularly advantageous when operating at low inlet pressures or when handling large mass flow.

Kinney vapor handling systems are also useful where process stream recovery is essential and in corrosive applications where the backing pump is made of compatible materials of construction or can be considered expendable. Since condensation is prevented in the oil sealed pump, it can handle most chemicals not destructive to oil. It is even possible to handle oil solvents, as the principle of operation is that of vacuum distillation.

Most systems comprise a KT rotary piston pump and a KLRC liquid ring pump, but different rotary piston pumps and backing pumps may be used. Where different pumps are used read "rotary piston pump" for KT pump and "backing pump" for KLRC in the following.

The KT pump is the source of heat and the KLRC pump provides the low pressure. Gas and non-condensable vapors are discharged by the KT pump into the oil separator and pumped through the KLRC pump to atmosphere, while condensable vapors are liquified in the pump sealant. The oil separator of the KT pump is operated at a pressure and temperature which precludes vapor condensation in the oil separator chamber, thus condensable vapors exit the pump as a superheated vapor or gas.

The pressure within the oil separator of the KT pump must be high enough to prevent interruption of the oil flow. The ball of the flow gage should float against the crown of the glass dome, otherwise the pressure is too low and air should immediately be bled into the oil separator, through the nearest vacuum relief valve, until the ball floats. Conversely, a dangerous condition could be created if the pressure is allowed to become too high in the oil separator, but this is prevented by the pressure relief valve. To maintain the pressure low for vacuum distillation and high enough to maintain oil flow through the sight gauge, two vacuum relief valves are installed in the manifolding between the two pumps. See the Installation section for adjustment of the vacuum relief valves.

Prestart Checks

Refer to the respective pump manuals for installation instructions relative to each pump such as oil filling, piping connections, etc.

1. When operating the unit in an enclosed area, it may be necessary, for health reasons. to have the area well ventilated. If ventilation is not adequate, the pump discharge should be filtered of piped to open air.

2. The belt guard must be properly secured in place at all times while the unit is running.

3. Do not block or restrict the flow of gas from the pump discharge. Back pressure within the pump could cause severe damage.

   Disconnect the pump from source electrical power prior to making repairs or adjustment to electrical components.

5. The vibration characteristics of the vapor handling vacuum system are so low that it can be located on any floor which will support its weight.

Starting Vapor Handling Systems

1. Close the isolation valve to the system or process. This is to prevent process vapor from condensing in the vacuum pump when it is cold.

2. Start the KT pump and bring the oil up to normal operating temperature.

3. Start the KLRC pump, and make sure that cooling water is circulating.

4. Make sure the KLRC pump does not cavitate, adjust the vacuum relief valve if necessary.

5. Open the isolation valve and adjust the distillation pressure as described below.

Adjusting Distillation Pressure

There are two methods of adjusting the distillation pressure in the separator of the oil sealed pump.

Assuming that the KT pump will operate at 150 °F (controlled coolant flow rate) while handling water vapor, the vacuum relief valve on the KT pump discharge piping could be set as high as 192 torr (22 inches of Mercury) which is the saturation vapor pressure of water but since there will be some cooler surfaces present, a 100 torr (26 inches of Mercury) setting (125 °F saturated vapor pressure) would be more practical.

The vacuum relief valve at the KLRC pump can now be adjusted to a slightly lower setting, say 75 torr (27 inches of Mercury). It will only open when the isolation valve is closed in order to prevent cavitation.

Once on stream, the non-condensible load may be high enough to make the adjustment of the vacuum relief valve superfluous. In that case increase the spring tension sufficiently on the KLRC vacuum relief valve for shut-off or adjust to the lowest level which will prevent cavitation in case system load is variable. In small pumps cavitation can be prevented at a pressure only a few torr higher than the equilibrium vapor pressure of the liquid ring sealant.

A similar method can be applied to other non-soluble vapors. In case of soluble vapors, the distillation pressure should be kept significantly lower than theoretical which often requires fairly high temperature in the oil sealed pump. In the absence of oxygen, oil temperature of 200 °F is not unreasonable.

If vacuum regulation using air is not desirable, use an inert gas blanket recirculating from the discharge of the of the KLRC pump. In such a situation, an after condenser may be desirable as well as a full sealant recovery system. In complicated applications, it is advisable to consult Kinney for assistance. The second method of adjusting the distillation pressure in the separator of the oil sealed pump is as follows: bring the primary pump to operation temperature (it heats up faster if isolated from the backing pump and operated with high gas ballast) and connect the vapor recovery system to the process vessel. Adjust the vacuum relief valve at the separator of the oil sealed pump to the best vacuum (lowest pressure) at which oil flow through the pump is still substantial. The oil flow rate can be observed at the oil flow indicator of the KT pump. On no account can the float-ball drop into its seat. If this happens, increase the separator pressure until oil flow is re-established. Unstable operation may take place when oil stripping is not efficient (oil temperature too low or separator pressure too high).

If the oil contamination is severe, it can best be eliminated or reduced by admitting air through the gas ballast valve rather than through the vacuum relief valve. The vacuum relief valve adjacent to the KLRC pump must be adjusted to prevent cavitation of the pump at the low end of the pressure range. Normally this valve should be set to open when pressure is reduced to an approximate range for 20 to 70 torr (29.2 to 27.2 inches of Mercury). With the liquid ring pump isolation valve closed and the sealant at equilibrium temperature, the vacuum relief valve should be adjusted in such a way as to eliminate the cavitation noise.

No adjustments are necessary to the pressure relief valve which opens when the pressure within the oil separator exceeds atmosphere. Discharging to atmosphere it has a pressure drop of only a few inches of water column. It shuts off tight under vacuum due to the elastomer (Buna-N) disc seal. Metal to metal seat valves can be substituted in case of extreme incompatibility.

Operating Oil Temperature

The operating oil temperature must be high enough to prevent condensing effects as the vapor enters the oil separator. The desired oil temperature can be attained by regulating the coolant water to the KT pump. when handling soluble gas (vapor), elevated operating temperature is usually preferred.

There are practical limits to KT pump maximum operating temperatures due to oxidation of the pump oil. When standard hydrocarbon vacuum pump oil is used, 180 °F is considered the maximum temperature in the presence of oxygen. When higher temperature is required, other pump fluids can be used, however cost and compatibility with the elastomers and process stream must be evaluated in advance.

Stopping Vapor Handling Systems

1. Close the system isolation valve.
2. Vent the suction to atmosphere, to move any oil in the rotary piston pump into the separator housing.
3. Stop the KLRC pump
4. Stop the KT pump
5. Ensure that cooling water is shut off.

REPLACEMENT PARTS

Parts lists for the booster and backing pumps may be found in the component instruction books, recommended spare parts are also shown. We recommend that Kinseal vacuum sealer, at least one change of oil, and a backing pump repair kit be kept on hand with the pump.

When ordering parts, please specify the serial number and model number of the pump and the item number and description of the parts required. The model and serial numbers are shown on the nameplate of each pump and the system frame.