KINNEY®

Kinney®
Liquid Ring Vacuum Pumping Systems

Manual 4816 Rev B p/n 004816 0000

WARNING: Do Not Operate Before Reading Manual

Liquid Ring Vacuum Pumping Systems
OPERATOR'S MANUAL

Models

DRSP DRDP OFRP ACRP

Operator's Manual: Liquid Ring Vacuum Pumping Systems

800.825.6937 | www.kinneyvacuum.com

Original Instructions

⚠WARNING

DO NOT OPERATE WITHOUT BELT GUARD

809762-A000

⚠CAUTION

DO NOT VALVE OR RESTRICT PUMP DISCHARGE OPENING.

USE OIL MIST ELIMINATOR WHEN OPERATING PUMP. ENSURE ADEQUATE VENTILATION WHEN DISCHARGING INDOORS.

REFER TO MANUAL SAFETY INSTRUCTIONS.

NOTICE

The above safety instruction tags were permanently affixed to your pump prior to shipment. Do not remove, paint over or obscure in any manner.

Failure to heed these warnings could result in serious bodily injury to the personnel operating and maintaining this equipment.

SAFETY PRECAUTIONS FOR LIQUID RING PUMPS

Please read the following safety information on this page before operating your vacuum pump.

- Do not operate the pump without the coupling and belt guard properly attached. Disconnect the pump motor from the electrical supply at the main disconnect before removing the belt guard. Replace the belt guard before reconnecting the power supply to the pump motor. Operating the pump without the belt guard properly installed exposes personnel in the vicinity of the pump to risk from rotating drive components.

⚠ **CAUTION: Do not operate the pump with oxygen-enriched gas in the suction line,** unless the pump has been properly cleaned, inspected and certified to be free of hydrocarbon presence and prepared with an inert fluid suitable for the application.

Oxygen-enriched gas is defined as gas of which the constituents include by volume (mol. %) an amount of oxygen greater than that of standard atmospheric air (typically 20-21% by volume).

If the oxygen content in the gas stream exceeds the proportions found in standard atmospheric air, then it is considered an oxygen-enriched gas and standard mineral oil, synthetic hydrocarbon oil or other non-inert fluids should not be used.

⚠ **WARNING: Pumping oxygen-enriched gases with mineral oil, synthetic hydrocarbon oil or other non-inert fluids can cause fire or explosion in the pump, resulting in damage or serious bodily injury or death.**

- Take precautions to avoid prolonged or excessive exposure to oil mist or process materials emanating from the discharge of the pump.
- Do not allow the pump to discharge into a closed, or inadequately ventilated room. Always use a discharge oil mist eliminator unless the pump discharge is discharged to outside atmosphere. Laws and ordinances may pertain to your local area regarding discharge of oil mist or vapor to atmosphere. Check local laws and ordinances prior to operation of the pump with discharge to outside atmosphere. Venting of the discharge of an oil mist eliminator to outside atmosphere is highly recommended.
- Do not restrict the pump discharge in any way, or place valves in the discharge line. The vacuum pump is a compressor and will generate high pressures without stalling the motor when operated at low suction pressures. **Excessive pressure could cause pump damage or serious bodily injury.**
- Disconnect the pump motor from the electrical supply at the main disconnect before disassembling or servicing the pump. Make sure pump is completely reassembled, the belt guard is properly installed, and that all fill and drain valves are installed and closed before reconnecting the power supply. **Accidental starting or operation of the pump while maintenance is in progress could cause pump damage or serious bodily injury.**
- Lift pump only by the lifting lugs supplied with the pump. DO NOT lift equipment attached to pump by the pump lifting lugs.
- Do not touch hot surfaces on the pump. In normal operation at low pressures, surface temperatures will not normally exceed 180° F (82° C). Prolonged operation at 200 Torr (267 mbar a) may cause surface temperatures as high as 220° F (104° C)

TABLE OF CONTENTS

Additional manuals may ship with your KINNEY Liquid Ring Vacuum Pumping System that provide detailed operation and maintenance instructions for the KINNEY KLRC™ Liquid Ring Vacuum Pump, electric motor, heat exchanger, instrumentation and control devices or other accessories shipped with your system. **We urge you to read and understand all operation and maintenance instructions prior to starting the equipment.**

If the KINNEY KLRC™ Liquid Ring Vacuum Pump manual is not included with the system, you can get a copy by postal mail by contacting us at:

Kinney
4840 West Kearney Street
Springfield, MO 65803-8702 USA
Tel: (417) 865-8715
Toll Free: (800) 825-6937
Fax: (417) 865-2950

You can also download KINNEY manuals online.

INTRODUCTION

CONGRATULATIONS on your purchase of a new KINNEY® Liquid Ring Vacuum Pumping System. Please examine the system for shipping damage, and if any damage is found, report it immediately to the carrier. If the pump is to be installed at a later date make sure it is stored in a clean, dry location and rotated regularly. Make sure covers are kept on all openings. If the system is stored outdoors be sure to protect it from weather and corrosion.

KINNEY vacuum pumps and systems are built to exacting standards and if properly installed and maintained will provide many years of reliable service. We urge you to take time to read and follow every step of these instructions when installing and maintaining your pump. We have tried to make these instructions as straightforward as possible. We realize getting any new piece of equipment up and running in as little time as possible is imperative to production.

Additional manuals may ship with your KINNEY Liquid Ring Vacuum Pumping System that provide detailed operation and maintenance instructions for the KINNEY KLRC™ Liquid Ring Vacuum Pump, electric motor, heat exchanger, instrumentation and control devices or other accessories shipped with your system. We urge you to read and understand all operation and maintenance instructions prior to starting the equipment.

WARNING: **Serious injury can result from operating or repairing this machine without first reading the service manual and taking adequate safety precautions.**

IMPORTANT: Record the model and serial numbers in the OPERATING DATA form below. You will save time and expense by including this reference identification on any replacement part orders, or if you require service or application assistance.

OPERATING DATA

It is to the user's advantage to have the requested data filled in below and available in the event a problem should develop in the vacuum pump or the system. This information is also helpful when ordering spare parts.

Model No. _____

Serial No. _____
(Recorded from nameplate on unit)

Startup Date _____

Pump RPM _____

Pump Sheave Diameter _____

Motor Sheave Diameter _____

Motor RPM _____ HP _____

Direct Drive Coupling Size _____

V-Belt Size _____ Length _____

Type of Lubrication: _____

Type of Sealant _____

Operating Vacuum _____

Any other special accessories supplied or in use:

_____

NOTES: _____

PRODUCT FEATURES

DRSP/DRDP/OFRP/ACRP liquid ring vacuum pumping systems incorporate features necessary for reliable, low maintenance operation. Each DRSP/DRDP/OFRP/ACRP system includes a separator tank with level gauge and/or control, vacuum relief valve, sealant heat exchanger, temperature, pressure and vacuum instrumentation, sealant isolation valves, and sealant flow control valve factory installed and pre-piped, so assembly at the installation site is minimized.

Full Sealant Recovery

DRSP/DRDP/OFRP/ACRP liquid ring vacuum systems incorporate full sealant recovery to minimize the need for makeup water or oil in the sealing system. This reduces utility demand and cost of ownership.

Ease of Installation & Maintenance

As DRSP/DRDP/OFRP/ACRP liquid ring vacuum systems are completely assembled at the factory, installation time and effort is minimized. DRSP/DRDP/OFRP/ACRP liquid ring vacuum systems are engineered to provide easy access to all areas of the liquid ring vacuum pump, motor and controls for maintenance and adjustment.

Vacuum Relief Valve

The vacuum relief valve (or VRV) is a high flow, reliable spring biased piston type. Its vacuum setting is adjustable.

CAUTION: As with all standard vacuum relief valves, the set range of the valve is very wide and improper setting of the valve can result in poor system performance or possible cavitation of the liquid ring vacuum pump. The valve is factory set to the specifications provided at time of order. Field adjustment of the vacuum relief valve should be limited to maintaining the vacuum level for which the system was designed.

If operation conditions are to change or the relief valve needs to be set at a point different from that specified in the initial order, always consult with Tuthill Vacuum & Blower Systems prior to making such adjustments.

Separator Tank

DRSP/DRDP/OFRP/ACRP liquid ring vacuum systems include a separator tank to remove liquid entrained in the discharge process gas stream, and provide make-up liquid volume for the liquid ring vacuum pump. The separator tank includes a level gauge and level control (optional) to protect against overfilling the liquid ring vacuum pump. The separator tank is equipped with a temperature gauge to monitor sealant liquid temperature.

Heat Exchanger

DRSP/DRDP/OFRP/ACRP liquid ring vacuum systems are supplied with a heat exchanger to remove waste heat to the heat transfer medium. The type of heat exchanger supplied can be either liquid-to-liquid or liquid to-air, and of varying styles and materials depending on requirements dictated by the application.

Instrumentation

Four basic gauges are provided with DRSP/DRDP/OFRP/ACRP liquid ring vacuum systems:

- Inlet Vacuum Gauge – Monitors inlet vacuum level
- Heat Exchanger Entry Temperature Gauge – Monitors temperature of sealant liquid entering the heat exchanger
- Heat Exchanger Exit Temperature Gauge – Monitors temperature of sealant liquid exiting the heat exchanger
- Inlet Sealant Line Compound Gauge – Monitors pressure of sealant line entering the vacuum pump

Additional gauges, switches or other instruments may also be included, depending on customer requirements

Valves

Three basic valves are provided with DRSP/DRDP/OFRP/ACRP liquid ring vacuum systems:

- Sealant Makeup Valve – For connecting to make-up liquid source
- System Isolation Valve – For isolating pump from the process system
- Manual Flow Control Valve – Regulates flow of sealant liquid into the pump

CAUTION: The Manual Flow Control Valve should never be closed while the pump is running. Closing the valve while the pump is running will starve the pump for sealant, resulting in unwarrantable damage to the pump.

INSTALLATION

Unpacking & Handling

Your DRSP/DRDP/OFRP/ACRP system was shipped from Kinney in perfect and undamaged condition. Occasionally, damage will occur during shipping. Be sure to carefully inspect your system for shipping damage, and if any damage is found, report it immediately to the carrier, who will assist you with filing a freight damage claim.

To move your system to its installation site we recommend that you leave it on its shipping skid if possible. The forks should extend the width of your system and padding should be placed between your system and the fork truck boom.

If it is necessary to lift your system with a crane, we recommend the use of a spreader bar and chains. The spreader bar should be greater than the width of your system and padding should be placed where chains may come in contact with the system to prevent chain damage.

Storage

In some cases it may be necessary to store your system for extended periods of several months before placing the unit in operation. When this is required, do the following:

1. Cover and seal all machine openings to prevent the entrance of water and dirt.
2. Cover all openings of motors to prevent the entrance of insects, rodents & vermin.
3. We do not recommend outside storage, but if outside storage is the only alternative, drain all traps and attendant piping if the storage conditions can reach below 36° F (2° C)
4. Cover with a waterproof tarpaulin that can be easily removed for in storage maintenance.
5. While in storage every two to three months hand rotate the blower and motor to prevent flat spots on the bearings that will lead to premature failure.

At the end of the storage period, follow the unpacking and startup procedures. If stored for more eighteen (18) months you should contact Kinney before placing your DRSP/DRDP/OFRP/ACRP system into service.

Location

The room or outdoor area selected for installation should be of adequate size to provide full access to your system for routine maintenance. It should have ventilation to keep the room as cool as possible. Operating at elevated temperatures can result in decreased system performance, and potential nuisance overload or temperature shutdowns. Lighting in the area should be sufficient to allow for safe and functional access to the equipment.

Foundation

Your DRSP/DRDP/OFRP system does not require a special foundation. However, it is necessary for the floor to be solid and level, and that the frame be adequately supported. We do recommend that the system be bolted to the floor.

Where a solid foundation is not feasible, care must be taken to ensure that your system is firmly anchored to adequate structural members.

Electrical

All electrical wiring should be performed by a qualified and licensed electrician in compliance with NEC standards and local codes as applicable. Be sure to investigate the local requirements before installing your DRSP/DRDP/OFRP/ACRP system. The power supply should be adequate and free of parasitic loads that will cause an undervoltage condition during operation. Otherwise, nuisance electrical shutdowns will result.

LUBRICATION

Do not start up the system until you are certain that the pump(s) and motor(s) have been properly and fully lubricated. (See Kinney KLRC™ Liquid Ring Vacuum Pump manual and the motor manual for details.)

PIPING

The intake and discharge connections on your DRSP/DRDP/OFRP/ACRP system are large enough to handle maximum volume with minimum friction loss. Be certain that all external intake piping is internally clean before connecting to your system. We recommend placing a 16-mesh wire screen backed with hardware cloth at the remote inlet connection of your system for the first 50 hours of use, or until the external piping is clean and free of debris and weld slag. Make provisions to clean the screen after a few hours of operation and completely discard it once the system is clean, as it will eventually deteriorate and small pieces going into the pump can cause serious damage.

STARTUP CHECKLIST

We recommend that these startup procedures are followed in sequence and checked (v) off in the boxes provided in any of the following cases:

- During initial installation
- After any shutdown period
- After maintenance work has been performed
- After system has been moved to a new location

				Dates Checked

☐ 1. Check that the proper electrical power is connected to the control panel. Unless otherwise specified, the standard motor control center is wired and equipped with overload protection and fusible disconnect switch for 3/60/460v.

WARNING: **Make certain power is off and locked out before touching any rotating element of the pump, motor or drive components.**

☐ 2. Check that the cooling water supply to the liquid ring pump heat exchanger is adequate in terms of flow rate, temperature, and supply pressure. Refer to the specification sheet accompanying the system for proper flow rate, temperature, and supply pressure.

☐ 3. Check that the proper size inlet and outlet piping is connected to the vacuum system. A flexible connector is provided on the suction line. A discharge flexible connector should also be used when piping to it.

☐ 4. Fill the separator tank with the appropriate sealant (water for DRSP/DRDP/ACRP or LR oil for OFRP systems) for which the system has been designed until the level in the sight glass coincides with the shaft level in the pump. Be sure that the valves between the separator tank and pump sealant inlet are open to allow free flow of sealant to the heat exchanger and liquid ring pump during filling. At no time should the liquid level be allowed to fall below the outlet connection on the separator tank.

☐ 5. After filling the liquid ring pump with the appropriate sealant to the proper level, check positioning of the hand valves.

a) Check that the small gland cooling valves leading to the mechanical seals are opened fully. They may be throttled down to half way open later if slightly higher vacuum is desired.

b) Check that the sealant inlet valve is opened fully.

c) Check that the inlet gas isolation valve is partially opened.

d) If the pump is equipped with an attenuation valve mounted on the interstage casing, it should be closed before start up and shut down.

e) On the OFRP systems, check that the needle valve on the return line of the oil mist eliminator is fully opened. It can be adjusted later to half open as necessary to achieve a deeper vacuum and still collect oil.

☐ 6) On initial start-up or if the pump has been sitting inactive for a long period of time, rotate the pump by hand to be sure it is mechanically free.

☐ 7) Jog each motor to check the proper direction of rotation. Facing the drive shaft of each pump:

a) All KLRC liquid ring pumps turn clockwise, except for the KLRC-40 and KLRC-75 which both turn counterclockwise.

b) If the system is equipped with an optional circulating pump, check for an arrow cast directly on the pump.

☐ 8) Check that the ambient temperature is within the design capabilities of the equipment. Standard design ambient temperatures are between 50 to 104 °F (10-40° C) Modifications may be required for start up at ambient temperatures outside of this range.

INITIAL STARTUP PROCEDURE

1. Vacuum Switch Settings:

   a. On simplex systems used in conjunction with a vacuum receiver tank of proper size set one pointer to maximum vacuum required (do not exceed 28" Hg vacuum [-95 kPa g] for water sealant, or 29" Hg vacuum [-98 kPa g] for oil sealant). Then, set the other pointer to the minimum vacuum required. This will cause the pump to evacuate the receiver tank until the maximum vacuum set point is reached and then shut down. When the vacuum in the receiver tank drops to the minimum vacuum setting, the pump will then start and increase the vacuum in the receiver to the higher point.

NOTE: The pump motor should not be started more than five (5) times per hour to avoid overheating. If the vacuum usage is great enough on the receiver to cause the pump to restart more frequently, then either a larger receiver volume should be selected, a duplex system should be used, or a minimum run timer should be installed in the motor control center to limit the number of starts to five (5) per hour. For systems equipped with a control panel, (standard on DRSP/DRDP, optional on ACRP/OFRP) minimum run timers are installed to prevent more than five (5) starts per hour. The pump(s) will continue to run until the timer expires, or the vacuum set point is reached, whichever occurs last.

   b. On simplex systems without a receiver tank, the pump is normally operated continuously by turning the H-O-A selector switch to H ("Hand" setting), which bypasses the vacuum switch.

   c. On duplex systems, two (2) vacuum switches are provided as well as an alternator. Switch #1 is used for the standard vacuum range (High-Low) to be maintained on the receiver tank as explained in 1a) by each pump (one [1] switch per pump). For example, switch #1 may have a high setting of 28" Hg vacuum [-95 kPa g] and a low of 26" Hg vacuum [-88 kPa g]. If the vacuum level in the receiver drops to 26" Hg [-88 kPa g] vacuum, pump "A" will start to bring the level back to 28" Hg vacuum [-95 kPa g]. On the next start, the alternator will select pump "B" to evacuate the receiver. Subsequent cycles will start pump "A", then pump "B".

      Switch #2 is used to set a minimum vacuum level where both pumps will start to bring the vacuum level back to the high setting shown on switch #1. On switch #2 the low vacuum setting is the significant set point. Set the lower pointer to this point. The higher pointer may be set at any value between the maximum setting on switch #1 and the low setting on switch #2. For example, if switch #1 is set at 28" and 26" Hg Vac and switch #2 is set at 26" and 24" Hg Vac, then if the vacuum level drops to 24" Hg Vac or less, both pumps will continue to operate until the vacuum is returned to the high setting on switch #1, 28" Hg Vac where both will shut down. See also Figure 1 on the facing page.

NOTE: On duplex systems with 50 HP motors or larger, a timer is incorporated to delay starting of the second pump by a few seconds to prevent excessive current draw if both started together.

   d. On a duplex system used without a receiver tank the pumps are normally operated in the manual mode by turning the H-O-A selector switch to H (Hand).

2. Turn on main power by turning fusible disconnect switches to "ON"
3. For initial check out, turn H-O-A selector switch to H. On duplex systems, start each pump separately.
4. Crack inlet isolation valve of the pump to be started.
5. Push start button for that pump.
6. Open cooling water valve to the heat exchanger.
7. Adjust the vacuum relief valve if necessary to prevent cavitation of the pump and still obtain the vacuum level required. Check the functioning of this valve with the main inlet isolation valve closed. The pump should not cavitate.
   When cavitation occurs, the pump sounds as though it has gravel in it. This noise will commonly occur when the pressure is low and the air or non-condensable gas flow is slight. Cavitation should be reduced or eliminated by bleeding air into the pump through the attenuation valve. If enough air can not be bled into the pump to satisfactorily quiet the pump, an air bleed valve should be installed. Non-condensable gas may be recirculated by adding a return line from the discharge separator tank to the pump inlet bleed valve.

   On oil sealed systems, a maximum vacuum level of 29" Hg vacuum [-95 kPa g] should be possible without cavitation and on water filled systems (assuming 60° F [15° C] cooling water) 28" Hg vacuum [-95 kPa g] should be possible without cavitation. Higher water temperatures will result in cavitation at lower vacuum.

8. Adjust the pump sealant inlet valve on units with sealant circulating pumps such that the compound pressure gauge between the pump sealant inlet and valve reads in a range between 15” Hg vacuum (-50 kPa g) and 10” Hg vacuum (-35 kPa g).

   For systems where the liquid ring pump(s) circulate the sealant, adjust the pump sealant inlet valve such that the compound pressure gauge between the pump sealant inlet and valve reads in a range between 10” Hg vacuum (-35 kPa g) and 0” Hg vacuum (0 kPa g).

9. Check the sealant level in the separator tank and add sealant as necessary. Some systems may be equipped with optional automatic sealant level control to handle this.
10. Check that the sealant flush to the mechanical seals is adequate by feeling the seal casing at each end of the pump (ahead of the bearings). You should be able to hold your hand on it with water sealed systems and for oil sealed systems it should be close to the oil sealant temperature.

WARNING: **Make certain all coupling or belt guards are correctly installed and secured in place before touching any part of the pump. Failure to make sure that guards are correctly installed and secured in place can result in serious bodily injury.**

11. If equipped with an oil mist eliminator (OME), check that sealant is being returned from the OME to the pump by feeling the return line. It should be warm to the touch, indicating return of sealant.
12. On special systems, check that all solenoid valves, flow, level, or pressure switches function properly.
13. After 30 minutes of operation, check the sealant temperature at the inlet and outlet points of the heat exchanger to be sure it is functioning properly. On oil sealed systems, a temperature modulating valve is provided on the coolant side of the heat exchanger. It can be adjusted to maintain the oil temperature between 115 – 180 °F (45 – 80° C) (higher settings are available – consult factory if higher settings are required) by turning the adjustment screw in the direction of the arrow (counterclockwise) for higher oil temperatures.
14. On duplex systems repeat the above procedure with the alternate pump.

After completing the iinitial startup procedure, of the entire system, it may be placed in process.

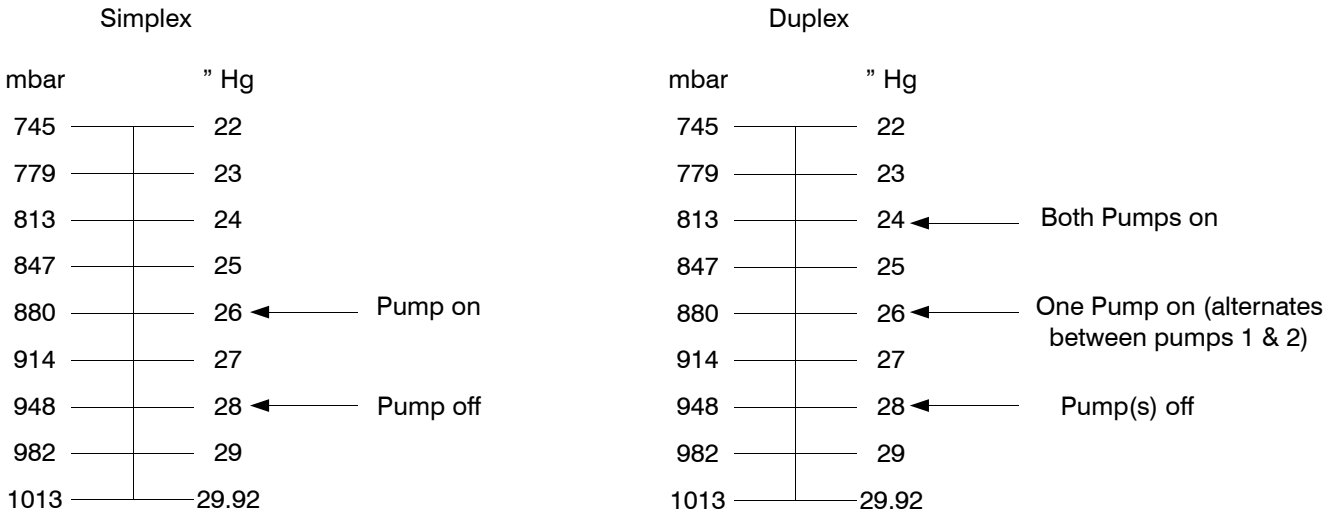


Figure 1. Typical Vacuum Switch Settings

ROUTINE STARTUP PROCEDURE

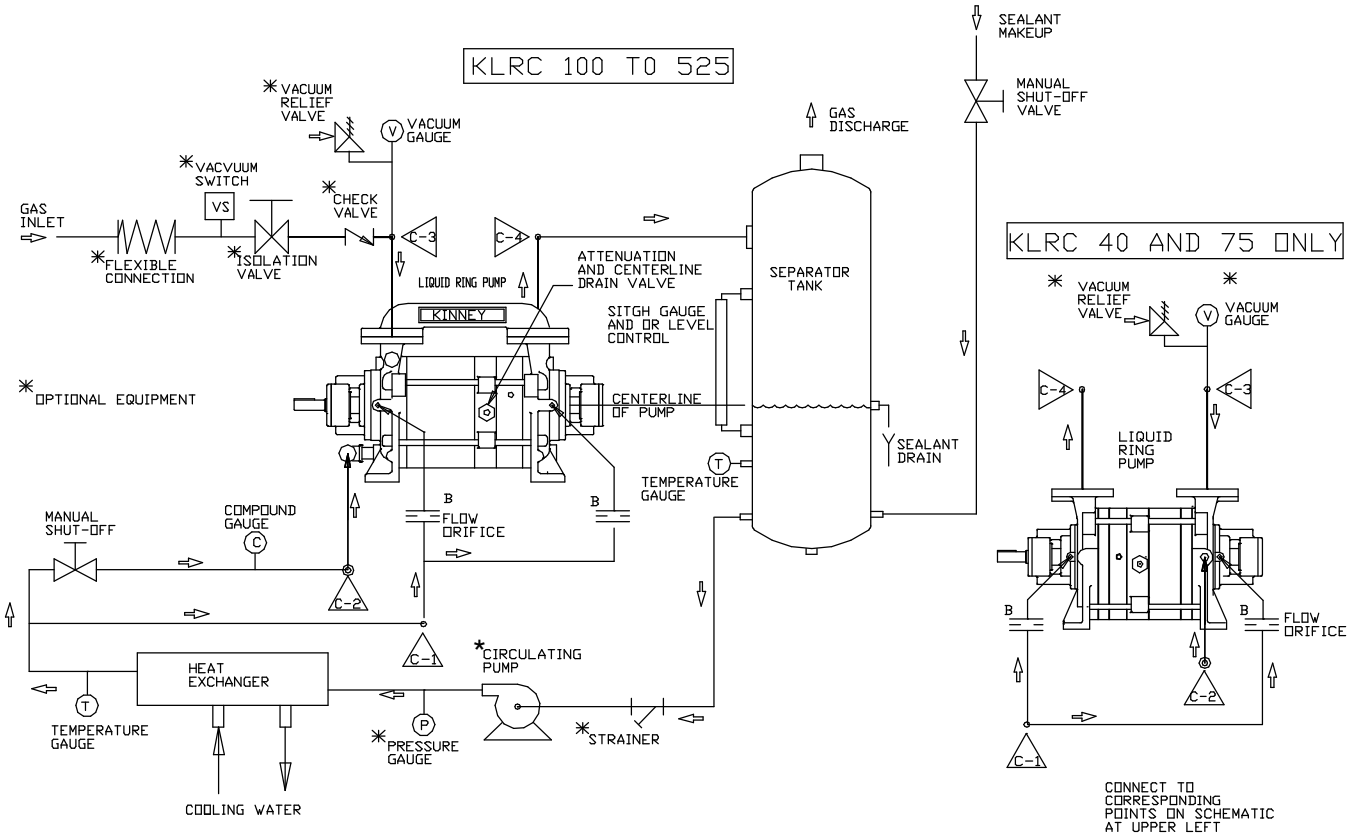
1. Check sealant level and add sealant as necessary to bring to proper level.
2. Open inlet isolation valve to vacuum receiver tank or process.
3. Turn on main power by turning fusible disconnect switch to “ON”.
4. Turn H-O-A selector switch to A (Auto) if used with vacuum receiver tank or to H (Hand) if not.
   NOTE: Remember when in A (Auto) mode the vacuum switches will be in the circuit and control the starting and stopping of the pump. A maximum of 5 starts per hour per motor is allowed to prevent possible damage to the motor. Minimum run timers are wired into the control center as standard equipment to insure the number of starts are not exceeded.
5. Push start button for each pump. On simplex systems the pump will start and evacuate the receiver to the high setting on the vacuum switch, whereupon it will shut down. When the vacuum drops to the low setting, the pump will start to return it to the high setting again.
6. On duplex systems, both pumps will start and evacuate the receiver to the high setting on vacuum switch #1 whereupon both will shut down. When the vacuum drops to the low setting on switch #1, one pump will alternately start to return the vacuum to the higher level. If one pump cannot handle the load and the vacuum level continues to drop to the low setting on switch #2, both pumps will operate and continue to do so until the vacuum is returned to the high setting on switch #1.
7. Cooling water solenoid valve will automatically open to allow flow to the heat exchanger.

SHUTDOWN PROCEDURE

1. Close inlet isolation valve.
2. Turn H-O-A selector switch to “OFF”.
3. Turn off main power.

TYPICAL DRSP/OFRP SYSTEM DIAGRAM

This representation is typical of systems supplied by Kinney, and id for reference only. Due to the wide variety of available custom options, your actual system may differ slightly in configuration. Consult the specific engineering drawings for your system for an exact representation.



TROUBLESHOOTING

CONDITION	CAUSE	POSSIBLE REMEDY
Seals Leaking	Seal incorrectly installed	Reinstall seal
	Seal worn or damaged	Replace seal
Reduced capacity	Rotational speed too low	Check supply voltage
	Vacuum leak	Locate and repair
	High sealant temperature	Check coolant flow and temperature Check heat exchanger cleanliness
	Incorrect sealant flow rate	See “Sealant flow rate” section in KLRC manual
Excessive noise	Defective bearing	Replace bearing
	Too much sealant liquid	Decrease flow rate
	Coupling misaligned	Align coupling
	Cavitation	Open attenuating valve or reset vacuum relief valve to increase flow
Overheating	Defective bearing	Replace bearing
	High sealant temperature	Check coolant flow and temperature
	Suction open to atmosphere	Adjust isolation valve
Excessive vibration	Coupling misaligned	Realign coupling
	Pump not properly anchored	Anchor
	See excessive noise	Check inlet pressure and gas flow
Motor overloaded	Excessive back pressure	Reduce height of pump discharge
	Too much sealant liquid	See table in KLRC manual for proper flow rate
	Misalignment	Realign motor and pump
	Defective bearing	Replace bearing
Abnormal bearing wear	Misaligned pump assembly	Realign pump and motor
Impeller binding or will not turn	Accumulation of rust or scale	See “Operation and Maintenance” section of KLRC manual
	Foreign object in pump	Dismantle pump and remove foreign object
Mechanical Seals squeal	Insufficient cooling liquid	Increase coolant flow to seal, check compatibility of sealant

NOTES:

PROPERTIES OF SEALANTS

Water is the most commonly used sealant in liquid ring vacuum pumps. Other fluids may be used to obtain process compatibility. In these applications special consideration should be given to the properties of the sealant, which may affect pump performance. Some of the properties of sealant which should be considered, are:

- Specific Gravity
- Specific Heat
- Viscosity
- Vapor Pressure

Additionally, the solubility of process gas in the sealant can be of significance and should be evaluated especially if the partial or full recovery system is used. When water is the sealant its chemical content should be evaluated since certain conditions will affect the service life of the pump. Generally if water is suitable to drink it is suitable for pump use. Hardness greater than 500 PPM will result in internal plating and fouling of pump parts. Service with hardness of less than 500 PPM depends upon operating temperature and the nature of the salt deposit. Naturally occurring well water with organic acid of pH-5 or higher is generally suitable, however pH of 7 or higher is preferred. Chemically treated water with sulfur content requires pH-7 or more. Water, which has a pH less than 5 should be treated, or the pump should have special materials of construction. If internal scaling affects performance, a water treatment specialist should be consulted. TVBS recommends that sealants and sealant systems be carefully evaluated and we invite you to discuss them with your TVBS Sales Professional or our Application Engineers.

Sealant Temperature

The rated volumetric capacity (ACFM) of a pump is based upon the use of incoming seal water at 60° F (15° C) . Seal water temperature affects the pump capacity. Table 2 provides data which when applied to the below formula will give the pumping capacity on dry air at water temperature other than 60° F (15° C) . To calculate volumetric pumping capacity (ACFM) or to approximate the capacity when using water at other than 60° F (15° C) the following formulas apply:

$$S_a = \frac{(S_{60})(P_1 - P_c)}{(P_1 - 13.3)}$$

Where: S_a = Actual capacity in ACFM, at P_1

S_{60} = Pump capacity with 60° F (15° C) sealant at P_1 This data is shown on our Liquid Ring Vacuum Pump Brochure #4120.

P_1 = Inlet pressure in Torr

P_c = Vapor pressure of sealant at actual sealant temperature

Table 2 on the facing page shows the vapor pressures of water at various temperatures.

Water Sealant Temperature ° F (° C)	Vapor Pressure Torr (mbar)
50 (10)	9.2 (12.3)
52 (11)	9.9 (13.2)
54 (12)	10.7 (14.3)
56 (13)	11.5 (15.3)
58 (14)	12.3 (16.4)
60 (15)	13.3 (17.7)
62 (17)	14.2 (18.9)
64 (18)	15.3 (20.4)
66 (19)	16.4 (21.9)
68 (20)	17.5 (23.3)
70 (21)	18.8 (25.1)
72 (22)	20.1 (26.8)
74 (23)	21.5 (28.7)
76 (24)	22.9 (30.5)
78 (26)	24.5 (32.7)
80 (27)	26.2 (34.9)

Table 2 Vapor Pressures of Water

WARRANTY – VACUUM PRODUCTS

Subject to the terms and conditions hereinafter set forth and set forth in General Terms of Sale, Kinney (the Seller) warrants products and parts of its manufacture, when shipped, and its work (including installation and start-up) when performed, will be of good quality and will be free from defects in material and workmanship. This warranty applies only to Seller's equipment, under use and service in accordance with Seller's written instructions, recommendations and ratings for installation, operating, maintenance and service of products, for a period as stated in the table below. Because of varying conditions of installation and operation, all guarantees of performance are subject to plus or minus 5% variation. (Non-standard materials are subject to a plus or minus 10% variation).

PRODUCT TYPE	WARRANTY DURATION
New (Non-Piston Pumps)	15 months after date of shipment or 12 months after initial startup date, whichever occurs firs
New (Piston Pumps)	30 months after date of shipment, on all units sold after June 1, 2014.
Repair	6 months after date of shipment or remaining warranty period, whichever is greater
Remanufactured	9 months after date of shipment or 6 months after initial startup date, whichever occurs firs

THIS WARRANTY EXTENDS ONLY TO BUYER AND/OR ORIGINAL END USER, AND IN NO EVENT SHALL THE SELLER BE LIABLE FOR PROPERTY DAMAGE SUSTAINED BY A PERSON DESIGNATED BY THE LAW OF ANY JURISDICTION AS A THIRD PARTY BENEFICIARY OF THIS WARRANTY OR ANY OTHER WARRANTY HELD TO SURVIVE SELLER'S DISCLAIMER.

All accessories furnished by Seller but manufactured by others bear only that manufacturer's standard warranty.

All claims for defective products, parts, or work under this warranty must be made in writing immediately upon discovery and, in any event within one (1) year from date of shipment of the applicable item and all claims for defective work must be made in writing immediately upon discovery and in any event within one (1) year from date of completion thereof by Seller. Unless done with prior written consent of Seller, any repairs, alterations or disassembly of Seller's equipment shall void warranty. Installation and transportation costs are not included and defective items must be held for Seller's inspection and returned to Seller's Ex-works point upon request.

THERE ARE NO WARRANTIES, EXPRESSED, IMPLIED OR STATUTORY WHICH EXTEND BEYOND THE DESCRIPTION ON THE FACE HEREOF, INCLUDING WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS OF PURPOSE.

After Buyer's submission of a claim as provided above and its approval, Seller shall at its option either repair or replace its product, part, or work at the original Ex-works point of shipment, or refund an equitable portion of the purchase price.

The products and parts sold hereunder are not warranted for operation with erosive or corrosive material or those which may lead to build up of material within the product supplied, nor those which are incompatible with the materials of construction. The Buyer shall have no claim whatsoever and no product or part shall be deemed to be defective by reason of failure to resist erosive or corrosive action nor for problems resulting from build-up of material within the unit nor for problems due to incompatibility with the materials of construction.

Any improper use, operation beyond capacity, substitution of parts not approved by Seller, or any alteration or repair by others in such manner as in Seller's judgment affects the product materially and adversely shall void this warranty.

No employee or representative of Seller other than an Officer of the Company is authorized to change this warranty in any way or grant any other warranty. Any such change by an Officer of the Company must be in writing.

The foregoing is Seller's only obligation and Buyer's only remedy for breach of warranty, and except for gross negligence, willful misconduct and remedies permitted under the General Terms of Sale in the sections on CONTRACT PERFORMANCE, INSPECTION AND ACCEPTANCE and the PATENTS Clause hereof, the foregoing is BUYER'S ONLY REMEDY HEREUNDER BY WAY OF BREACH OF CONTRACT, TORT OR OTHERWISE, WITHOUT REGARD TO WHETHER ANY DEFECT WAS DISCOVERED OR LATENT AT THE TIME OF DELIVERY OF THE PRODUCT OR WORK. In no event shall Buyer be entitled to incidental or consequential damages. Any action for breach of this agreement must commence within one (1) year after the cause of action has occurred.

June, 2014

NOTES

IMPORTANT

All vacuum boosters and vacuum pumps manufactured by Kinney are date coded at time of shipment. In order to assure you of the full benefits of the product warranty, please complete, tear out and return the product registration card. You may also register your product online at www.kinneyvaccum.com or contact Customer Service.

IMPORTANT

It is to the user's advantage to have the requested data filled in below and available in the event a problem should develop in the blower or the system. This information is also helpful when ordering spare parts.

Company _____

Location _____

City State/Province ZIP/Postal Code Country

Telephone: ( ) _____

E-mail: _____

Model: _____

Serial Number: _____

Date of Purchase: _____

Date of Startup: _____

PLEASE CHECK ONE

Vacuum Furnace	☐
Vacuum Coating	☐
Pharmaceutical	☐
Semiconductor/Electronics	☐
Food/Meat Packing	☐
Gas/Petrochemical	☐
Other _____	☐

BY: _____

KINNEY®

Kinney
4840 West Kearney Street
Springfield, Missouri USA 5803-8702
O 417.865.8715 800.825.6937
F 417.865.2950
www.kinneyvacuum.com

Manual 4816 Rev A p/n 004816 0000
04/21