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INSTALLATION
OPERATION
MAINTENANCE
INSTRUCTION

BULLETIN No. 9490-IOM-2000 Rev. C

PULSA Series® 9490

Hydraulic Diaphragm Metering Pump

PULSA SERIES GUARANTEE

Should you experience a problem with your Pulsafeeder pump, first consult the troubleshooting guide in your operation and maintenance manual. If the problem is not covered or cannot be solved, please contact your local Pulsafeeder Sales Representative, or our Technical Services Department for further assistance.

Trained technicians are available to diagnose your problem and arrange a solution. Solutions may include purchase of replacement parts or returning the unit to the factory for inspection and repair. All returns require a Return Authorization number to be issued by Pulsafeeder. Parts purchased to correct a warranty issue may be credited after an examination of original parts by Pulsafeeder. Warranty parts returned as defective which test good will be sent back freight collect. No credit will be issued on any replacement electronic parts.

Any modifications or out-of-warranty repairs will be subject to bench fees and costs associated with replacement parts.

In addition, Pulsafeeder guarantees its PULSA Series drive assemblies for a period of two years from the date of shipment. All other material and workmanship are fully covered for a period of one year. Any parts found to be defective within the above time span will be replaced free of charge, F.O.B. factory.

Equipment or accessories manufactured by others but purchased through Pulsafeeder, such as electric motors, are guaranteed only to the extent of the original manufacturer.

Damages incurred from misuse, abuse, and/or improper protection during storage will be cause to void the guarantee. Erosion, corrosion, or improper application of the equipment or related piping by the buyer or any third party is also excluded from the guarantee.

The above guarantee is in lieu of any other guarantee, either expressed or implied. We make no warranty of fitness or merchantability. No agent of ours is authorized to make any warranty other than the above.

Safety Considerations:

1. Read and understand all related instructions and documentation before attempting to install or maintain this equipment
2. Observe all special instructions, notes, and cautions.
3. Act with care and exercise good common sense and judgment during all installation, adjustment, and maintenance procedures.
4. Ensure that all safety and work procedures and standards that are applicable to your company and facility are followed during the installation, maintenance, and operation of this equipment.

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Conventions

For the remainder of this bulletin, the following Conventions are in effect.

WARNING

A WARNING DEFINES A CONDITION THAT COULD CAUSE DAMAGE TO BOTH THE EQUIPMENT AND THE PERSONNEL OPERATING IT. PAY CLOSE ATTENTION TO ANY WARNING.

NOTE

Notes are general information meant to make operating the equipment easier.

TIP

Tips have been included within this bulletin to help the operator run the equipment in the most efficient manner possible. These "Tips" are drawn from the knowledge and experience of our staff engineers, and input from the field.

1. Introduction

1.1 General Description

Metering pumps are positive displacement reciprocating pumps that combine the high efficiency of the plunger pump with diaphragm sealing to prevent product leakage. Each pump consists of a power end and a process end separated by a hydraulically operated diaphragm. Individual pumps will vary in appearance due to various liquid ends, accessories, and multiplexing; however, the basic principles of operation remain the same.

2. Principles Of Operation

2.1 Overall Operation

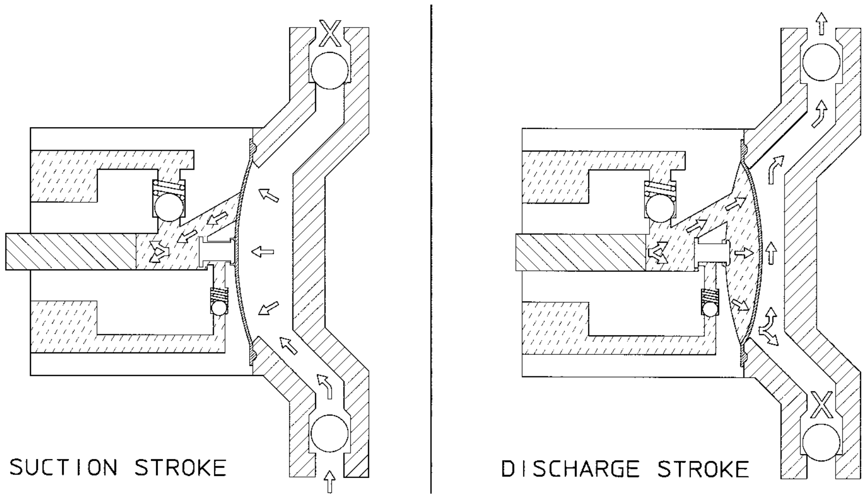

Figure 1

A piston reciprocates within an accurately sized cylinder at a preset stroke length, displacing an exact volume of fluid. This piston does not pump chemicals: it pumps a hydraulic fluid.

The piston and associated mechanisms are enclosed in the pumphead and intermediate housing which also serves as a hydraulic oil reservoir.

A diaphragm separates the oil from the product pumped. The diaphragm moves in exact response to piston displacement. The diaphragm does no work, and acts only as a separator.

Oil displacement is translated into equal product displacement. Piston retraction causes the product to enter through the suction check valve. Piston advance causes the discharge of an equal amount of the product through the discharge check valve.

2.2 Component Location

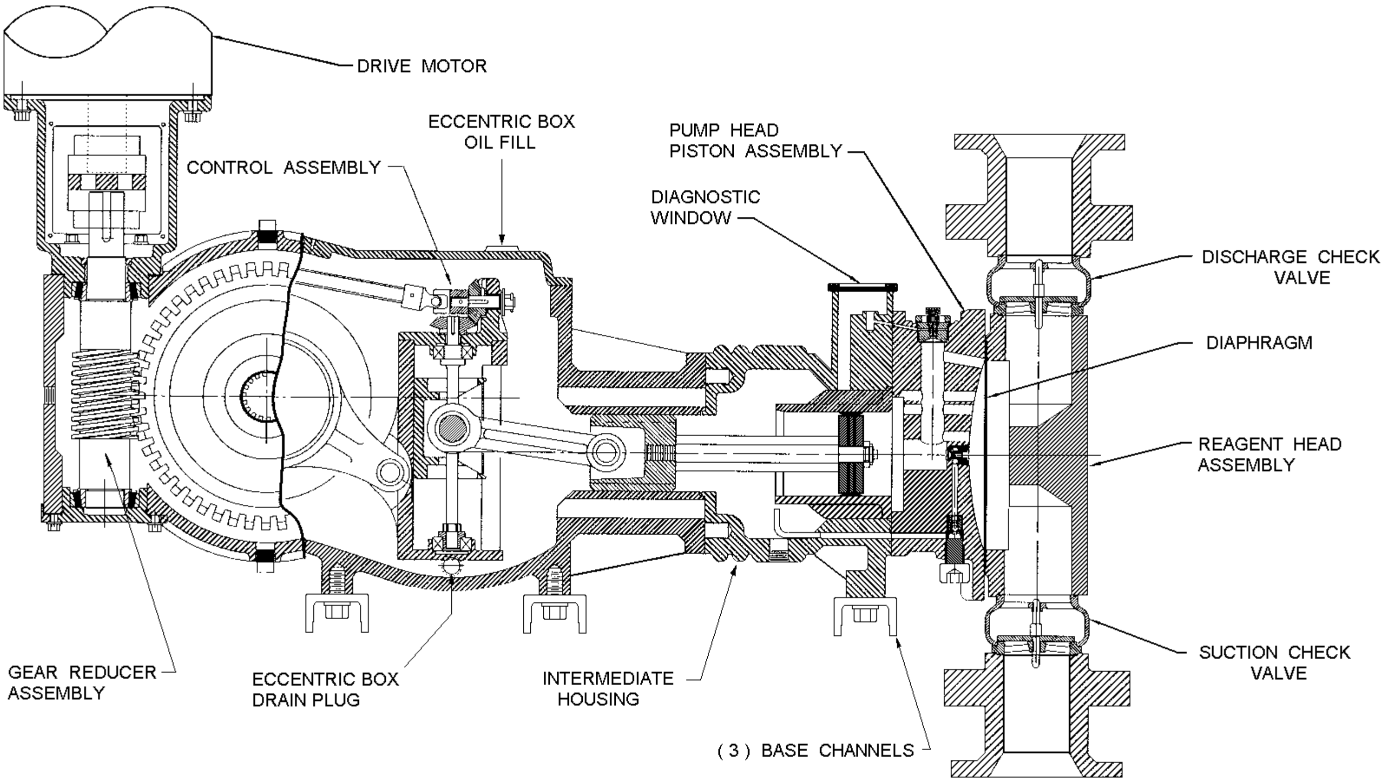

Figure 2

2.2.1 Standard Reagent Head Assembly

The typical reagent head assembly consists of the following:

a) Reagent Head
b) Diaphragm
c) Suction and Discharge Check valves

NOTE **High flow pump models use disk valves.**

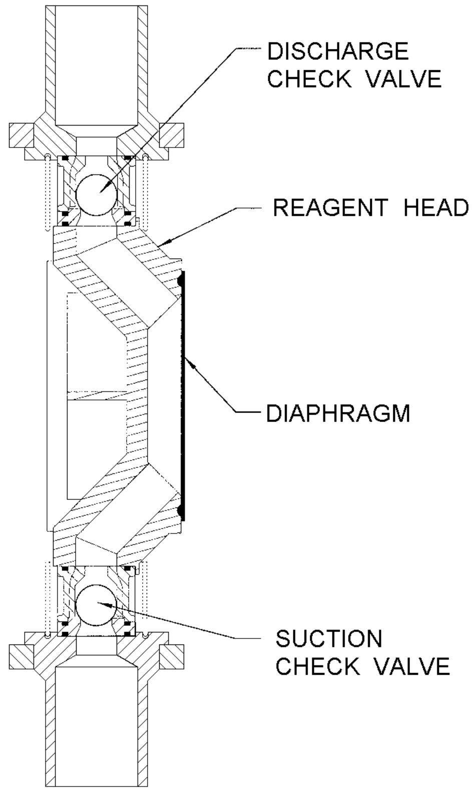

Figure 3

This assembly is the only part of the pump to contact the process liquid; consequently, maintenance is critical to pump performance.

2.2.2 Pump Head/Piston assembly

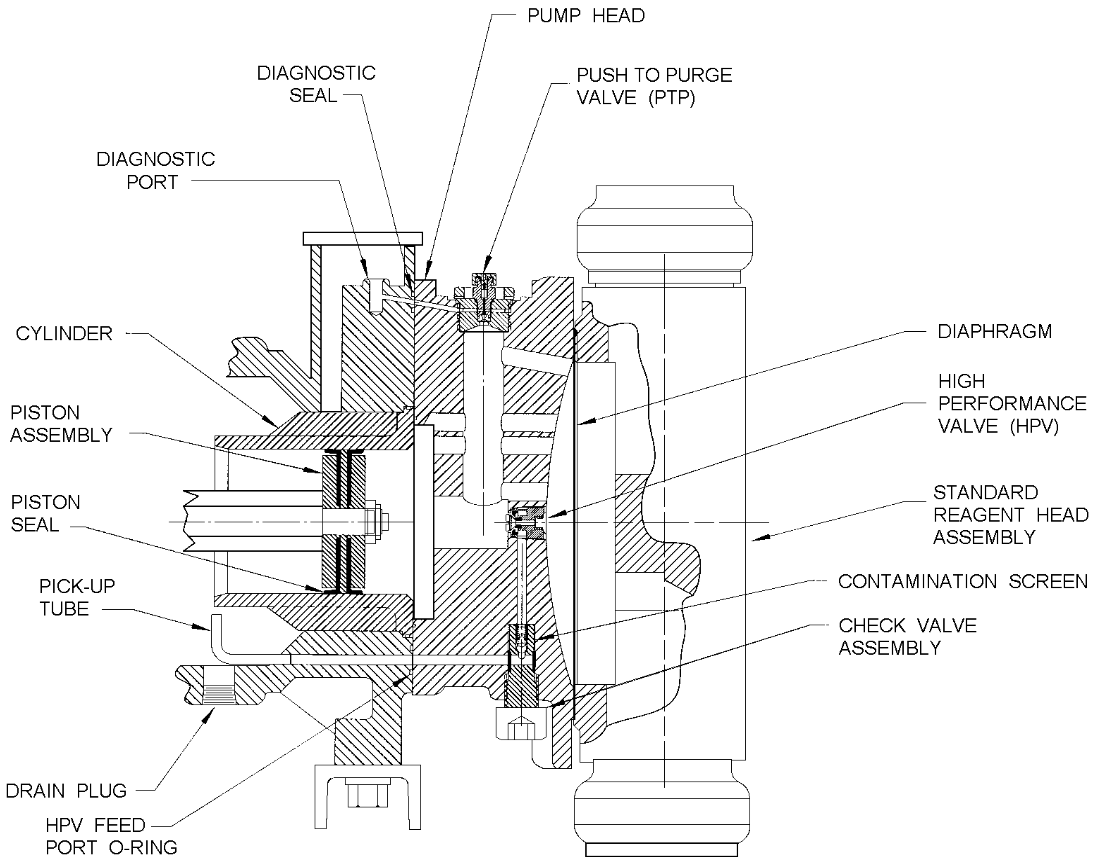

Figure 4

The pump head/piston assembly is installed on the intermediate housing. This assembly contains the hydraulic system which consists of the pump head, cylinder, piston assembly, and three hydraulic valves:

- PTP (**P**ush-**T**o-**P**urge automatic bleed)
- HPV (**H**ydraulic **P**erformance **V**alve)
- HBV (**H**ydraulic **B**ypass **V**alve).

The **PTP** valve is situated at the top of the pump head and automatically removes gases from the hydraulic system during normal operation. Momentary manual actuation of the external valve button overrides automatic operation to validate priming or to determine diaphragm integrity. The **HPV** valve automatically maintains the required hydraulic oil volume by replacing any oil lost over time past the piston or through the **PTP** valve. The **HBV** valve protects the pump from over-pressurizing by relieving any excess pressure in the pump's hydraulic system.

2.2.3 Control Assembly

By changing the length of the piston stroke in a pump, the amount of product displaced can be increased or decreased. The *PULSA* Series diaphragm metering pump Model 9490 contains an adjustment mechanism which controls stroke length (***Figure 5***). The mechanism consists of an oscillating housing, a slider block which fits inside the housing and a connecting rod attached to the block. The housing pivots on horizontal bearing pins and oscillates through a fixed arc from the action of the eccentric-driven rear connecting rod. The position of the block within the housing is adjustable. Pushing in and rotating the external self-locking hand wheel causes a threaded shaft in the housing to turn. This shaft is threaded through the block and raises or lowers the block as the hand wheel is turned. When the block is centered on the pivot point of the housing it is motionless. As it is lowered off center, it develops increasing reciprocating movement (***Figure 5***) which is transmitted through the connecting rod. Side thrust on the piston is eliminated by the use of a cross-head block that travels in a bore between the connecting rod and piston assembly.

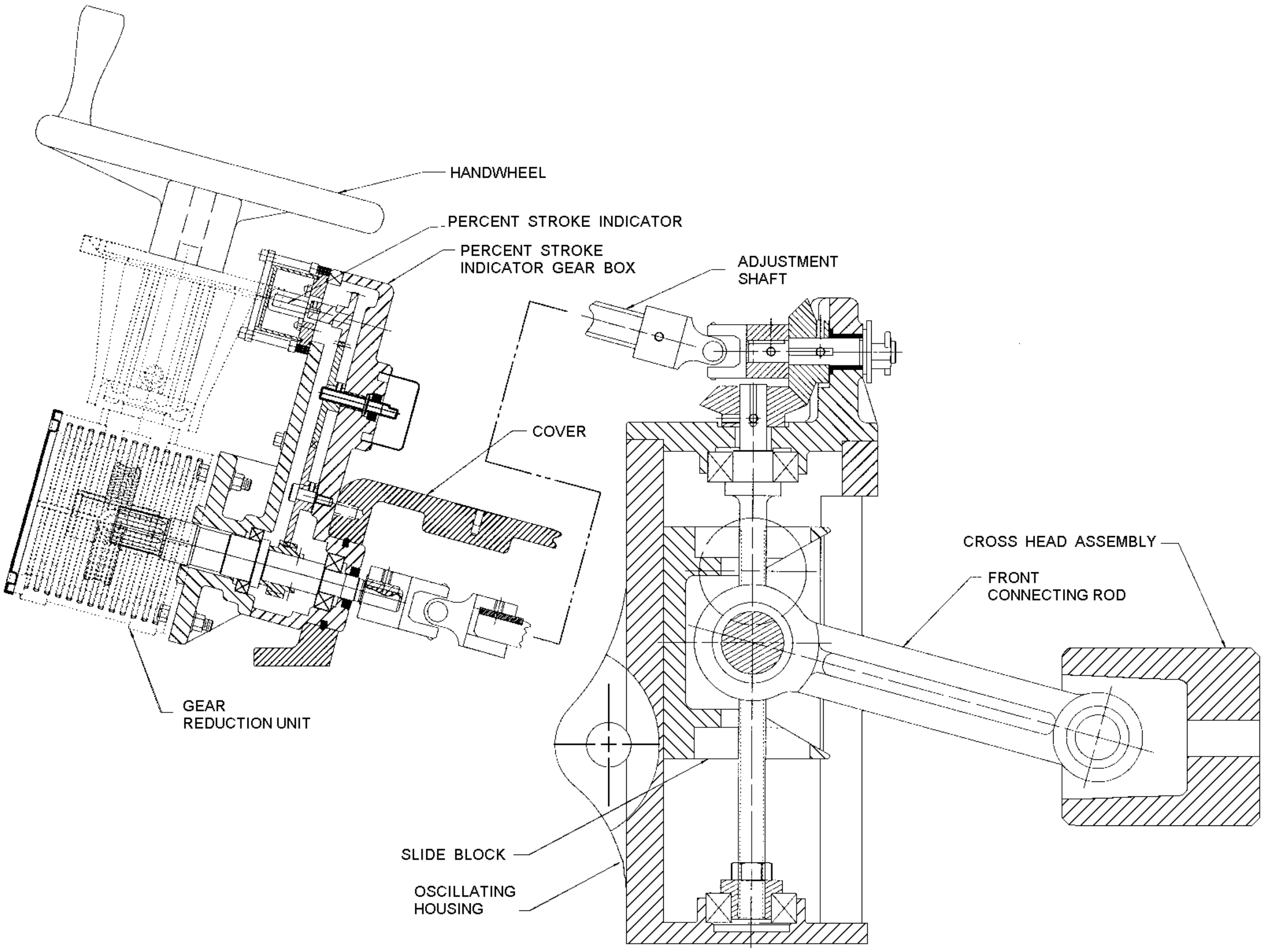

Figure 5

PULSA Series pumps incorporate a full motion style of stroke length adjustment to control piston travel during each stroke. The stroke length setting is denoted by a (0 – 100%) scale with one tenth increments. It is located on the top of the control gearbox.

2.2.4 Gear Reducer Assembly

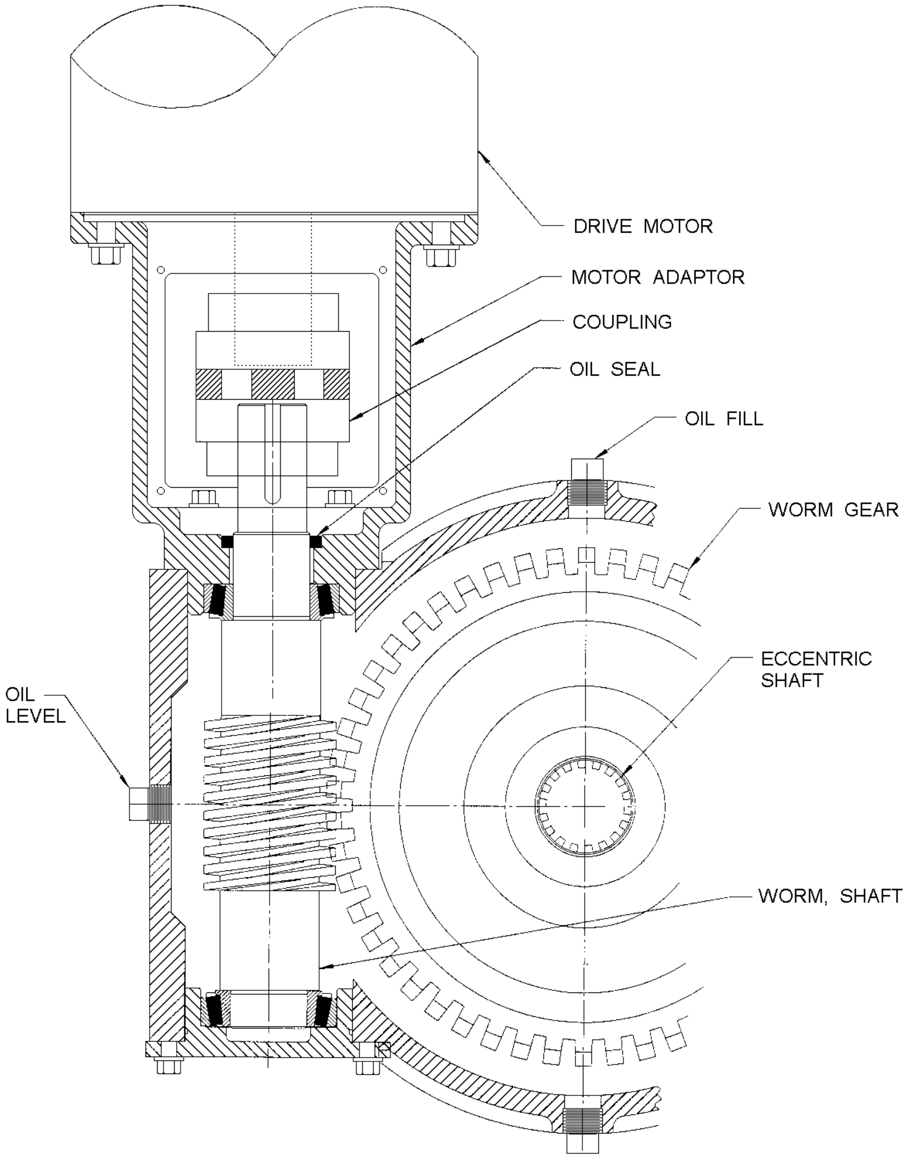

Figure 6

9490 pumps are driven by a standard C-face electric motor mounted on the motor adaptor input flange. The motor drives a set of worm gears that convert rotational speed into torque. They in turn power the eccentric shaft assembly that converts rotary motion to reciprocating motion.

Optional construction gearboxes can also be provided.

More than one pump can be driven through a single drive assembly. This is referred to as multiplexing. The pumps are mounted on a common gear reducer assembly on the driver pump and the pump without a gear reducer is called the driven pump. Bases are optional and can be provided per customer specification.

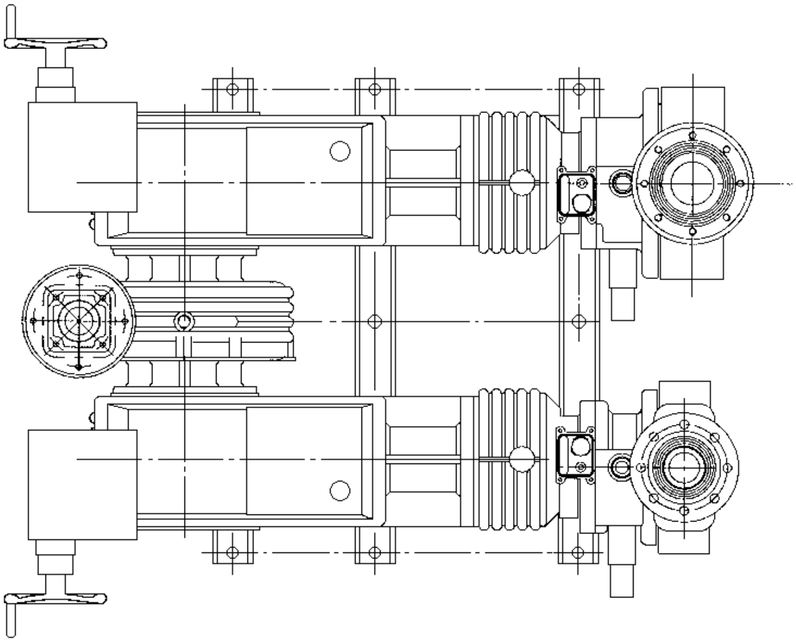

Figure 7

Whenever pumps are multiplexed the eccentric shafts are positioned to place a uniform load on the driver. Before full disassembly always note the relative positions of the eccentric shafts to each other so they can be reassembled back in the same orientation.

3. Equipment Inspection

Check all equipment for completeness against the order and for any evidence of shipping damage. Shortages or damage should be reported immediately to the carrier and your PULSA Series representative.

4. Storage Instructions

4.1 Short Term

Storage of PULSA Series pumps for up to 12 months is considered short-term. The recommended short-term storage procedures are:

a) Store the pump indoors at room temperature in a dry environment.
b) Prior to startup, inspect housing, and gearbox. Replenish hydraulic and gearbox oils as required to maintain operating levels. If water or condensation is present, change oil as described in the ***Equipment Startup*** section.
c) Prior to startup, perform a complete inspection and then start up in accordance with instructions in this manual.

4.2 Long Term

Every twelve months, in addition to the above short-term procedures, power up the motor and operate the pump for a minimum of one hour. It is not necessary to have liquid in the reagent head during this operation, but the suction and discharge ports must be open to atmosphere.

After twelve months of storage, Pulsafeeder’s warranty cannot cover items that are subject to deterioration with age such as seals and gaskets. If the pump has been in storage longer than 12 months it is recommended that all seals and gaskets be inspected and replaced as necessary prior to startup. Materials and labor to replace this class of item under this circumstance are the purchaser’s responsibility. For a continuance of the 5 year warranty after extended storage, equipment inspection and any required refurbishing must be done by a Pulsafeeder representative.

5. Installation

5.1 Location

When selecting an installation site or designing a skid package, consideration should be given to access for routine maintenance.

PULSA Series pumps are designed to operate indoors and outdoors, but a hood or covering for outdoor service is recommended. External heating or the use of synthetic lubricants for the gearbox is recommended if ambient temperatures below 20°C (0°F) are anticipated. Check with the factory if you are concerned with the suitability of the operating environment.

The pump must be rigidly bolted to a solid and flat foundation to minimize vibration, which can loosen connections. The pump must be level within 2°. This will assure that the hydraulic and gear oils are maintained at the proper levels and that the check valves can operate properly.

5.2 Piping System

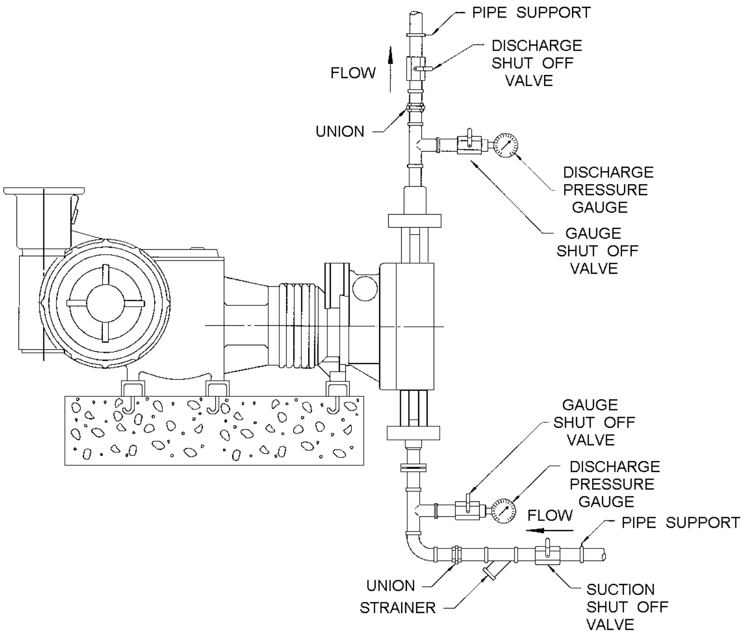

Figure 8

All piping systems should include:

1. Shutoff valves and unions (or flanges) on suction and discharge piping.
   a) This permits check valve inspection without draining long runs of piping.
   b) Shutoff valves should be of the same size as connecting pipe.
   c) Ball valves are preferred since they offer minimum flow restriction.
2. An inlet strainer, if the product is not a slurry.
   a) Pump check valves are susceptible to dirt and other solid contaminants unless designed for that service, and any accumulation can cause malfunction.
   b) The strainer should be located between the suction shutoff valve and the pump suction valve.
   c) It must be sized to accommodate the flow rate and the anticipated level of contamination.
   d) 100 mesh screen is recommended.
3. Vacuum/pressure gauges in the suction and discharge lines in order to check system operation.
   a) Gauges should be fitted with protective shutoff valves for isolation while not in use.
4. A separate system relief valve to protect piping and process equipment, including the pump, from excess process pressures.
   a) The hydraulic bypass valve (HBV) in the pump is not intended to protect the system.

Piping weight must not be supported by valve housings or other portions of the reagent head, as the resulting stresses can cause leaks. If appropriate, provide for thermal expansion and contraction so that no excess force or movement is applied to the pump.

In piping assembly, use a sealing compound chemically compatible with the process material. Users of sealing tape are cautioned to ensure that the entering pipe thread ends are not taped, and that tape is removed from previously-used threads prior to re-use. Both new and existing piping should be cleaned, preferably by flushing with a clean liquid (compatible with process material) and blown out with air, prior to connection to the pump.

5.2.1 Suction Pressure Requirements

Although metering pumps have suction lift capability, all pump installations should have minimum lift for optimum performance. A flooded suction (i.e., suction fluid level higher than the centerline of the pump) is preferable whenever possible. The pump should be located as close as possible to the suction side reservoir or other source.

If suction lift is required, the net positive suction pressure required ($NPSH_R$) is **5 psia** (or **0.35 bar**). If this requirement is not met the process liquid may cavitate inside the pump, degrading metering accuracy. In addition, suction pressure must be maintained at a minimum absolute value of **5 psia** (or **0.35 bar**) to ensure proper hydraulic system and proper pump operation.

The maximum inlet pressure is limited to 30 psig with composite TFE/elastomer diaphragms.

NOTE **Higher pressures may be possible with optional alternate diaphragm materials.**

Refer to ***Appendix I*** for procedures for the calculation of suction pressure.

5.2.2 Discharge Pressure Requirements

All *PULSA* Series Metering Pumps are designed for continuous service at the rated discharge pressure. If system suction pressure were to exceed system discharge pressure (a condition sometimes described as “pumping downhill” or “flow-through”), flow would be generated in addition to that caused by the pump, resulting in a reduction in accuracy and loss of control over the metering process. To prevent this condition, discharge pressure must exceed suction pressure by at least **25 psia** (or **1.7 bar**). This can be achieved where necessary by installing a backpressure valve in the discharge line.

Discharge pressure must never exceed the maximum nameplate rating of the pump.

Refer to ***Appendix I*** for procedures for the calculation of discharge pressure.

6. Equipment Startup

6.1 Lubrication

WARNING

9490 PUMPS USE TWO SEPARATE OILS: *PULSA*LUBE 7H, HYDRAULIC OIL FOR THE ECCENTRIC BOX AND *PULSA*LUBE 9M, GEAR OIL FOR THE GEARBOX. CONFUSION BETWEEN THE TWO WILL IMPAIR PERFORMANCE AND COULD DAMAGE THE PUMP.

6.1.1 Oil Capacities

***PULSA*lube 7H hydraulic oil** is available in 5 gallon (Part #: NP 980002-007), 15 Gallon (Part #: NP980002-008) and 55 gallon (Part #: NP980002-006) containers.

***PULSA*lube 9M gear oil** is available in 1 gallon (Part #: NP980003-001) or 5 gallon (Part #: NP980003-007) containers.

It is recommended that adequate supplies of both *PULSA*lube oils be on hand for periodic changes and emergency requirements.

The approximate amounts of oil required to fill 9490 pumps to specified levels are:

Hydraulic oil No. 7H (purple)		
Eccentric Box	15-20	Gallons
Gear oil No. 9M (amber)		
"A" Gearbox	14-15	Quarts
"B" Gearbox	4-5	Quarts

6.1.2 Hydraulic Oil Fill

The pump is shipped with the proper level of hydraulic oil. The oil level is visible through the sight glass on the back of the eccentric box.

The diagnostic window is also another place to check the oil level and to fill the pump with oil.

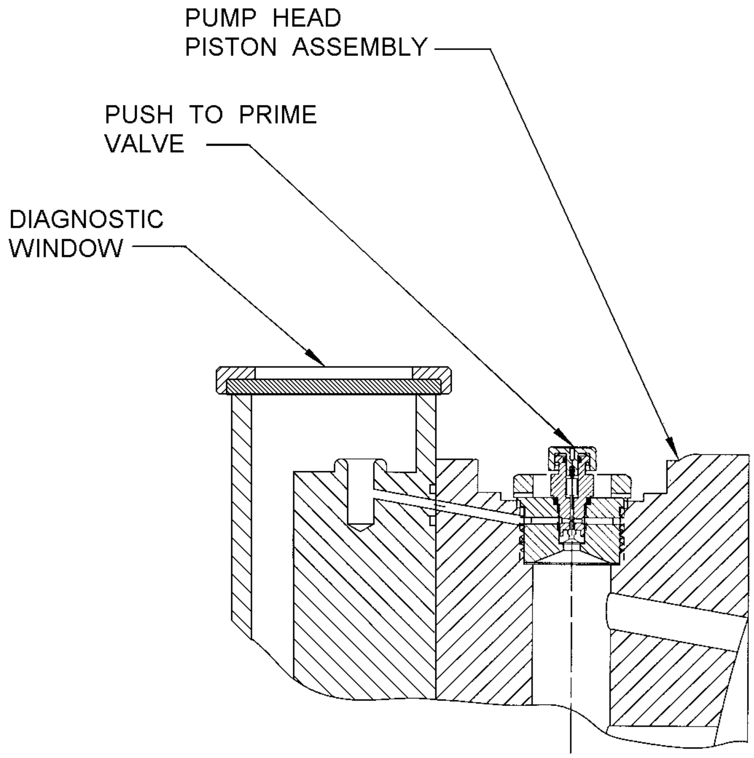

Figure 9

6.1.3 Gear Oil Fill

The pump is shipped with the proper level of gear oil. In all pump configurations, one pipe plug is present at the top of the gearbox and one is on the side at the centerline level. Remove the top plug and fill with *PULSA*lube 9M (amber) gear oil to the level of the gear box side port (refer to ***Figure 28***). Replace both pipe plugs after filling.

6.1.4 Oil Changes

The recommended oil change intervals are dependent upon the operating environment and level of pump usage, classified as follows:

1. Normal service: clean/dry atmosphere, an ambient operating temperature of 0°C to 40°C (32°F to 104°F) and up to 2,000 annual operating hours.
2. Severe Service: humid atmosphere, an ambient operating temperature below 0°C (32°F) or above 40°C (104°F), and over 2,000 annual operating hours.

6.1.4.1 Hydraulic Oil Change:

The recommended hydraulic oil change interval is 2 years for normal service and 1 year for severe service. The procedure is as follows:

1. Disconnect the power source to the drive motor.
2. Relieve all pressure from the piping system.
3. Remove the oil fill cap from the top of the eccentric box cover.
4. Drain the oil by removing the drain plug on the side, near the bottom of the eccentric box, and the plug on the bottom of the intermediate housing
5. Remove and clean the HPV check valve screen (refer to ***Section 7.4.2 – Check Valve Screen - Removal and Cleaning***.)
6. Replace the drain plugs.
7. Fill the eccentric box with *PULSA*lube 7H (purple) hydraulic oil (refer to ***Hydraulic Oil Fill***).
8. Replace the oil fill cap.

6.1.4.2 Gear Oil Change:

The recommended gear oil change interval is two years for normal service and one year for severe service. The procedure is as follows:

1. Disconnect the power source to the drive motor.
2. Relieve all pressure from the piping system.
3. Remove the fill plug from the top of the gearbox.
4. Drain the oil by removing the drain plug on the bottom of the gearbox.
5. Replace the drain plug.
6. Refill with fresh *PULSA*lube 9M (amber) gear oil (refer to ***Gear Oil Fill***).
7. Be sure to replace the top fill plug and side plug (if removed).

6.2 Startup

6.2.1 Output Adjustment

Due to the possibility of piping leaks, it is best to start the pump at 0% output and then slowly increase the setting to 100%.

The manually controlled *PULSA* Series 9490 has a hand wheel for manual stroke adjustment. Mounted on the rear of the eccentric box cover, the hand wheel can be adjusted at any point from 0 (0000 on the digital position indicator) to 100% (1000 on the digital indicator) by pushing in and then rotating as required. Stroke length is locked during pump operation to prevent drift. Pushing the hand wheel in temporarily disengages the lock for adjustment; release after adjustment automatically resets the lock at the new setting.

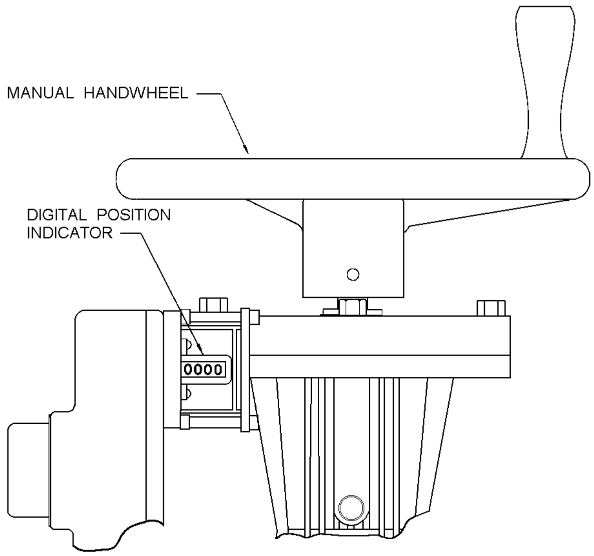

Figure 10

The hand wheel gearbox can be removed and rotated through 45° increments if necessary to improve operator access to the hand wheel.

6.2.2 Priming the Pumphead

All pumps are shipped with a fully primed hydraulic system. However, during shipping and handling some air may enter the hydraulic system. Generally this air will be automatically purged after a short run-in period. If necessary, rapid purging may be accomplished by:

a) Fully depressing and holding the PTP valve while the pump is operating at any stroke rate above 30%.

   With the valve depressed, oil should begin to flow out of the small diagnostic port (refer to ***Figure 9***).

b) Hold the valve down for several seconds after the oil is clear of bubbles to ensure a good prime.

If the pump fails to prime refer to ***Section 7.2.1, Priming the Pumphead***.

6.2.3 Priming the Reagent Head

1. Open the suction and discharge line shutoff valves.
2. If the piping system design and the storage tank are such that the product flows due to gravity through the pump, no priming is required.

   In the event the discharge line contains a significant amount of pressurized air or other gas, it may be necessary to lower the discharge pressure to enable the pump to self-prime.
3. If the installation involves a suction lift, it may be necessary to prime the reagent head and suction line. Try priming the reagent head first.
   a) Remove the discharge valve by unscrewing the four tie bar bolts and removing the valve as a unit.
   b) Fill the head through the discharge valve port with process (or compatible) liquid
   c) Reinstall the valve and retighten the tie bar bolts.
4. Start the pump at the 100% stroke length setting to prime the pump. If this does not work, it will be necessary to fill the suction line.

   Filling of the suction line will necessitate the use of a foot valve or similar device at the end of the suction line so that liquid can be maintained above the reservoir level.
   a) Remove the suction valve assembly.
   b) Fill the line
   c) Replace the valve.
   d) Remove the discharge valve assembly and fill the reagent head as described in Step 3 above.

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6.2.4 Calibration

All metering pumps must be calibrated to accurately specify stroke length settings for required flow rates.

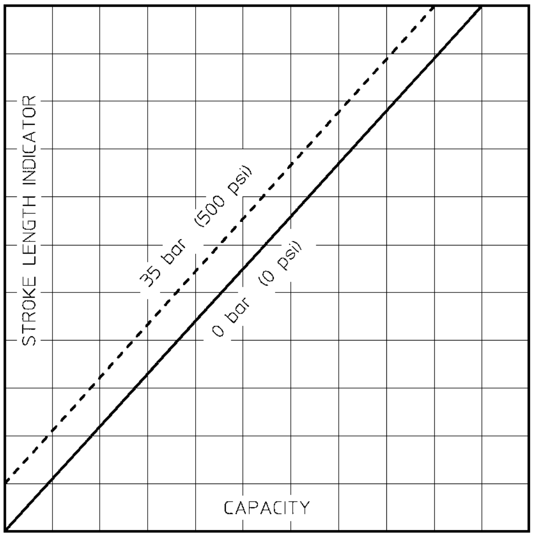


Figure 11

A typical calibration chart is shown in ***Figure 11***. Although output is linear with respect to stroke length setting, an increase in discharge pressure decreases output uniformly, describing a series of parallel lines, one for each pressure (only two are shown).

The theoretical output flow rate at atmospheric output pressure is based on the displacement of the hydraulic piston (the product of piston cross-sectional area and stroke length) and the stroking rate of the pump. Whenever possible, calibration should be performed under actual process conditions (i.e., the same or a similar process liquid at system operating pressure).

To assure a sound hydraulic system, run the pump for 10-15 minutes prior to calibration. This will allow the PTP (automatic bleed) valve to purge any air from the system.

TIP

Allowing the pump to run for several hours prior to performing a calibration will provide better results.

Procedure for constructing a calibration chart,

1. Measure the flow rate several times at three or more stroke settings (i.e., 25, 50, 75, and 100%).
2. Plot these values on linear graph paper.
3. Draw a best-fit line through the points.

   For stable conditions, this line should predict stroke settings to attain required outputs.

7. Maintenance

WARNING

BEFORE PERFORMING ANY MAINTENANCE REQUIRING REAGENT HEAD OR VALVE (WET END) DISASSEMBLY, BE SURE TO RELIEVE PRESSURE FROM THE PIPING SYSTEM

WARNING

WHERE HAZARDOUS PROCESS MATERIALS ARE INVOLVED, RENDER THE PUMP SAFE TO PERSONNEL AND THE ENVIRONMENT BY CLEANING AND CHEMICALLY NEUTRALIZING AS APPROPRIATE. WEAR PROTECTIVE CLOTHING AND EQUIPMENT AS APPROPRIATE.

Accurate records from the early stages of pump operation will indicate the type and levels of required maintenance. A preventative maintenance program based on such records will minimize operational problems. It is not possible to forecast the lives of wetted parts such as diaphragms and check valves. Since corrosion rates and operational conditions affect functional material life, each metering pump must be considered according to its particular service conditions.

PULSA Series KOPkits contain all replacement parts normally used in a preventative maintenance program. It is recommended that KOPkits and *PULSA*lube hydraulic and gear oils be kept available at all times.

Each *PULSA* Series pump is provided with an individual specification data sheet included in the parts list package. The data sheet contains important information relating to the application along with pump serial number, pump specifications (i.e., materials, piston size, stroking rate, etc.).

7.1 Wet End Removal, Inspection, And Reinstallation

WARNING

IF THE DIAPHRAGM HAS FAILED, PROCESS MATERIAL MAY HAVE CONTAMINATED THE PUMP HYDRAULIC OIL. HANDLE WITH APPROPRIATE CARE, CLEAN AND REPLACE OIL IF REQUIRED.

WARNING

DUE TO THE SIZE AND WEIGHT OF WET END COMPONENTS, CARE MUST BE USED TO SELECT THE PROPER TOOLS AND LIFTING EQUIPMENT FOR HEAVY LOADS.

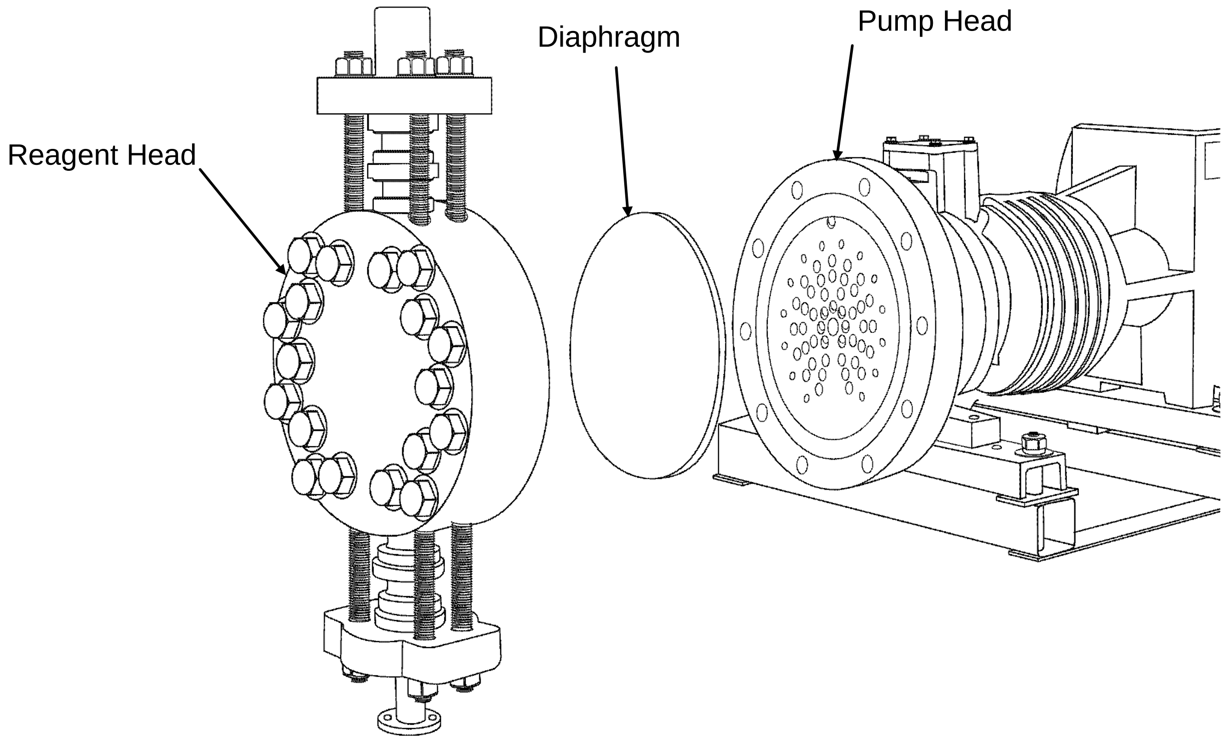


Figure 12

PULSA Series diaphragms do not have a specific cycle life; however, the accumulation of foreign material or the entrapment of sharp particles between the diaphragm and dish cavity can eventually cause failure. Failure can also occur as a result of hydraulic system malfunction or chemical attack. Periodic diaphragm inspection and replacement is recommended.

NOTE **Take all precautions to prevent environmental and personnel exposure to hazardous materials.**

Diaphragm Replacement procedure

1. Disconnect the power source to the drive motor.
2. Relieve all pressure from the piping system.
3. Close the inlet and outlet shutoff valves (refer to ***Figure 8***).
4. Disconnect piping to the reagent head and drain any process liquid, following material safety precautions from the process liquid manufacturer.
5. Place a pan underneath the pump head to catch any liquid leakage.
6. Remove the valving as in Section 7.3.2 and pour out any liquids retained by the check valves into a suitable container, continuing to follow safety precautions as appropriate.
7. Remove all but two top reagent head bolts.

   Oil will leak out between the pump head and reagent head as the bolts are loosened.
8. Install proper lifting devices to the tie bar holes, and remove the final bolts and rinse or clean the reagent head with an appropriate material.
9. Remove and inspect the diaphragm. It may have taken a permanent convex/concave set as a result of normal flexure and conformance to the dish plate. This condition is normal and is not cause for replacement.

NOTE **The diaphragm must be replaced if it is excessively deformed, dimpled, or obviously damaged.**

10. To install a diaphragm, first ensure that the critical sealing areas of the diaphragm, reagent head, and pump head are clean and free of debris.

    When reinstalling a used diaphragm it is not necessary to maintain the previous orientation relative to the reagent head or pump head hole pattern.
    a) Apply a thin coat of O-Lube or silicon grease to the outer side of the back of the diaphragm (approximately 1” wide from the edge of the diaphragm).
    b) Place the diaphragm into the counter bore on the pump head and press firmly around the outer edge.
11. Place the reagent head up to the diaphragm and install the head bolts finger tight (just in contact with the reagent head front face).
12. Tighten the bolts in an alternating pattern as displayed in ***Appendix III***, to ensure an even seating force. Initially torque the nuts/bolts to one half the value recommended in ***Appendix III***. Tighten the nuts/bolts to the specified value the second time around.
13. Re-prime the pump following the procedure outlined in the next section.

7.2 Priming The Pump

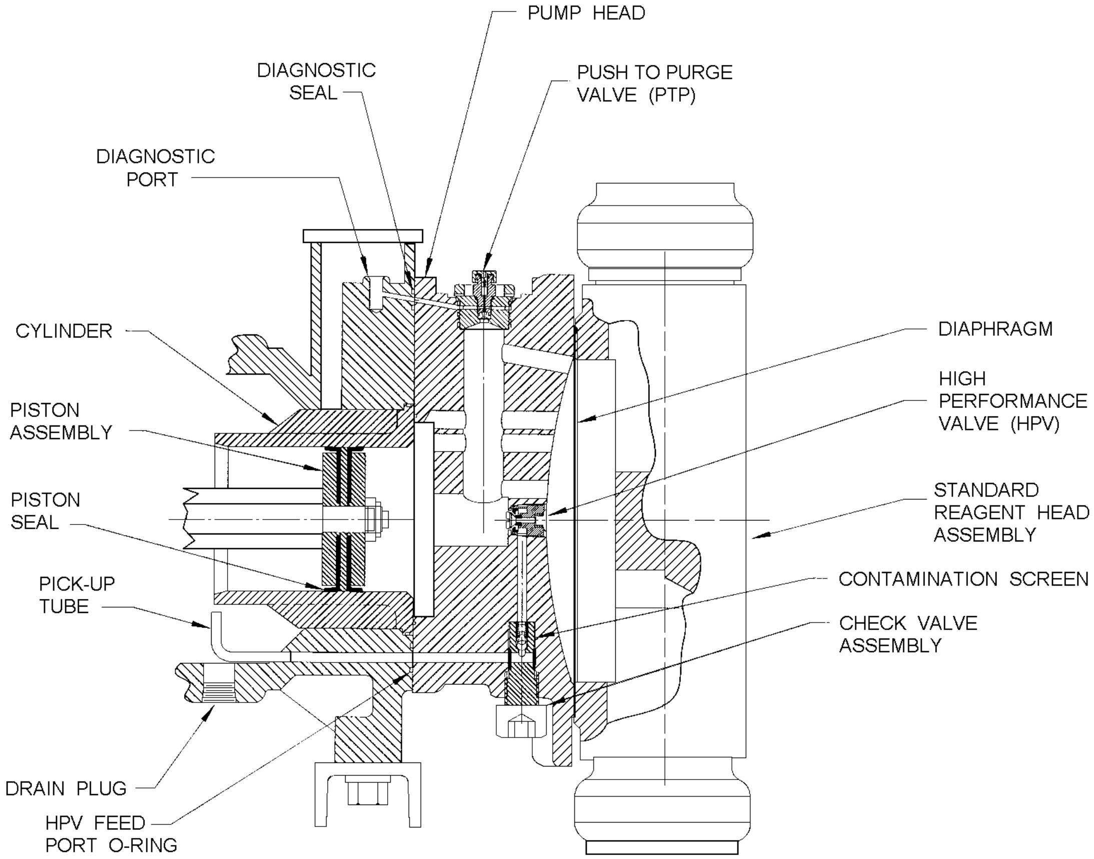


Figure 13

Use the following procedure to prime the pumphead

1. Disconnect the power source to the drive motor.
2. Relieve all pressure from the piping system and where possible allow liquid to enter the reagent head assembly.
3. Verify the eccentric box is filled with hydraulic fluid and fill with *PULSA*lube 7H hydraulic oil if necessary.
4. Set the pump stroke length to a value between 0 and 20 %.
5. Connect power to the drive motor.
6. Turn on the pump and adjust the stroke length slowly to the maximum setting (100%).
7. Fully depress and hold the PTP valve for several seconds periodically as the stroke length is adjusted. Within several minutes oil should begin to flow out of the small diagnostic port (refer to ***Figure 13***). Continue to press the valve periodically until the oil is clear of bubbles. The pump is now primed. If oil fails to flow out of the diagnostic port after two minutes, proceed to Step 8.

8. Turn off the pump.
9. Remove power from the pump.
10. Remove the PTP valve from the pumphead carefully.
11. Reset the stroke length to zero percent.
12. Using a small plastic funnel, slowly pour oil into the pumphead through the PTP valve port until full.
13. Replace the PTP valve, ensuring that the flat copper gasket and o-ring are properly in place.
14. Connect power to the pump.
15. Turn on the pump and adjust the stroke length slowly to the maximum setting (100%).
16. Fully depress and hold the PTP valve for several seconds periodically as the stroke length is adjusted. Within several minutes oil should begin to flow out of the small diagnostic port (refer to ***Figure 13***). Continue to press the valve periodically until the oil is clear of bubbles

7.3 Check Valves

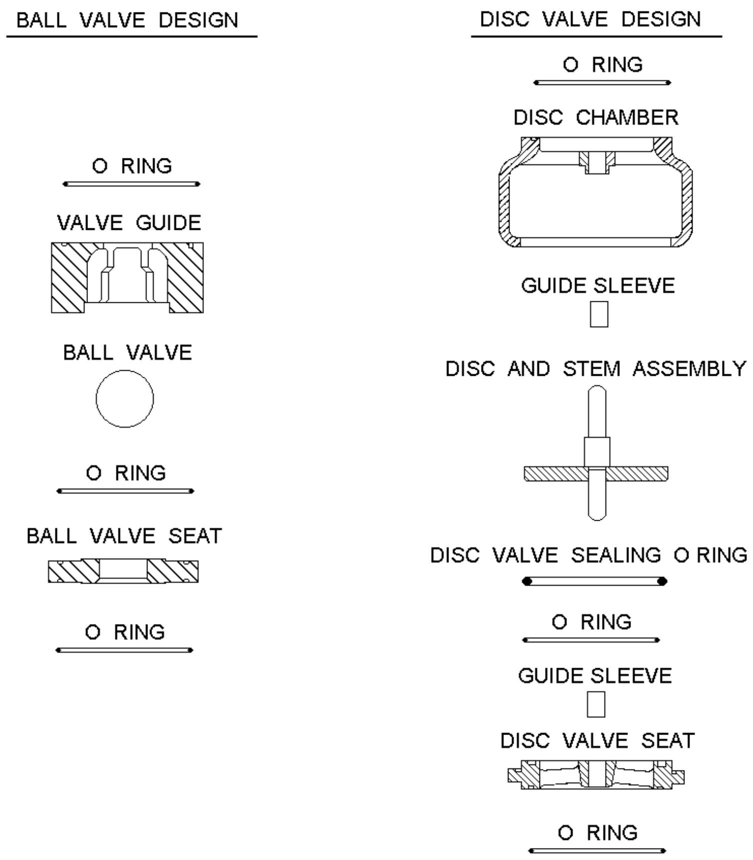


Figure 14

Most fluid metering problems are related to check valves. Problems can be caused by solids accumulation between valve and seat, corrosion of seating surfaces, erosion, or physical damage due to wear or the presence of foreign objects.

Two types of check valves are used, the ball type for lower flows and the disk type for higher flows.

The ball valve incorporates a ball, guide, and seat. Flow in the unchecked direction lifts the ball off the seat, allowing liquid to pass through the guide. Reverse flow forces the ball down, sealing it against the sharp edge of the seat. The guide permits the ball to rotate but restricts vertical and lateral movement in order to minimize “slip” or reverse flow. Ball rotation prolongs life by distributing wear over the entire surface of the ball. Since ball return is by gravity, the valve must be in the vertical position in order to function properly. Parts are sealed by o-rings.

The disk valve functions as does the ball valve, except that the ball is replaced by a spring-loaded guided disk assembly. The seat may contain a captured o-ring to facilitate sealing, unless process conditions require a metal to metal seal.

7.3.1 Check Valve Removal

NOTE **Take all precautions to prevent environmental and personnel exposure to hazardous materials.**

1. Disconnect the power source to the drive motor.
2. Relieve all pressure from the piping system.
3. Close the inlet and outlet shutoff valves (refer to ***Figure 8***).
4. Loosen the suction valve tie-bar bolts and spring the suction piping slightly to drain any liquid from the reagent head cavity. If the piping is closely connected it may be necessary to disconnect a union or flange.
5. Remove the suction check valve assembly, holding it together as a unit.
6. Loosen the tie bar bolts on the discharge valve and spring the piping slightly to drain any liquid.
7. Remove the discharge check valve assembly, holding it together as a unit.

7.3.2 Ball Valve – Inspection and Repair

Ball Valve Inspection and Repair procedure

1. Disassemble both valves.

   Seats should have sharp edges or a small chamfer, free from dents or nicks.
2. Examine components for wear by holding the ball firmly against its mating seat in front of a bright light to inspect for fit.

NOTE **Observation of light between ball and seat is cause for replacement of either or both components.**

3. Reassemble both valves using new parts as required. The o-rings should always be replaced.

7.3.3 Disk Valve – Inspection and Repair

Disk Valve Inspection and Repair procedure

1. Disassemble valves and inspect components for wear.

   The seats and lower disk surfaces contacting the seats should remain flat and smooth. Although it is normal for the o-ring in the seat to be flattened after significant use, replacement is recommended as a part of valve maintenance.
2. The seat o-ring is captured by an internal lip in its groove in the seat, removal requires the following destructive procedure.
   a) Position a small blade type screwdriver against the outer edge of the o-ring at an angle of approximately 45 degrees.
   b) Taking care not to damage the sides of the seat, drive the screwdriver into the o-ring.
   c) Using the screwdriver, pry one section of the o-ring out of the groove.
   d) Grip the O-Ring with pliers, and remove it from the seat.
3. To install the replacement seat o-ring, place it on the seat above the groove.
   a) Position a flat metal object over the o-ring
   b) Apply uniform light pressure using a hand arbor press.

The slight movement that accompanies seating can be easily felt through the press handle.

WARNING

DO NOT TRY TO INSTALL THE RING BY HAMMERING, AS THE SEATING WILL NOT BE UNIFORM. THE RING MAY BE DAMAGED AND THE PUMP PERFORMANCE MAY BE IMPAIRED

4. Reassemble both valves using new parts as required. Sealing O-Rings should always be replaced.

7.3.4 Check Valve Reinstallation

Use the following procedure to reinstall a Check Valve(s)

1. Reinstall both valve assemblies, taking care to ensure that they are correctly oriented with balls or disks above seats. Refer to ***Figure 14***.
2. Tighten the tie bar bolts evenly, making sure the valve assemblies are assembled squarely. Refer to ***Appendix III*** for torque values.

NOTE

For best results, always loosen the unions or flanges on either side of the system piping prior to re tightening the check valve assemblies. Retighten the unions or flanges after the check valves are securely tightened into position.

3. Check for leaks and retighten tie bar bolts as necessary.

7.4 Hydraulic Performance Valve (HPV)

During normal pump operation hydraulic fluid is continually discharged through the automatic bleed valve and may also be lost past the piston seals. This causes the diaphragm to be drawn further back on each successive suction stroke until it actuates the HPV. Once the valve is actuated, oil is allowed to flow into the hydraulic system until the piston reaches the end of the suction stroke. As the piston starts forward a check valve prevents oil from flowing back through the HPV, thereby allowing the valve to close as the diaphragm moves forward. Through this process the diaphragm is continually maintained in a proper operating position relative to the pumphead dishplate. Since the HPV is unaffected by the vacuum level in the pumphead, oil cannot be inadvertently brought into the hydraulic system which would result in over-extension and damage to the diaphragm. This feature provides pump protection should the suction line become restricted or closed for up to 1 – 2 hours.

PULSA 9490 pumps High Performance Valves (refer to ***Figure 16***) are factory preset and require no maintenance provided the hydraulic oil remains clean. The check valve in series with the HPV includes a screen to trap contaminants (refer to ***Figure 18***) and should be removed and cleaned with each change of the hydraulic oil as indicated below. Should the HPV require removal for cleaning or replacement follow the procedure below.

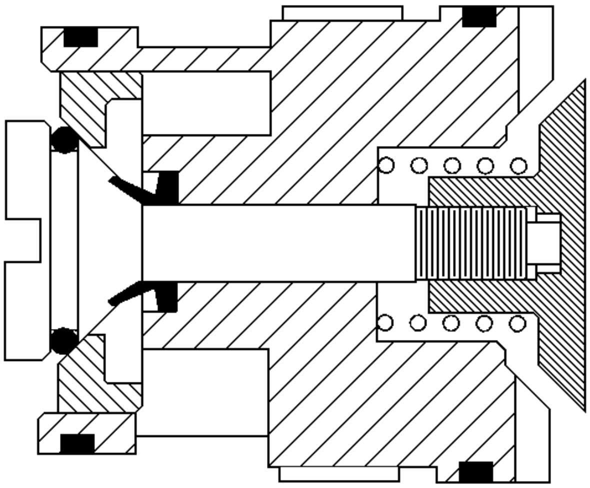


Figure 15

7.4.1 Check Valve Screen - Removal and Cleaning

Check Valve Screen - Removal and Cleaning procedure

1. Disconnect the power source to the drive motor
2. Relieve all pressure from the piping system.
3. Drain hydraulic fluid from the eccentric box.
4. Unscrew the check valve from the bottom of pump head.
5. Clean the valve and check valve screen in a solvent compatible with the nitrile seal material and blow air through the valve to remove all contaminants.
6. Inspect the O-Rings for nicks or other damage and replace if necessary.
7. Lubricate the O-Rings with *PULSA*lube 7H and replace the valve, tightening securely.
8. Re-install the eccentric box drain plug and refill with *PULSA*lube 7H hydraulic oil.

7.4.2 HPV Removal and Replacement

HPV Removal and Replacement procedure

1. Drain hydraulic oil from the eccentric box and intermediate housing.
2. Remove the reagent head and diaphragm (refer to ***Section 7.1.1***). Using *PULSA* Spanner Wrench #NP660001-000 or suitable substitute, remove the HPV check valve assembly.

NOTE **The HPV valve assembly may have been shimmed at the factory for proper valve placement. The shims (if any) will be located in the back of the valve assembly hole of the pump head. Locate these shims and ensure they are reinstalled with the valve (used or new).**

3. If cleaning of the valve is required, use a solvent compatible with nitrile rubber and blow air through the valve to remove all contaminants.
4. Inspect the O-Rings on the body of the valve for nicks or other damage and replace if required.
5. Lubricate the O-Rings with *PULSA*lube 7H and carefully insert the HPV into the dish side bore of the pumphead.
6. Rotate the valve into the pumphead until it is fully seated.
7. Tighten into pump head with *PULSA* Spanner Wrench #NP660001-000 or suitable substitute.

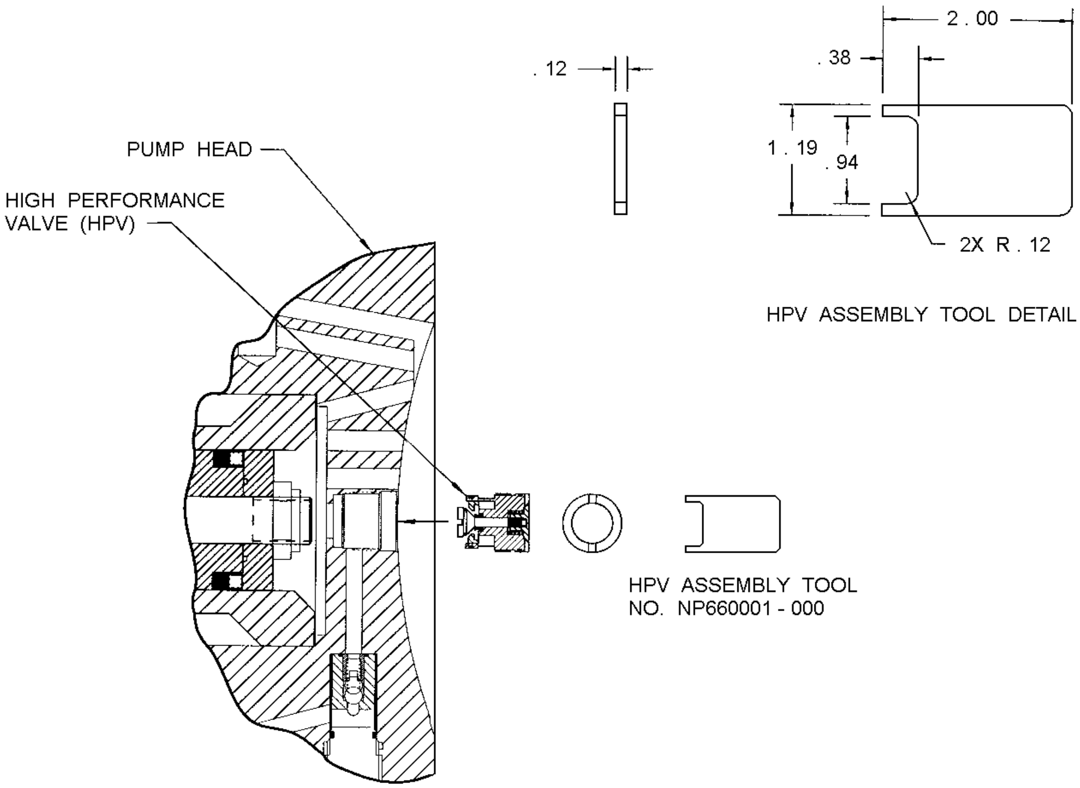


Figure 16

8. Reinstall the diaphragm and reagent head.
9. Re-install the eccentric box drain plug and fill with *PULSA*lube 7H hydraulic oil.
10. Reprime the pump.

7.5 Hydraulic Bypass Valve (HBV)

All *PULSA* Series pumps incorporate a Hydraulic Bypass Valve which is an adjustable spring loaded valve ported into the hydraulic cavity of the pumphead. The valve is designed to protect the pump against excessive hydraulic pressure and will not limit or regulate system pressure. The valve is factory-adjusted for pressure as originally specified, or at 10% above the rated pump pressure.

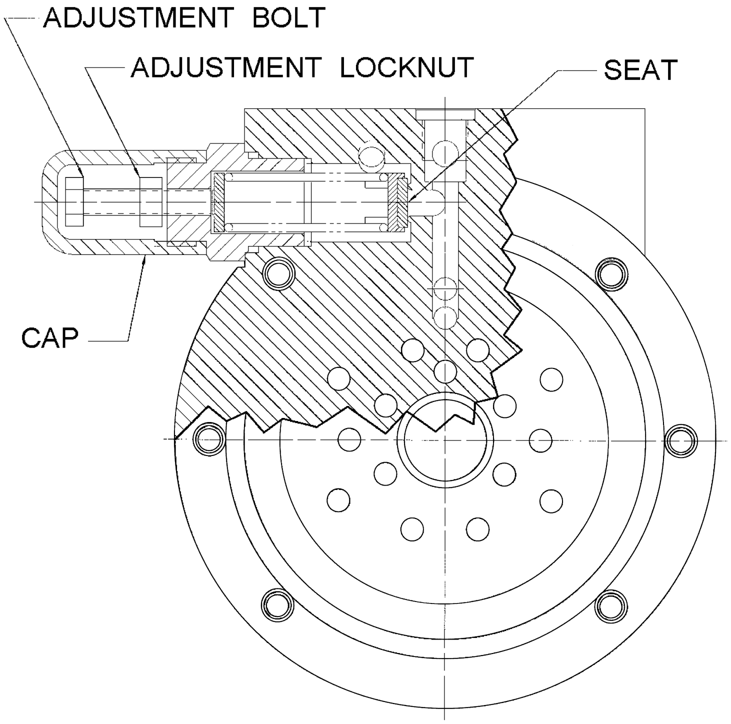


Figure 17

The HBV is located at the top of the pumphead and any discharge, indicating over pressurization, is visible at the outer diagnostics port (refer to ***figure 18***)

Adjusting the HBV valve

1. Remove the valve cover.
2. Loosen the locknut.
3. Turn the adjustment screw clockwise (as seen facing the screw) to increase the bypass pressure or counterclockwise to decrease it.

   The locking nut must be tightened after adjustment.

Pump damage may occur during a system upset, if the hydraulic bypass pressure is set higher than 10% over the design pressure of the pump. Conversely, if the setting is too low the valve will operate on each discharge stroke. This results in decreased pumping capacity and will eventually affect the efficiency of the valve.

To check the hydraulic bypass pressure setting, install a gauge and a regulating valve in the pump discharge line. The gauge must be between the pump and valve. For convenience, locate the two as close to the pump as possible. With the pump operating at maximum stroke length, gradually increase the discharge pressure and observe when the HBV starts to operate. The cracking pressure of the valve must be at least as high as the maximum pressure of the system but no more than 10% over the pumps rated pressure. After adjustment tighten the lock nut and reinstall the metal cover.

Periodic inspection of the valve seat is recommended. If it becomes worn or damaged leakage will occur regardless of how tightly the valve is adjusted.

7.5.1 PTP (Automatic Bleed Valve)

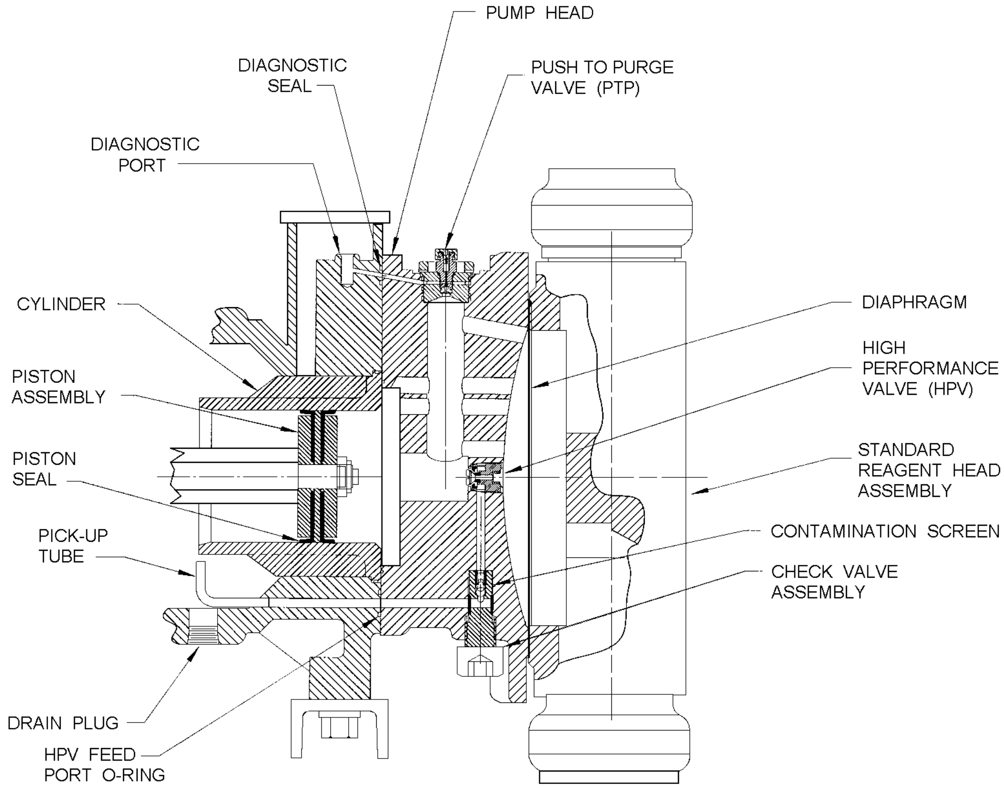


Figure 18

The PTP (automatic bleed valve) is a gravity-operated ball check valve which automatically removes gases from the hydraulic system. On each discharge stroke of the pump, hydraulic pressure drives the ball off the lower seat, expelling any accumulation of gases at the top of the hydraulic system. An upper seat limits ball travel and flow during each actuation. On each suction stroke, the ball is positioned (by gravity) against the lower seat to prevent reentry of gas into the system. When all gas has been expelled, a small amount of oil will be displaced on each discharge stroke. This oil is returned by gravity to the hydraulic reservoir.

Under normal operating conditions this ongoing process removes minute, invisible accumulations of gas long before they are visible or detrimental to pump operation. To accelerate hydraulic startup, pressing the spring-loaded button at the top of the valve holds the valve momentarily open so that large amounts of gas can be instantly purged. When the button is released, the valve reverts to normal automatic operation. Bleed valve operation can be monitored by observing oil flow from the discharge port through the diagnostic window.

7.5.2 PTP Removal, Cleaning, and Reinstallation

NOTE **Any accumulation of solids can cause the valve to malfunction.**

1. Disconnect the power source to the drive motor.
2. Relieve all pressure from the piping system.
3. Slowly unscrew the valve to gradually relieve any residual hydraulic system pressure.
4. Remove the valve and clean it by soaking in compatible solvent.

   Valve operation can be confirmed by blowing air through it in both directions and listening for the “click” sound of ball-seat contact in both directions.
5. Verify that the copper gasket is installed at the bottom of the threaded hole in the pump head.

   The copper gasket need not be replaced provided that it is sound and undamaged.

   The elastomer gasket around the upper portion of the valve assembly may be likewise re-used.

NOTE **This valve is not repairable and must be replaced if it continues to malfunction after cleaning.**

7.6 Piston Seal

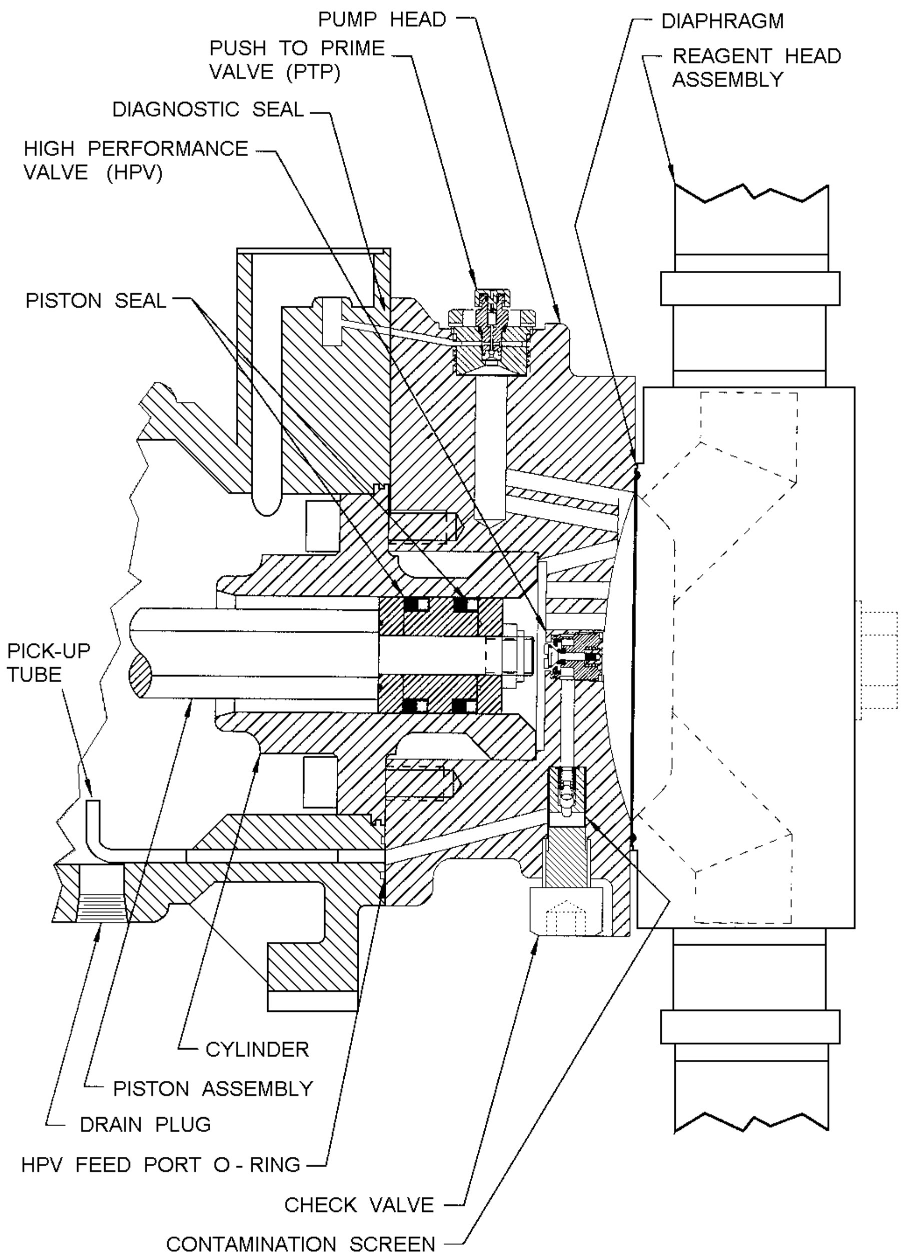


Figure 19

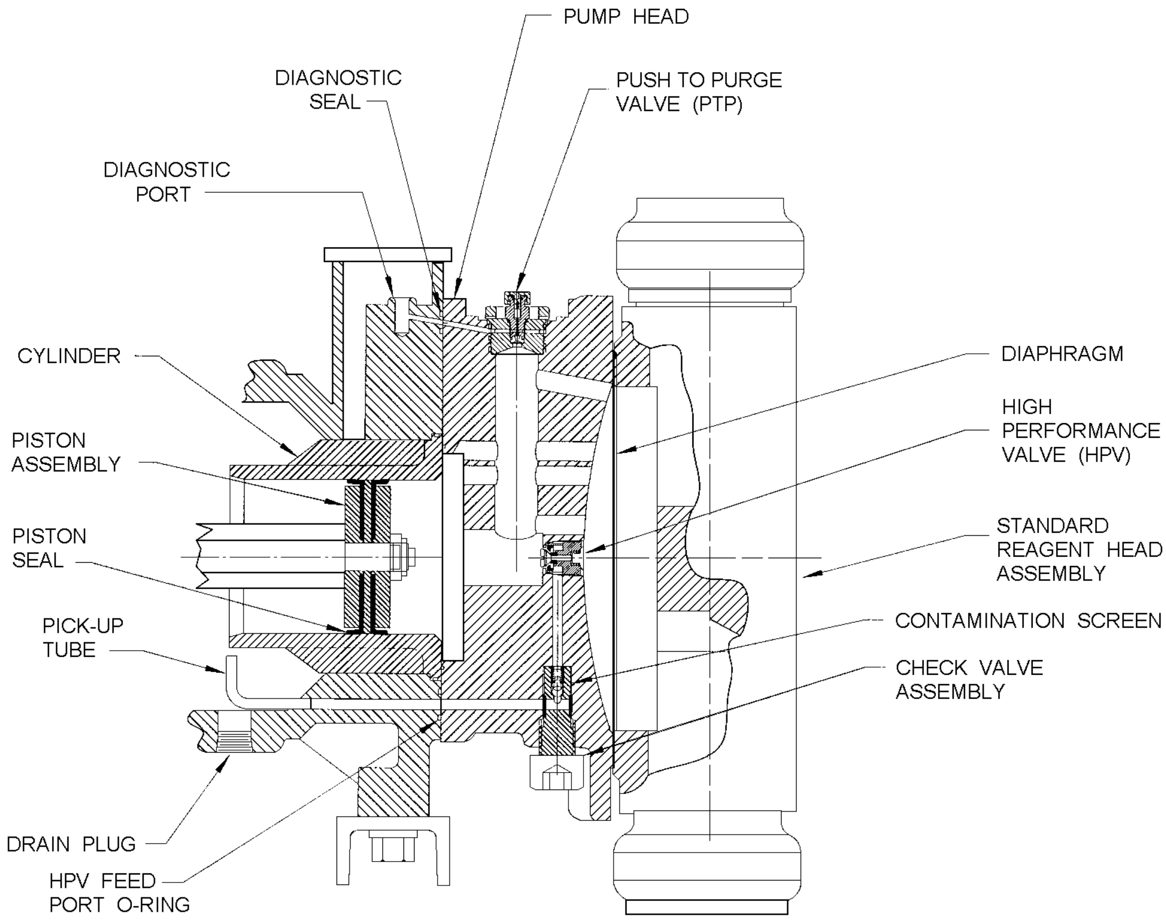


Figure 20

7.6.1 General Description

The piston seals are of molded plastic or leather piston cup construction. Two different seal arrangements are used. On the 1 - 3" pistons, refer to ***Figure 19***. On the 4 – 5” pistons refer to ***Figure 20***. With oil changes at recommended intervals, piston seals should give years of service.

7.6.2 Piston Seal Removal (1 - 3" pistons)

Piston Seal Removal Procedure

1. Remove the reagent head and diaphragm (refer ***to Section 7.1, Wet End Removal, Inspection and Reinstallation***).
2. Using proper hoisting techniques, support the pump head.
3. Remove the six nuts that secure the pumphead to the intermediate housing.
4. Carefully slide the pumphead/cylinder assembly straight off the piston assembly, taking care not to damage the threaded studs.
5. Remove the piston retaining bolt and the piston assembly parts.
6. Wipe the piston end and the inside of the piston assembly parts clean.

7.6.3 Piston Seal Reinstallation (1 - 3" pistons)

Piston Seal Reinstallation

It is important to apply an anaerobic thread locking compound to the threads of the hex nut and torque to 140 foot-pounds to prevent loosening during operation.

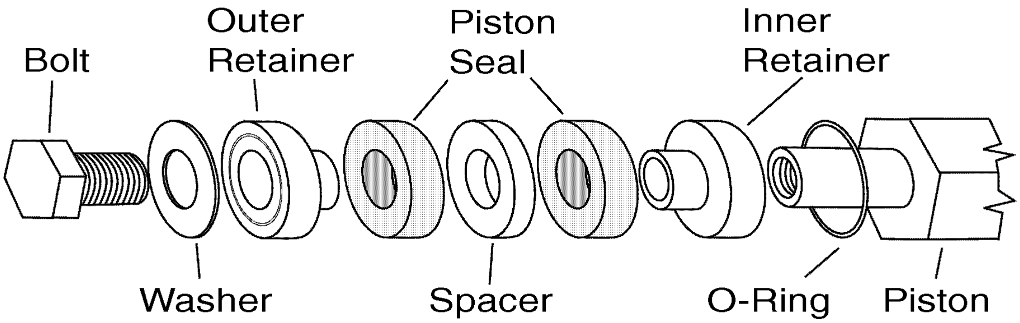


Figure 21

7. Apply *PULSA*lube 7H hydraulic oil to the piston seals, retainer, piston end, and the O-Ring.
8. Position and press the O-Ring into place in the Inner Retainer O-Ring groove.

NOTE **There are two retainers in the piston assembly. These retainers are identical and have been named “Inner” and “Outer” only for documentation purposes. Remember that the retainer closest to the piston must have an O-Ring installed.**

9. Place the Piston Seal on the Inner Retainer.
10. Slide the Inner Retainer / Piston Seal / O-Ring assembly onto the piston.
11. Slide the Spacer on the Piston.
12. Place the Piston Seal on the Outer Retainer.
13. Slide the Outer Retainer / Piston Seal assembly onto the piston.
14. Insert and tighten the bolt and washer assembly into the end of the piston.
15. Using proper lifting techniques, position and then connect the pump head assembly to the Intermediate Housing.
16. Replace the reagent head and diaphragm (refer to ***Section 7.1, Wet End Removal, Inspection and Reinstallation***).
17. Fill the eccentric box with *PULSA*lube 7H hydraulic oil and prime the pump head (refer to ***Section 6 – Equipment Startup***).

7.6.4 Piston Seal Removal (4 - 5" pistons)

Piston Seal Removal Procedure

1. Remove the reagent head and diaphragm (refer to ***Section 7.1, Wet End Removal, Inspection and Reinstallation***).
2. Using proper hoisting techniques, support the pump head and intermediate housing.
3. Remove the eight nuts that secure the intermediate housing to the eccentric housing.
4. Carefully remove the intermediate housing / pumphead assembly, taking care not to damage the threaded studs.
5. Remove the piston retaining nut and the piston seal assembly parts.
6. Wipe the piston end and the inside of the piston assembly parts clean.

7.6.5 Piston Seal Reinstallation (4 - 5" pistons)

Piston Seal Reinstallation

It is important to apply an anaerobic thread locking compound to the threads of the hex nut and torque to 140 foot-pounds to prevent loosening during operation.

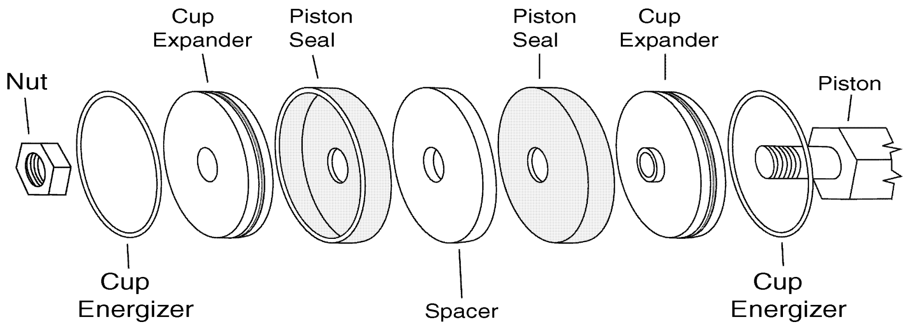


Figure 22

1. Apply *PULSA*lube 7H hydraulic oil to the piston seals, Expander, piston end, and Energizer.
2. Position and press the Cup Energizer into place on both of the Cup Expanders.

NOTE **There are two retainers in the piston assembly. These retainers are identical and have been named "Inner" and "Outer" only for documentation purposes. Remember that the retainer closest to the piston must have an O-Ring installed.**

3. Place the Piston Seal on one of the Cup Expander / Cup Energizer assembly's.
4. Slide the Piston Seal / Cup Expander / Cup Energizer assembly onto the piston.
5. Slide the Spacer on the Piston.
6. Place the Piston Seal on the remaining Cup Expander / Cup Energizer assembly.
7. Slide this Piston Seal / Cup Expander / Cup Energizer assembly onto the piston..
8. Thread and then tighten the bolt into the end of the piston.
9. Using proper lifting techniques, position and then connect the intermediate housing / pump head assembly to the eccentric box.
10. Replace the reagent head and diaphragm (refer to ***Section 7.1, Wet End Removal, Inspection and Reinstallation***).
11. Fill the eccentric box with *PULSA*lube 7H hydraulic oil and prime the pump head (refer to ***Section 6 – Equipment Startup***).

7.7 Oil Seals

7.7.1 General Description

The 9490 pump has three oil seals:

Motor Adaptor Seal	Inside the motor adaptor, below the worm shaft coupling.
Gearbox Oil Seal	Inside the mounting flange of the gearbox.
Eccentric Box Seal	Side of the eccentric cap where the eccentric shaft protrudes.

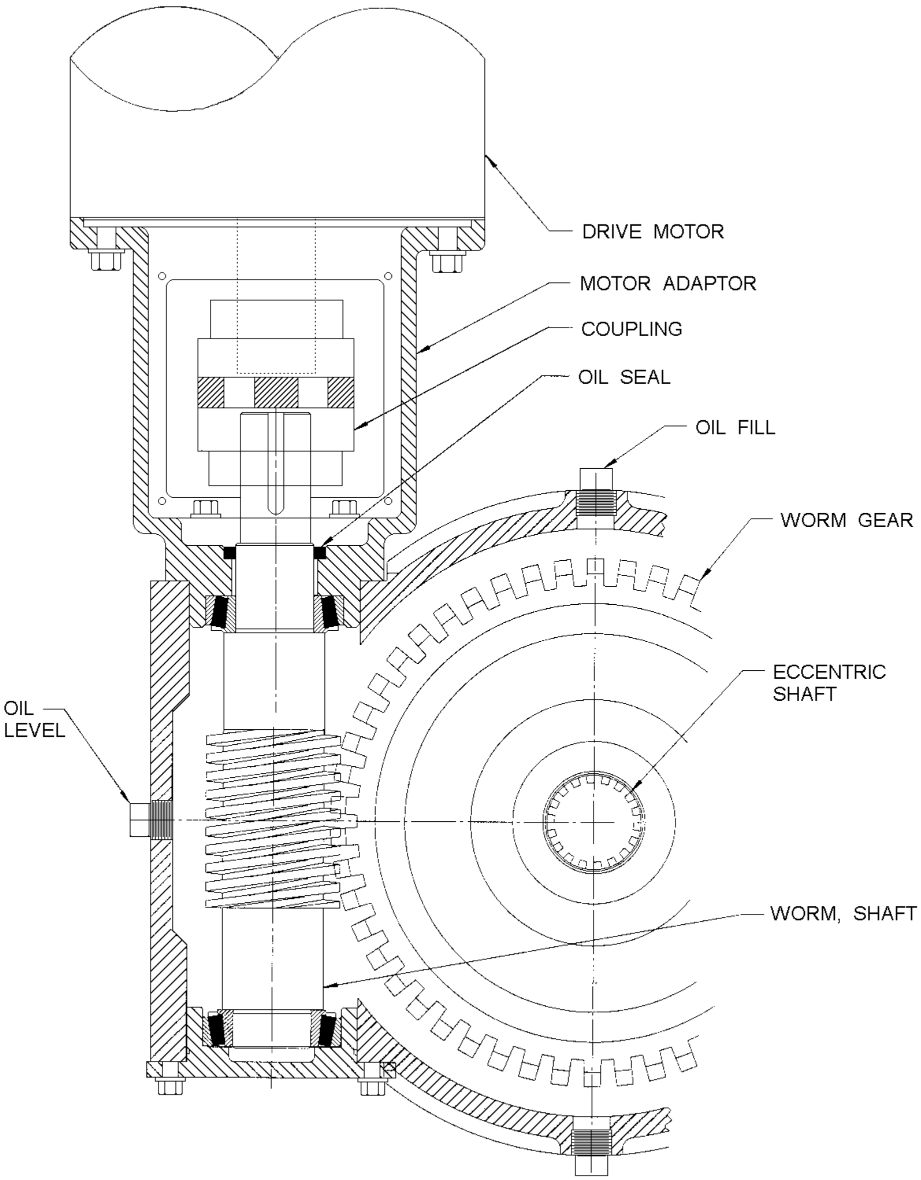


Figure 23

7.7.2 Oil Seal Removal and Replacement

7.7.2.1 Motor Adaptor Oil Seal Removal and Replacement

1. Remove power from the 9490 pump assembly.
2. Attach required lifting device to the motor.
   Do not put any tension on the pump motor at this time.
3. Remove the four Motor Attachment Bolts from the motor (refer to *Figure 24*).
4. Open the Access Panel by removing the four Access Panel Screws.

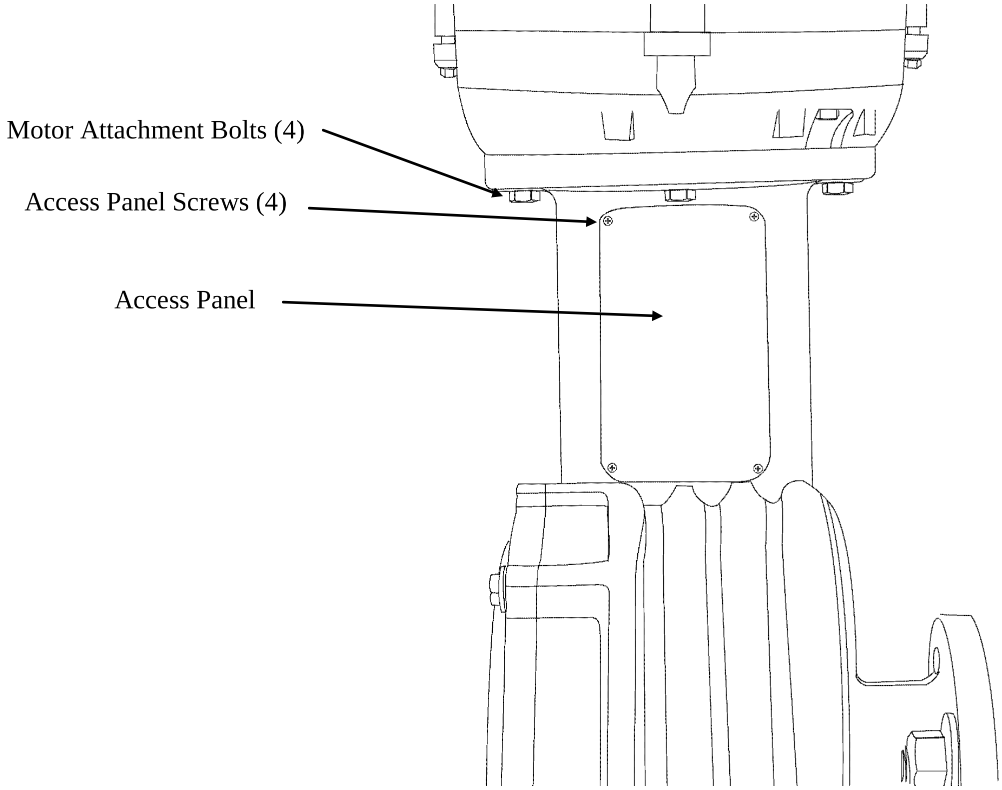


Figure 24

5. Remove the Motor and Upper Coupling assembly by lifting straight up.
6. Rotate the Lower Coupling Assembly by hand until the Coupling Setscrew is visible.
7. Loosen the Lower Coupling Setscrew.

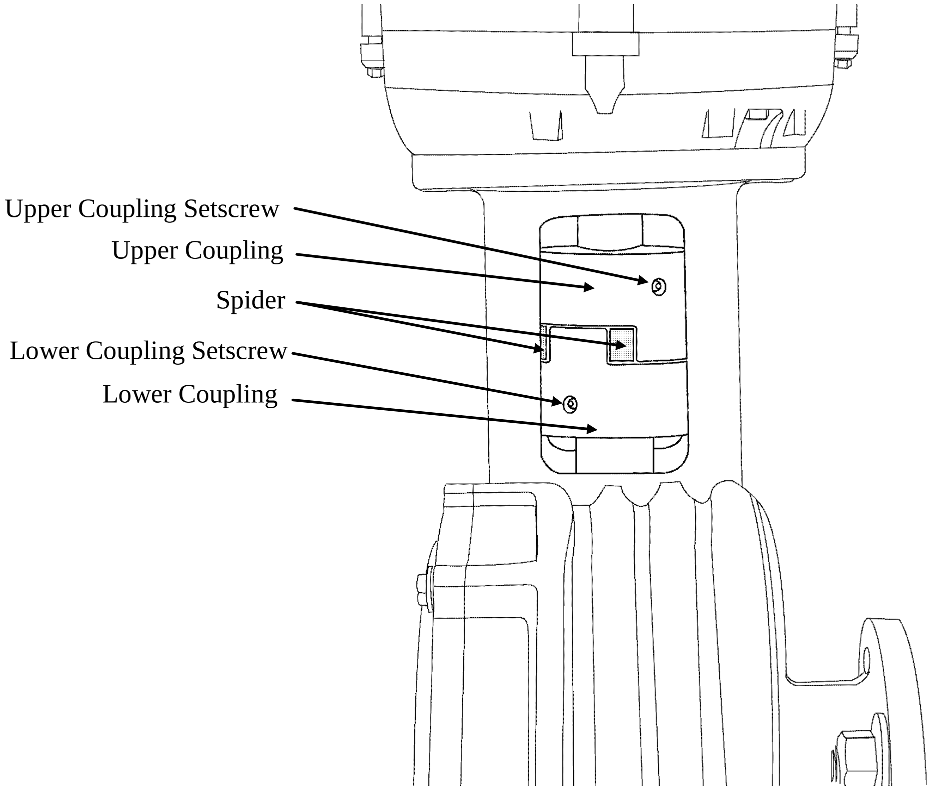


Figure 25

8. Remove the lower coupling and coupling spider.
9. Remove the four motor adapter bolts and lift the motor adapter from the gearbox.
   Take care not to lose the shim(s) {if present} from between the motor adapter and gearbox.

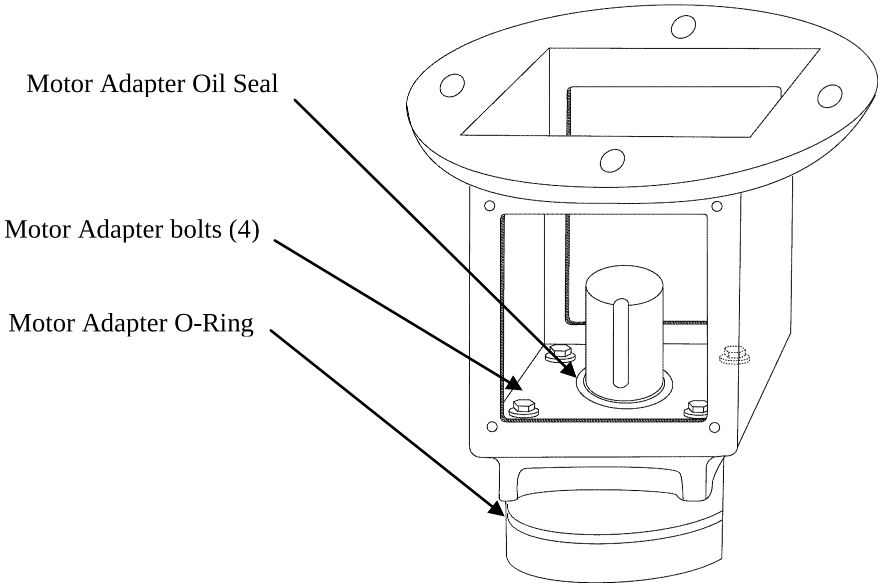


Figure 26

10. Remove the Motor Adaptor oil seal from the motor adapter.
11. Lubricate the replacement Motor Adaptor oil seal with silicone grease or *PULSA*lube 9M gear oil.
12. Install the Motor Adaptor oil seal by pressing it into position.
13. Start the re-assembly process by inspecting the Motor Adaptor o-ring.

    If there is no damage visible the o-ring can be reused.
14. Lightly coat the Motor Adaptor o-ring with silicone grease or *PULSA*lube 9M gear oil.
15. Verify that all shims (if there were any) are in place.
16. Install the Motor Adaptor over the gearbox worm shaft, taking care to not cut the seal and then bolt in place.

    The worm gear shaft is to have .003 max end play.
17. Slip the Lower Coupling and Spider over the worm gear shaft.
18. Position the coupling half flush to the end of the worm shaft.
19. Tighten the setscrew.
20. Lower the motor / Upper Coupling into position.

    As you are positioning the motor, it may be necessary to rotate the Lower Coupling / Spider assembly to facilitate proper alignment.
21. Once the coupling is aligned, lower the motor assembly until full contact has been made with the lower coupling.
22. Insert and tighten the motor mounting bolts that were removed in Step 3.
23. Restore power to the 9490 pump assembly.

7.7.2.2 Gearbox Oil Seal Removal and Replacement

1. Remove all power from the 9490 assembly.
2. Attach required lifting device to the motor.
   Do not put any tension on the pump motor at this time.
3. Remove the four Motor Attachment Bolts from the motor (refer to ***Figure 24***).
4. Open the Access Panel by removing the four Access Panel Screws.
5. Remove the Motor and Upper Coupling assembly by lifting straight up.
   Place the Motor and Upper Coupling assembly aside, taking care not to damage the Upper Coupling assembly.

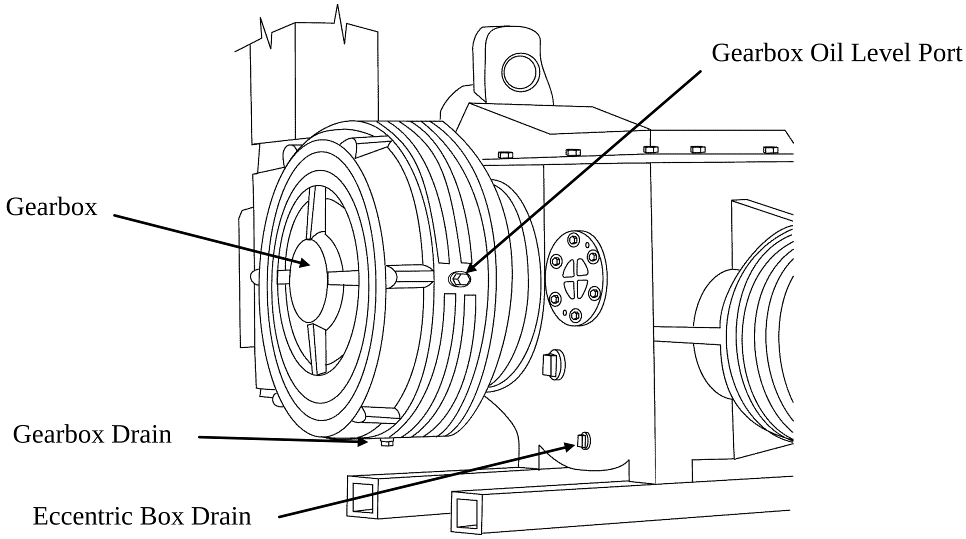


Figure 27

6. Drain the gearbox.

NOTE **While draining the gearbox, check the fluids for any sign of contamination. If the heavy gear oil appears contaminated, replace it.**

7. Connect the required lifting device to the gearbox.
8. Loosen the four gearbox mounting nuts.
9. Put a light amount of tension on the gearbox.
10. Remove the four gearbox mounting nuts.
11. Remove the gearbox from the eccentric box, sliding it off the eccentric shaft.
    Support the gearbox appropriately to be able to pull it off horizontally.

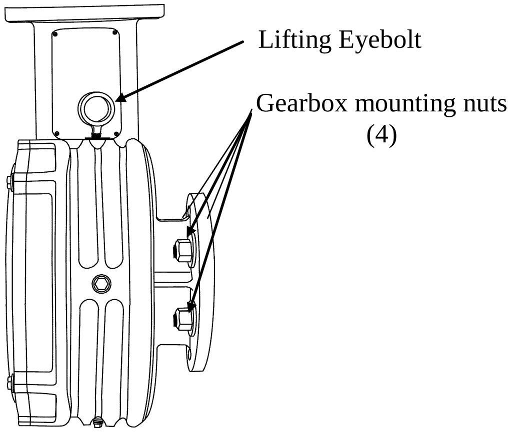


Figure 28

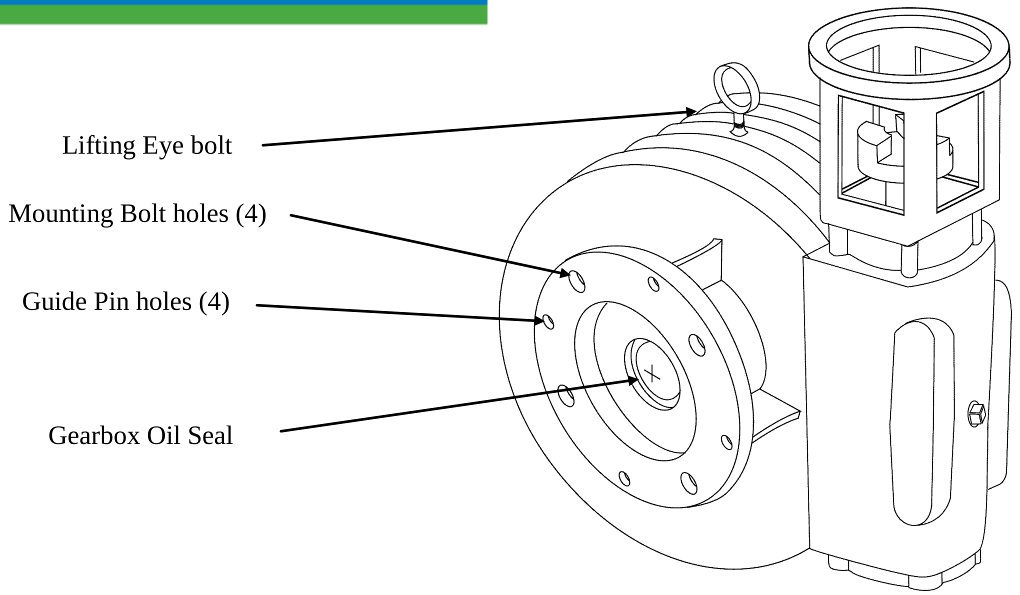


Figure 29

12. Remove the gearbox oil seal.
13. Lubricate the replacement with silicone grease or *PULSA*lube 9M gear oil.
14. Install the oil seal by pressing into position.
15. Reinstall by reversing the disassembly procedure.
    Take care not to damage the seal when reinstalling the gearbox.
16. Refill the gearbox with *PULSA*lube 9M gear oil.

7.7.2.3 Eccentric Box Oil Seal Removal and Replacement

1. Remove the gearbox following the procedure defined in ***Section 7.7.2.2***.
2. Drain the hydraulic fluid from the eccentric box

NOTE **While draining the Eccentric, check the hydraulic fluid for any sign of contamination. If the hydraulic fluid appears contaminated, replace it.**

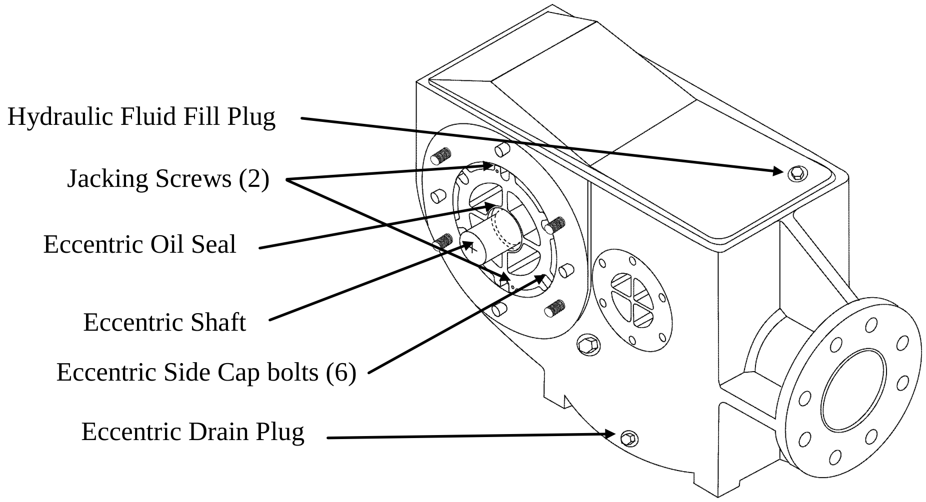


Figure 30

3. Remove the six bolts that retain the eccentric side cap to the eccentric box.
4. Insert the two 1/4 X 20 jacking screws into the eccentric side cap.
5. Use the Jacking screws to break the eccentric side cap free from the eccentric box.
6. Remove the eccentric side cap and support the eccentric shaft.
   Keep track of any shims present for later reinstallation.

NOTE **Once the side cap is free, remove and store the jacking screws for later use. Do not attempt to reinstall the side cap with the jacking screws in place.**

7. Remove the Eccentric Box Oil seal.

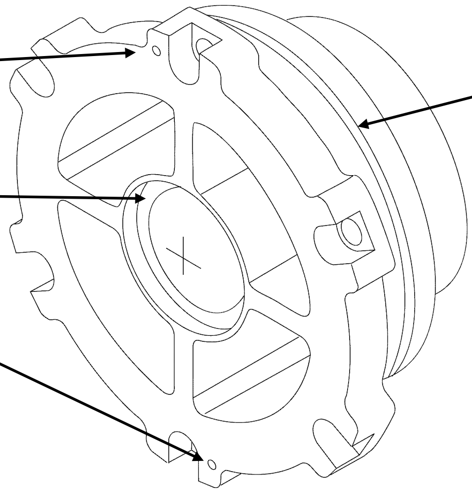


Figure 31

8. Lubricate the replacement O-Ring with silicone grease, and install by pressing into position.
9. Lubricate the cap O-Ring with silicone or *PULSA*lube 7H oil before reinstallation.
10. Reinstall by reversing the disassembly procedure.
    Maximum eccentric shaft endplay is .003 inches.
11. Refill the eccentric box with *PULSA*lube 7H hydraulic fluid.
12. Place the 9490 system in its normal operating condition.

7.8 Cover Assembly

7.8.1 Cover Assembly Removal and Reinstallation

The handwheel on manually controlled pumps is linked to the oscillating housing by universals, and a telescoping slip joint (refer to ***Figure 33***). When the cover is removed, the relationship between the two halves of the joint must be maintained or pump calibration will be affected.

Cover Assembly Removal

1. Press and hold the handwheel in and then turn in a counter clockwise direction to adjust the stroke length dial indicator to zero.

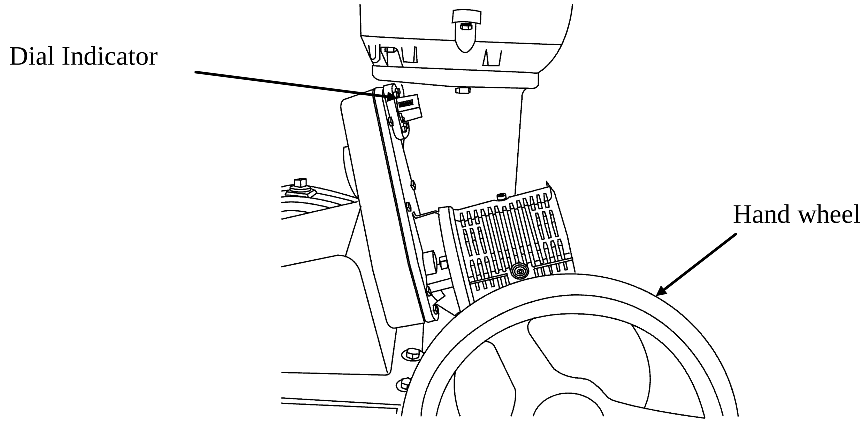


Figure 32

Use caution when approaching the 0000 mark. It is possible for the dial indicator to go beyond zero. Allow the handwheel locking mechanism to engage to the nearest detent.

2. Disconnect the power source to the drive motor.
3. Remove the 12 cover screws.
4. Pull the cover back away from the pump head and lift off. Use care not to rotate the adjustment shaft. Slip the square shaft out of the square tube without turning the shafts.

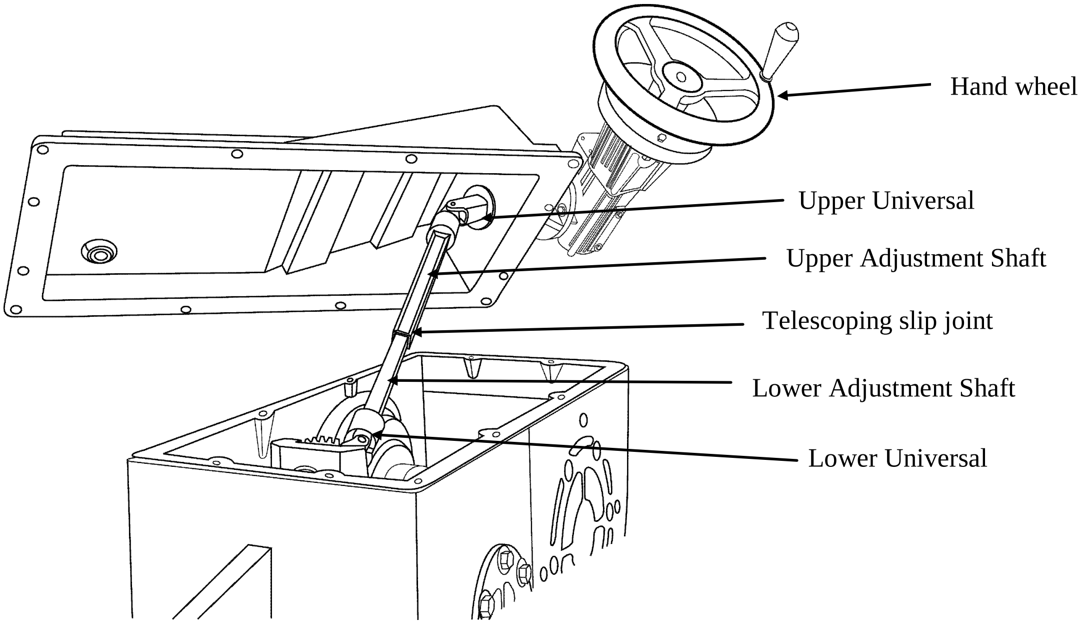


Figure 33

Cover Assembly Reinstallation

If the lower adjustment shaft has been turned while the cover was removed from the pump, the stroke control needs to be re-calibrated.

1. Turn the lower adjustment shaft counterclockwise until the slide block stops against the top of the oscillating housing (refer to ***Figure 5***).
2. Turn the adjustment shaft clockwise 2 full turns.

   The stroke control is now at the zero position.
3. Coat all surfaces of the slip joint assembly with silicone grease.
4. Verify the dial indicator registers zero.
   a) Angle the front of the cover up to expose the square tube.
   b) While holding the tube, carefully move the cover forward to engage the shaft (refer to ***Figure 34***).

IMPORTANT!!! The shaft and tube must be reassembled with the same orientation as when the cover was removed.

5. Place the cover on top of the gearbox and replace the screws.

   The indicator should read zero within 0005. If it does not, then remove the cover, turn the handle until it reads zero, and reinstall it as described in Step 2.
6. After re-assembly, turn the handle a few turns in both directions to check for proper operation.

7.9 Motor Removal and Reinstallation

1. Remove power from the 9490 pump assembly.
2. Disconnect the motor wiring from the motor.
3. Attach required lifting device to the motor.

   Do not put any tension on the pump motor at this time.
4. Remove the four Motor Attachment Bolts from the motor (refer to ***Figure 24***).

   Some European motors will have eight bolts
5. Open the access panel by removing the four access panel screws to expose the coupling.

NOTE **The coupling is an interlocking jaw design and uses an elastomer spider between the two coupling halves. The upper half of the coupling remains on the motor shaft and the lower half stays on the gear shaft.**

6. Lift the motor from the mounting adaptor.
7. If the motor is to be replaced, position the “old” motor so that the upper coupling is accessible.
8. Loosen the upper coupling setscrew to allow removal of the upper coupling half, taking care to not lose the shaft key.
9. Install the upper coupling half on the shaft of the replacement motor, ensuring that the shaft key is in place.
10. Align the end of the shaft flush with the inner surface of the coupling and tighten the setscrew.
11. Reinstall the motor by reversing the steps above.

8. Replacement Parts

8.1 PULSA Series KOPkit Program

PULSA Series KOPkits contain all replacement parts normally used in a preventative maintenance program. (*PULSA*lube 7H hydraulic and *PULSA*lube 9M gear oils are also available for preventative maintenance programs. Refer to the Equipment Startup section).

There is a specific KOPkit for every *PULSA* Series pump model. When practical, each KOPkit is vacuum-packed for extended storage.

All *PULSA* Series pumps will have the KOPkit number identified on:

a) the pump nameplate,

b) the specification data sheet,

c) the Pulsafeeder order documents.

KOPkits can also be selected from the technical data sheet shipped with the pump or by a Pulsafeeder representative.

8.2 Ordering KOPkits or Parts

When ordering replacement parts always specify:

a) Pump model and serial number (stamped on pump nameplate), e.g., Model No. NPH9490A0001 with Serial No. B216245.

b) Part number and description from the PULSA Series parts list. Include the three-character suffix.

NOTE **PULSA Series part numbers begin either with the letters "NP", or the letter "W", e.g., NP170001-TNR or W210221-001.**

9. Troubleshooting Chart

Difficulty	Probable Cause	Remedy
Pump does not start	1. Coupling disconnected	Connect coupling
	2. Faulty power source	Check power source
	3. Blown fuse, circuit breaker	Replace - eliminate overload
	4. Broken wire	Locate and repair
	5. Wired improperly	Check wiring diagram
	6. Closed line valves	Open valves
No delivery	1. Motor not running	Check power source. Check wiring diagram
	2. Supply tank empty	Fill tank
	3. Lines clogged	Clean and flush
	4. Closed line valves	Open valves
	5. Check valves held open with solids	Clean - inspect
	6. Vapor lock, cavitation	Increase suction pressure
	7. Prime lost	Reprime, check for leak
	8. Strainer clogged	Remove and clean. Replace screen if necessary
	9. Hydraulic system underprimed	Refer to ***Repriming the Pump***
Low delivery	1. Motor speed too low	Check voltages, frequency, wiring, and Terminal connections. Check nameplate vs. Specifications.
	2. Check valves worn or dirty	Clean, replace if damaged
	3. Hydraulic bypass valve operating each stroke	Refer to ***Hydraulic Bypass Valve***
	4. Calibration system error	Evaluate and correct
	5. Product viscosity too high	Lower viscosity by increasing product temperature. Increase pump and/or piping size
	6. Product cavitating	Increase suction pressure. Cool product as necessary
	7. Piston seal worn or damaged by contamination	Inspect and replace if necessary, refer to ***Piston Seal***.
Delivery gradually drops	1. Check valve leakage	Clean, replace if damaged
	2. Leak in suction line	Locate and correct
	3. Strainer fouled	Clean or replace screen
	4. Product change	Check viscosity
	5. Bypass leakage	Correct for bypass valve leakage
	6. Piston seal worn or damaged by contamination	Inspect and replace if necessary refer to ***Piston Seal***
	7. Supply tank vent plugged	Unplug vent
Delivery erratic	1. Leak in suction line	Locate and correct
	2. Product cavitating	Increase suction pressure
	3. Entrained air or gas in product	Consult factory for suggested venting
	4. Motor speed erratic	Check voltage and frequency
	5. Fouled check valves	Clean, replace if necessary
Delivery higher than rated	1. Suction pressure higher than discharge pressure	Install back pressure valve or consult factory for piping recommendations
	2. Discharge piping too small	Increase pipe size - install pulsation dampener in discharge line
	3. Back pressure valve set too low	Increase setting
	4. Back pressure valve leaks	Repair, clean, or replace

Difficulty	Probable Cause	Remedy
Pump loses hydraulic oil	1. Diaphragm ruptured	Replace
	2. Leaky seal	Replace
	3. Cover gasket leaks	Replace or retighten
	4. Eccentric box overfilled	Remove excess oil
Air bleeds continuously from PTP (automatic bleed valve)	1. Hydraulic oil level low	Refill to correct level
	2. Hydraulic bypass valve operating each stroke	Refer to ***Hydraulic Bypass Valve***
	3. Suction pressure too low	Increase pressure
	4. Oil breakdown. Temperature high	Change oil type, consult factory
	5. Plugged hydraulic refill inlet check	Clean contamination screen
Noisy gearing, knocking	1. Discharge pressure too high	Reduce pressure
	2. Water hammer	Install pulsation dampener
	3. Hydraulic bypass valve set too high	Readjust (refer to ***Hydraulic Bypass Valve***)
	4. Stroke length at partial setting	Nondestructive knocking sometimes occurs at reduced stroke lengths.
Piping noisy	1. Pipe size too small	Increase size of piping – install pulsation dampener
	2. Pipe runs too long	Install pulsation dampener in line
	3. Surge chamber flooded	Replace with air or inert gas. If a pulsation dampener is installed, replace diaphragm and recharge
	4. No Pulsation Dampener used	Install pulsation dampener
Motor overheats	1. Pump overloaded	Check operating conditions against pump design requirements
	2. High or low voltage	Check power source
	3. Loose wire	Trace and correct
Diaphragm Damage	1. Diaphragm extruded into pumphead holes	Check and clean oil contamination screen. Reduce discharge pressure to pump design limits. Relieve discharge pressure before stopping pump.
	2. Diaphragm extrudes into pumphead holes	Verify PTP bleeder is bypassing oil. Increase dynamic suction pressure to at least 5 psia. Replace or clean hydraulic performance valve. Replace worn piston seals.

10. Appendix I – Piping Calculations

Suction Head Requirements

All reciprocating metering pumps require a net positive suction head (NPSHR). Refer to ***Table 1*** for the (NPSHR) required for PULSA Series pump models. The NPSHR is defined as the pressure required above the absolute vapor pressure of the process fluid at the pumping temperature. This pressure is required at the suction port of the pump throughout the entire pump stroking cycle in order to prevent cavitation of the process fluid within the reagent head. The NPSHR is one of the requirements necessary to assure metering accuracy.

$NPSH_R$	
English (psi)	5
Metric (bar)	0.35

Table 1. $NPSH_R$ values

The net positive suction head available ($NPSH_A$) must be greater than the $NPSH_R$. The $NPSH_A$ of any given system is calculated as follows for comparison to the $NPSH_R$ as shown in Table 1.

Equation 1 – For fluid viscosity below 50 centipoise.

$$NPSH_A = P_A \pm P_H - P_V - \left(\frac{L_S RGQ}{C_1 d^2} \right)$$

Equation 2 – For fluid viscosity above 50 centipoise.

$$NPSH_A = P_A \pm P_H - P_V - \sqrt{\left(\frac{L_S RGQ}{C_1 d^2} \right)^2 + \left(\frac{L_S \mu Q}{C_2 d^4} \right)^2}$$

The variables used in Equations 1 through 5 must be in the units shown in Table 2 for the constants listed below to be used correctly.

Variable	Units Set	
	English	Metric
NPSH	psi	bar
P_A	psia	bar(a)
P_H	psi	bar
P_V	psia	bar(a)
L_S	feet	meters
R	strokes/min	strokes/min
G	no units	no units
Q	gallons/hr	liters/hr
d	inches	millimeters
μ	centipoise	centipoise
L_D	feet	meters
P_T	psi	bar
P_P	psi	bar
V_P	feet/sec	meters/sec
C_1	24,600	640
C_2	45,700	1.84
C_3	46.8	0.91

Table 2. Unit sets and constant values for use in Equations 1 through 5.

NOTE **If piping sizes vary throughout the suction line, different additive values may be used for the pressure losses attributed to the liquid's acceleration and deceleration.**

NOTE **Use the last term of Equation 1 or 2 as many times as needed in the equation to adjust for different lengths of different pipe diameters in the suction line. (Everything but the pipe length and diameter will stay the same in the equation.)**

NOTE **All reciprocating metering pumps also require that a minimum absolute pressure, minimum suction head (MSH), be maintained at the pump inlet throughout the pumping cycle to ensure a stable hydraulic system and proper pump operation.**

MSH	
English, (psia)	5.0
Metric, (bar(a))	0.35

Table 3. Minimum values for the sum of NPSHA and vapor pressure. (MSH)

NOTE **The sum of the NPSHA and the vapor pressure (P_V) must be greater than the values shown in *Table 3*.**

System Back Pressure

The system back pressure must exceed the suction pressure by at least 25 psi (1.7 bar) in order to prevent flowthrough, however it must not exceed the rated discharge pressure of the pump.

Flowthrough can be defined as the process liquid flowing from a higher pressure to a lower pressure (downhill pumping), which attributes to pump failure and undesired flow at pump shutdown.

If the system back pressure is not at least 25 psi (1.7 bar) greater than the suction pressure, a back pressure valve must be installed in the discharge piping. To calculate the system's total back pressure use Equation 3 or 4 below.

Equation 3. For fluid viscosity below 50 centipoise.

$$P_T = \left(\frac{L_D RGQ}{C_1 d^2} \right) + P_P \pm P_H$$

Equation 4. For fluid viscosity above 50 centipoise.

$$P_T = \sqrt{\left(\frac{L_D RGQ}{C_1 d^2} \right)^2 + \left(\frac{L_D \mu Q}{C_2 d^4} \right)^2} + P_P \pm P_H$$

Nomenclature

$NPSH_R$	=	Net positive suction head required, [psi, bar]
$NPSH_A$	=	Net positive suction head available, [psi, bar]
P_A	=	Pressure at the surface of the liquid being pumped (atmospheric or supply tank blanket pressure) [psi(a), bar(a)]
P_H	=	Head pressure above (+) or below (-) the pump centerline, [psi, bar,] (convert from ft or m)
P_V	=	Absolute vapor pressure at pumping temperature of the process liquid at pump inlet, [psi(a), bar(a)]
L_S	=	Length of suction piping (actual, not equivalent), [ft, m]
R	=	Pump stroking rate, strokes/min [spm]
G	=	Specific gravity of process liquid, [no units]
Q	=	Pump average flow rate, [gph, lph]
d	=	Internal pipe diameter, [inches, mm]
C_1 ,C_2 ,C_3	=	Numeric constants used in Equations 1- 5 [no units]
μ	=	Viscosity of process liquid at pumping temperature, centipoise [cp]
L_D	=	Length of discharge piping (actual, not equivalent), [ft, m]
P_P	=	System discharge pressure, [psi(g), bar(g)]
P_T	=	Peak pump discharge pressure at the discharge port, [psi(g), bar(g)]
V_P	=	Peak liquid velocity generated by the pump, (suction or discharge) [ft/s, m/s]

11. Appendix II – Oil Specifications

*PULSA*lube #7H

API Gravity (ASTM D 287) = 31

Viscosity (ASTM D 2161) 175 SSU @ 100°F (38°C)

Viscosity (ASTM D 2161) 51 SSU @ 210°F (99°C)

Viscosity Index (ASTM D 2270) = 193

Pour Point (ASTM D 97) – 60°F (–51°C)

Flash Point, COC (ASTM D 92) 367°F (186°C)

Fire Point, COC (ASTM D 92) 403°F (205°C)

Color = purple

*PULSA*lube #9M

AGMA Number = 7

ISO Viscosity Grade = 460

API Gravity = 28.7

Viscosity (ASTM D 2161) 2100 SSU @ 100°F (38°C)

Viscosity (ASTM D 2161) 141 SSU @ 210°F (99°C)

Viscosity Index (ASTM D 2270) = 159

Pour Point (ASTM D 67) – 10°F (– 24°C)

Flash Point, COC (ASTM D 92) 560°F (293°C)

Timken OK Load (ASTM D 2782) Lb (kg) = 100lb (45kg)

Four Ball EP Test (ASTM D 2783)

- Weld Point kg = 255
- Load Wear Index = 44

Rust Test (ASTM D 665A&B) = Pass

Oxidation Test (ASTM D 2893) = Pass

Demulsibility Test (ASTM D 2711) = Pass

Foam Test (ASTM D 892) = Pass

Copper Corrosion (ASTM D 130) = 1-A

Color = dark amber

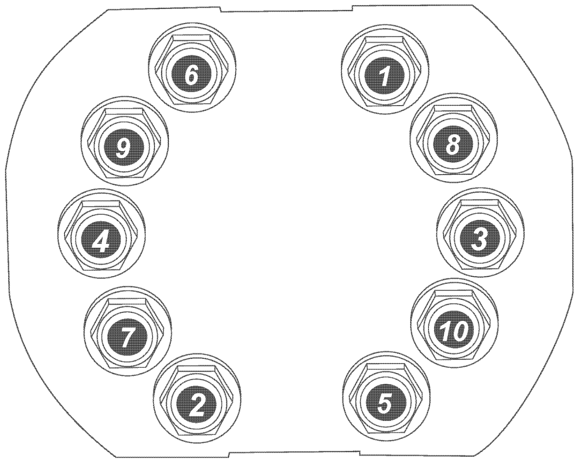
12. Appendix III – Bolt Torque Recommendations

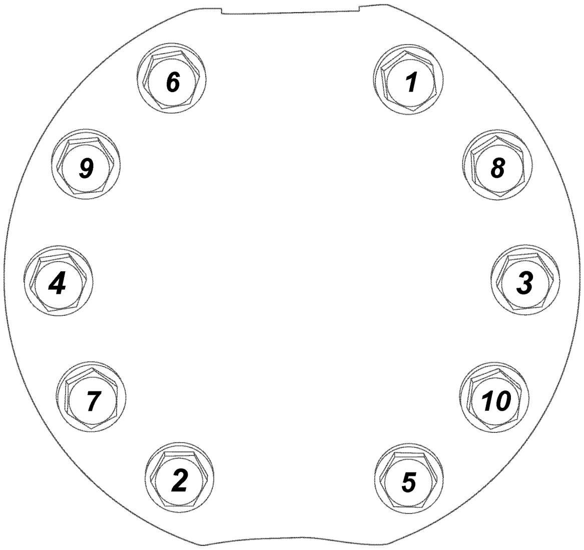
Reagent Head and Tie-Bars

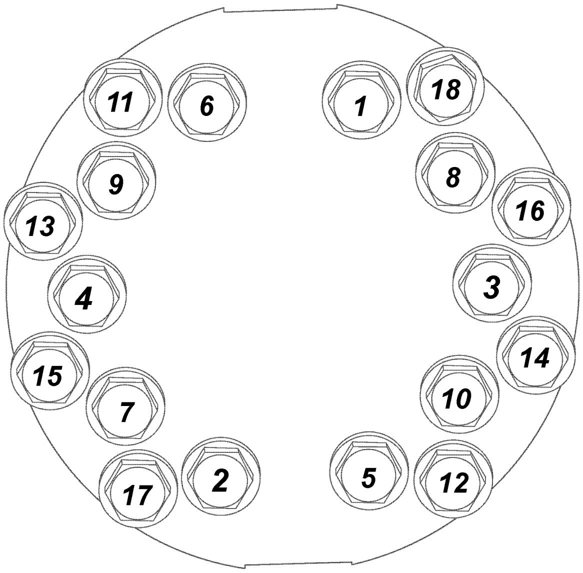
Reagent Head Number	Reagent Head Bolt Size/(Qty)	Torque Ft. Lbs./N-m	Tie Bar Bolt Size	Torque Ft. Lbs/N-m
NP-160083-XXX	1.50 - 6 (10)	1000/1360	1.36 - 6	335/460
NP-160043-XXX	1.00 - 8 (10)	246/330	1.25 - 7	190/260
NP-160044-XXX	1.38 - 6 (10)	656/890	1.50 - 6	190/260
NP-160045-XXX	1.00 - 8 (10)	185/250	1.00 - 8	100/135
NP-160046-XXX	1.00 - 8 (10)	155/210	1.00 - 8	100/135

NOTE

When torquing bolts, make sure you start with bolts equally hand tight. Then torque to one half the specified rating following the bolt patterns below. Once you have completed the first pass, then torque to the final rating.

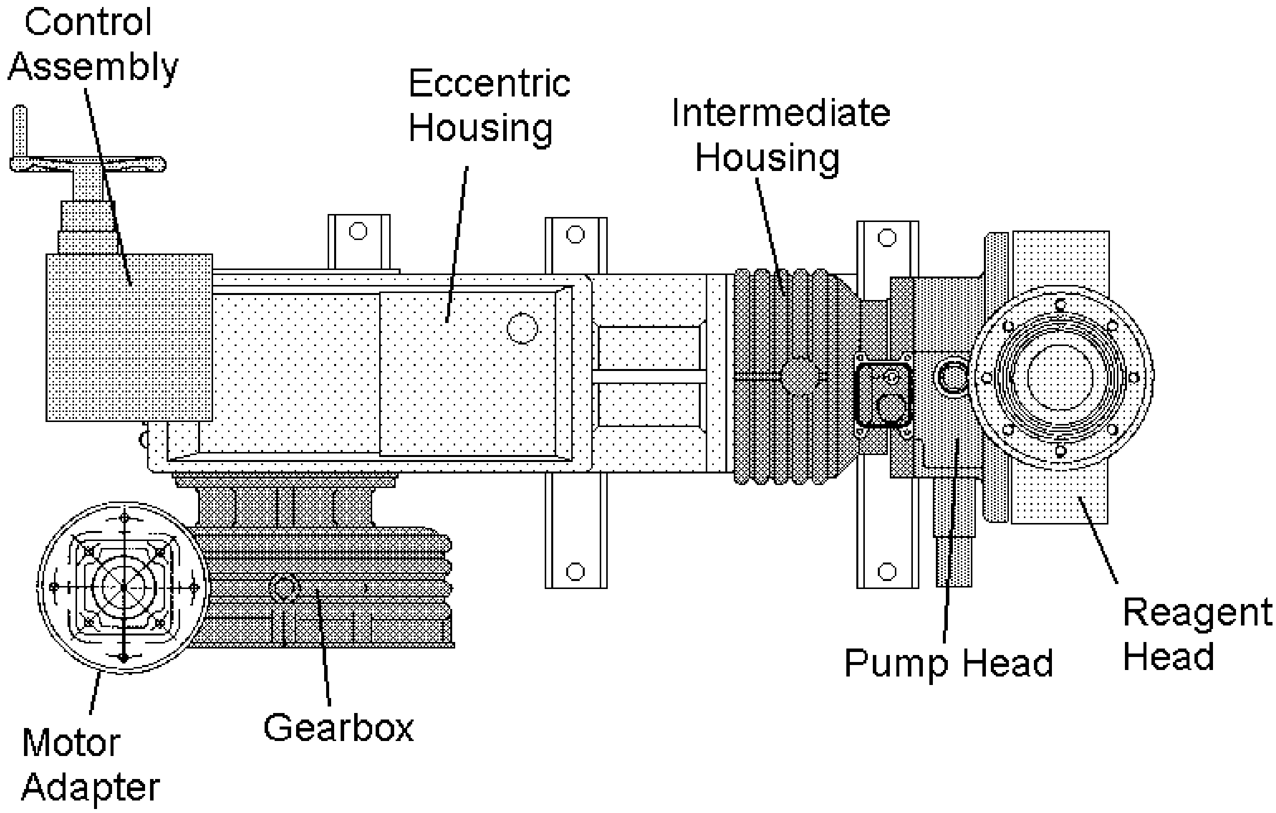






Cylinder Bolts

Piston Size	Bolt Size	Torque Ft. Lbs/N-m
1.5	.75 - 10	250 / 340
2.0	.75 - 10	250 / 340
2.5	.75 - 10	150 / 205
3.0	.75 - 10	150 / 205
4.0	NR	
5.5	NR	



13. Appendix IV PULSAlarm Leak Detection

13.1 PULSAlarm Leak Detection Reagent Head Assembly

The PULSAlarm leak detection reagent head assembly consists of reagent head, leak detection diaphragm, suction and discharge check valves, vacuum bleed port, and optional pressure/vacuum switch and gauge. The reagent head, diaphragm, suction and discharge check valves are the only parts of the pump to contact the process liquid; consequently, maintenance is critical to pump performance

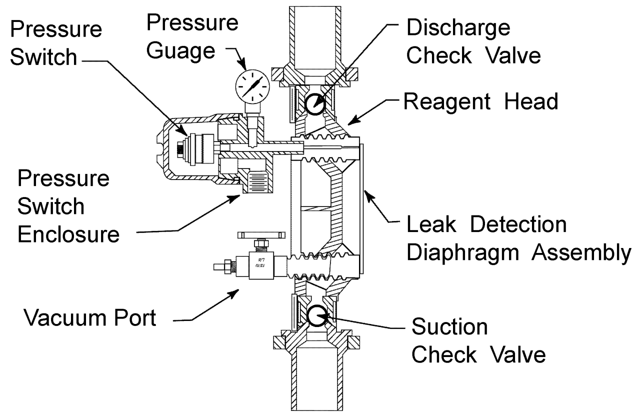


Figure 24

WARNING

A sealed system must be maintained at all times during pump operation, whether leak detection is required or not. If the proper level of vacuum, between 10 in and 26 in. (250mm to 650mm) Hg, or a sealed pressure system is not present, decreased flow and/or diaphragm damage will occur. Please note that the factory setpoint for actuation of the vacuum switch is 6 in (152mm) Hg (vacuum) or 5 psig (pressure).

13.2 PULSAlarm Leak Detection Diaphragm

Double, or sandwiched, TFE diaphragms are sealed at their peripheries to an intermediate metal spacer ring. The space between the diaphragms is sealed so that the diaphragm functions as does a standard single diaphragm. For the vacuum system, the space between the diaphragms is evacuated of air to produce a vacuum. For the pressure system, the space between the diaphragms is filled with a small amount of fluid. At startup, any excess fluid in the system is expelled through the check valve, and then the system is capped and sealed. The fluid as supplied from the factory is a silicone-based oil, but an alternate fluid can be used if compatibility with the materials of construction is verified. This space is connected to an adjustable electrical switch (optional) that actuates in response to loss of vacuum or buildup of pressure resulting from rupture of either or both diaphragms. Switch operation can be used to perform any external function, typically to signal an alarm or turn off the pump. For component location refer to ***Figure26.***

NOTE

PULSAlarm leak detection can utilize a vacuum or pressure detection system. Although both systems are similar, they do utilize different parts and require specific set-up procedures. Always ensure that you are following the procedure correct for your system.

13.3 Leak Detection Option – Setup for Vacuum

A vacuum must be maintained at all times during pump operation, otherwise, the diaphragm halves may separate during the suction stroke of the pump, reducing flow capacity and potentially damaging the diaphragm.

Pumps incorporating the leak detection option are shipped from the factory with the system evacuated to the operating vacuum of 650 mm Hg (26 in. Hg). Due to flexure of the TFE diaphragms during transit and storage, the initial vacuum may not be present at startup. When this occurs, re-evacuate the system to the operating vacuum of 650 mm Hg (26 in. Hg).

12. Apply power to the alarm circuit.
13. Connect a vacuum pump capable of generating 26 inches of vacuum to the Vacuum port, open the needle valve, and evacuate the system. A hand-operated vacuum pump is generally appropriate for this procedure.
14. If required, verify system operation.

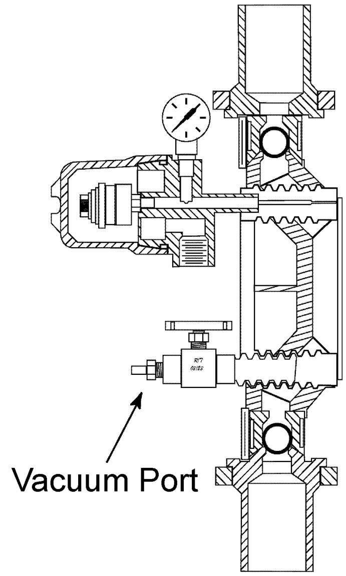


Figure 25

13.4 Leak Detection Option – Setup for Pressure

Pumps incorporating pressure leak detection are shipped from the factory with the system fully set up to work at full pump pressure. No further setup is required. The standard factory barrier fluid is silicone oil, if any other customer-specified media is used it must be compatible with construction materials. The system will require proper setup after maintenance or repairs, see section 11.5 on the following page for the proper procedure.

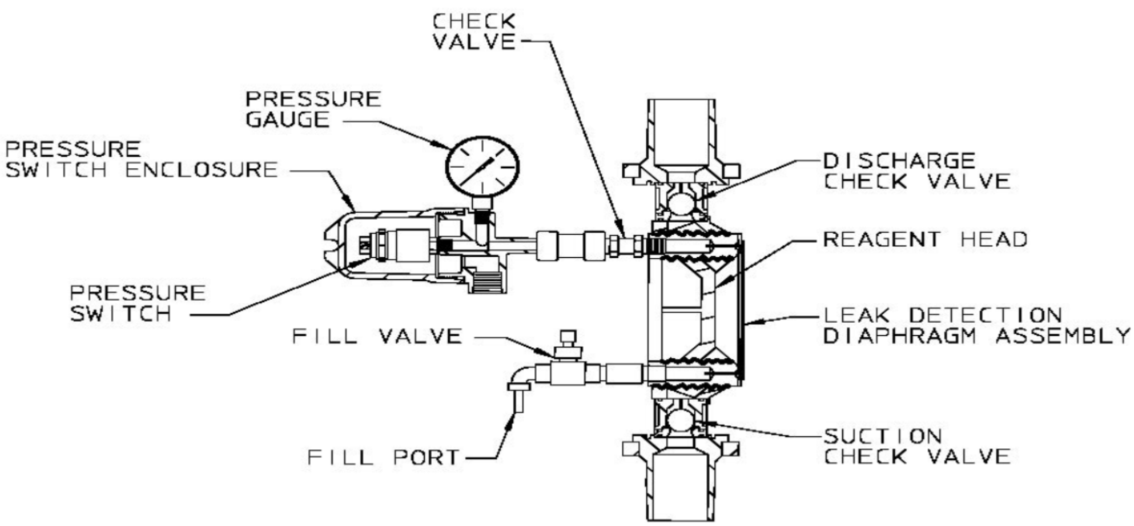


Figure 26

13.5 Pressure System Set-up and Priming

NOTE **If the pressurized leak detection system is opened to the atmosphere during maintenance or inspection, the system must be re-primed properly to avoid diaphragm damage and ensure proper leak detection operation and system performance.**

WARNING **The standard factory intermediate fluid is a Silicone oil. If any other customer-specified media is used, it must be compatible with the materials of construction. Refer to the fluid manufacturer's literature for appropriate safety precautions.**

Use the following procedure to set-up the pressurized leak-detection system:

1. Complete re-assembly of the diaphragm, reagent head, and external components. **Ensure that reagent head and tie-bar bolts are tightened according to the appropriate torque specifications** (consult Appendix III)
2. Remove the pressure gauge from the housing body and replace with the straight tubing connection supplied with the pump or conversion kit. Connect a vacuum supply (hand vacuum pump) to the tube fitting.

NOTE **If the system was previously sealed, you may need to remove the plug and re-install the hose fittings at the fill port. There should be a container in the vacuum line to trap excess barrier fluid. An inexpensive automotive brake bleeding kit is appropriate for this purpose.**

3. Connect the fill tube, supplied with the replacement diaphragm, to the fill valve tubing connection. Any short length of the appropriate sized tubing may be used for this purpose.
4. Open the fill valve.
5. Place the fill tube into a container of the barrier fluid being used.
6. Apply vacuum, the fluid should rise into the fill tube and enter the system.
7. Observe the fluid at the exit (vacuum pump) side. When clear, air free fluid is observed, close the fill valve, while maintaining the vacuum on the system to begin the process of drawing out excess fluid.

NOTE **If you a re-using a previous diaphragm, it will take time for the silicone fluid to migrate through the system, be patient!**

8. Release the vacuum, and remove both the fill tube and the vacuum pump from the fittings.

Continues next page…

9. Empty the fill tube of fluid, and place it on the fitting near the switch, extending upwards, open to the atmosphere.
10. Ensure that the eccentric box of the pump has been filled to the appropriate level with the correct hydraulic fluid.
11. Adjust the pump to the zero stroke (0%) position.
12. **If the pump is not already hydraulically primed**, remove the PTP valve from the top of the pump head. Using a plastic funnel or similar, slowly pour hydraulic fluid into the pump head cavity until full.
13. Inspect the PTP valve to ensure the sealing o-ring is still in position, and re-install the valve.
14. In order to fully balance and evacuate the leak detection system, the pump must now run at normal discharge pressure for a period of one hour. This ensures that excess barrier fluid is fully evacuated from the system.
15. Supply either process fluid, or test fluid (i.e. water) to the suction fitting and ensure that the discharge system is configured for safe operation. The pump can be started with minimal discharge pressure and then slowly brought up to full pressure, if the system allows for this.
16. Apply power and start the pump.
17. Adjust the pump slowly to full (100%) stroke.
18. Hold down the PTP valve momentarily and observe the middle port under the diagnostic cover. If no fluid is coming from this port, stop the pump and return to step 11. If fluid is present, continue to step 19.
19. Slowly increase the discharge pressure to full operating pressure, and continue to run the pump for a period of one hour.
20. During this time, excess barrier fluid will be displaced from the system into the short length of tubing attached to the exit port, balancing the system for proper operation. A small pen mark on the tube can assist in observing this process visually.
21. After the one-hour startup period, remove the tubing and connection from the housing body and reinstall the pressure gage. Remove the fitting from the fill port and replace with the supplied pipe plug.
22. Reconnect the alarm switch to the external system if necessary.
23. The pump and pressure leak-detection system are now properly prepared and ready for normal service. During normal operation, the gauge should indicate 0 (zero) pressure.

NOTE

Under certain circumstances, the system may not completely evacuate excess barrier fluid during the procedure as outlined above. In these cases, after several days run time, a small amount of pressure may build in the system. If this occurs, simply loosen the pressure gauge from the switch housing and relieve a small amount of barrier fluid, returning the system to a zero-pressure state.

NOTE

Once this startup procedure is completed, the pressure leak detection system should require no further maintenance.

13.6 Leak Detection System Maintenance

NOTE **Although the PULSAlarm leak detection system requires minimal maintenance, vacuum must be maintained to prevent false alarms and diaphragm damage.**

13.6.1 Vacuum Setpoint Adjustment

If the optional switch is purchased, it is factory preset at the specified vacuum setpoint, 150 mm Hg (6 in. Hg), at which loss of vacuum causes the vacuum switch to actuate. The standard pressure switch is set to actuate at 5 psig.

❖ **Use the following procedure to perform a Vacuum setpoint adjustment:**

15. Disconnect the alarm circuit from the vacuum switch.
16. Remove the switch enclosure cover and loosen the knurled locking ring on the switch.
17. Rotate the hex adjusting ring counterclockwise to increase or clockwise to decrease the setpoint.
18. Verify the new setpoint (refer to the next section).
19. Repeat steps (3) and (4) above until the required setpoint as attained.
20. Tighten the switch locking ring and replace the switch enclosure cover.
21. Reconnect the alarm circuit to the vacuum switch.

❖ **Use the following procedure to perform a setpoint adjustment test**

22. Evacuate the system to approximately 650 mm Hg (26 in. Hg) OR properly prime and prepare the pressure system.
23. Remove the switch cover and connect ohmmeter leads across the common terminal and the other terminal used in operation (NO or NC).
24. Record the status of the switch (open or closed).
25. a. Vacuum: Break the vacuum system at any point external to the pump to permit gradual loss of vacuum.

    b. Pressure: remove the pressure gauge, and install a hand pump or other means of producing a small amount of pressure in the system.
26. Observe the ohmmeter to detect actuation.

The setpoint can be observed by reading the vacuum/pressure gauge upon actuation.

13.7 PULSAlarm Leak Detection Diaphragm Maintenance

WARNING

After diaphragm failure, pressurized process fluid can be present in any part of the PULSAlarm leak detection vacuum system. Take appropriate precautions and handle with care.

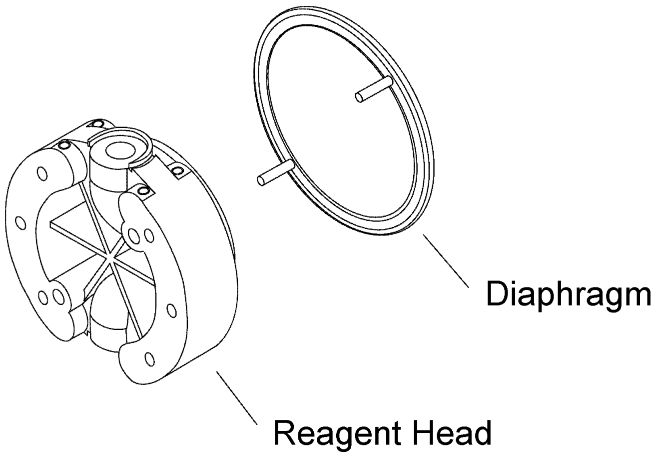


Figure 27

13.7.1 Leak Detection Diaphragm Removal

❖ **Use the following procedure to remove the Leak Detection Diaphragm:**

27. Disconnect the power source to the drive motor.
28. Relieve all pressure from the piping system, and close the inlet and outlet shutoff valves
29. Take all precautions to prevent environmental and personnel exposure to hazardous materials.
30. Place a suitable container underneath the pump head to catch any liquid leakage.
31. Disconnect process piping and drain any process liquid, following material safety precautions.
32. Remove all but one top reagent head bolt. Oil will leak out between the pump head and reagent head as the bolts are loosened.
33. Tilt the head and pour out any liquids retained by the check valves into a suitable container, continuing to follow safety precautions as appropriate.
34. Remove the alarm switch assembly or pressure gauge from the reagent head.
35. Remove the bleed valve assembly and flat gasket from the reagent head.
36. Rinse or clean the reagent head with an appropriate material.
37. Remove the diaphragm by running a blunt blade along the periphery and prying it out.

13.7.2 Inspection

Remove and inspect the diaphragm assembly. It may have taken a permanent convex/concave set as a result of normal flexure and conformance to the dish-plate. This condition is normal and is not cause for replacement. The diaphragm must be replaced if it is deformed, dimpled, or obviously damaged.

NOTE **If the diaphragms have been removed from the spacer ring, the entire assembly should be replaced to ensure proper sealing of its components.**

13.7.3 Leak Detection Diaphragm Reinstallation

38. Ensure that the critical sealing areas of diaphragm assembly, reagent head, and pump head are clean and free from debris. Align the diaphragm assembly capillary tubes with mating holes in the seal groove in the reagent head and position it in place against the reagent head. Ensure seating of the diaphragm sealing ring into the mating groove in the reagent head.
39. Install the reagent head bolts and tighten in an alternating pattern to ensure an even seating force. Torque to the values recommended in ***Appendix III***.
40. Apply sealing compound to the gauge/pressure switch assembly and reinstall to the upper port on the reagent head.
41. Apply sealing compound to the fill valve assembly and reinstall to the lower port on the reagent head.
42. Open the needle valve
43. Connect a hand-held vacuum pump or other vacuum source to the vacuum port, which fits 6 mm (1/4 in.) I.D. tubing.
44. **For a vacuum system, evacuate to approximately 650 mm Hg (26 in. Hg) and securely tighten the needle valve after evacuation.** Diaphragm damage or decreased flow will occur if a vacuum is not drawn before the pump is returned to service. Refer to section 13.3 “Setup for Vacuum”.
45. Re-prime the pump head hydraulic system, see Section 7.2
46. **For a pressure system, see section 13.5, “Pressure System Set-up and Priming”**
47. If required, test vacuum or pressure system operation.
48. After diaphragm set-up and priming, the pump is ready to be returned to service.

13.8 Leak Detection system conversion

Leak detection system conversion information can be found in Bulletin CV-LD-0203 (vacuum to pressure system). For further conversion information and kits, please contact your local Pulsafeeder sales representative.

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