PULSA Series®

DIAPHRAGM METERING PUMPS

Installation Operation Maintenance Instruction

Bulletin No. 680H

PULSAFEEDER®
A Unit of IDEX Corporation

Manufacturers of Quality Pumps,
Controls and Systems

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How It Works

A standard foot mounted motor drives a worm shaft at constant speed. Through worm gear reduction and eccentric, a reciprocating power stroke is transferred to a plunger. The length of plunger stroke determines pump capacity and can be adjusted manually to provide pumping range from 0-100% of rating. However, this plunger does not pump chemicals, but an exceptionally stable oil*, having excellent lubricating qualities. This makes a perfect pumping medium.

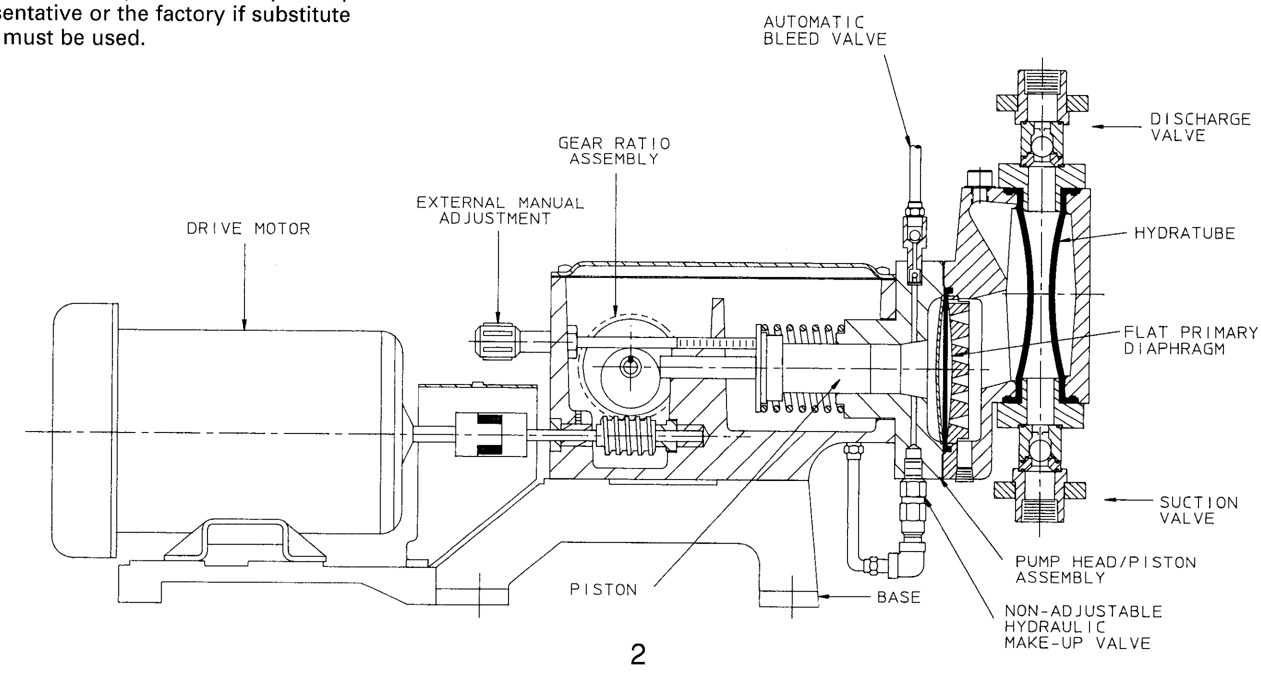
*A special property petroleum oil tradenamed "PULSAlube" is generally used as hydraulic fluid. Continual reference to "oil" as hydraulic medium implies its general use rather than its use of necessity. Check with your representative or the factory if substitute oil must be used.

Hydraulically Balanced HYDRA-TUBE Diaphragm Design

Using this oil, the plunger hydraulically moves a flat disc type elastomer diaphragm which in turn causes compression and decompression on a secondary sealed hydraulic reservoir, (Figure 2). This secondary reservoir surrounds a cylindrical diaphragm. The compression and decompression of this intermediate hydraulic fluid transmits a controlled squeeze and release on the cylindrical HYDRATUBE diaphragm, thereby displacing process liquid which is contained within it. Inlet and outlet check valves, operating in unison with the HYDRATUBE movement, precisely control liquid flow in one direction. Since they are gravity seating valves, flow is from bottom to top.

HYDRATUBE Housing Assembly

The HYDRATUBE confines the liquid pumped internally isolated from any contact with the hydraulic system. The HYDRATUBE housing assembly consists of a ductile iron casting which positions the HYDRATUBE and contains the intermediate fluids, a support plate to protect the primary diaphragm from over travel, and inlet and discharge check valve.



The HYDRATUBE responds exactly to the action of the primary flat diaphragm through the medium of an intermediate fluid selected for compatibility with the casting and other material. The HYDRATUBE is available in several elastomers including the Dupont products, Viton, Hypalon and Nordel which provides a satisfactory chemical resistance for a wide variety of corrosive fluids.

Pump Head Assemblies

The hydraulic pump head assembly contains the plunger, cylinder and various hydraulic components to protect and maintain a precise hydraulic balance between the plunger and diaphragm.

Make-up, Hydraulic Bypass and Bleeder Valves Within the Hydraulic System

Make-up Valve

Any leakage past the plunger, however slight, is replaced by the make-up valve which permits flow of replacement oil from the oil reservoir. This is an automatic function. The oil loss allows the diaphragm to get out of phase with the plunger thus creating a vacuum ahead of the plunger during the suction stroke of the pump. The make-up valves are factory set.

Hydraulic Bypass

Any excess hydraulic pressure buildup within the pump compression chamber due to accidental valve closure or line stoppage is relieved through the hydraulic bypass valve. It blows off oil under excess pressure ahead of the plunger back into the reservoir thus terminating the pumping action and protecting the pump mechanism. Hydraulic bypass valves are factory set at full design pressure unless specified differently by purchaser.

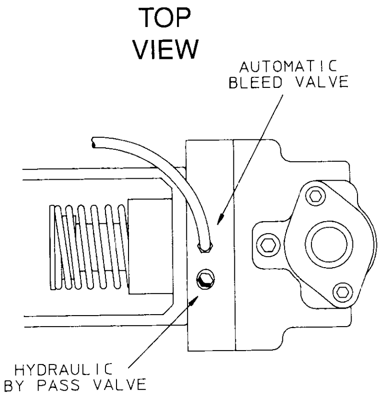
Pressure Relief Valve

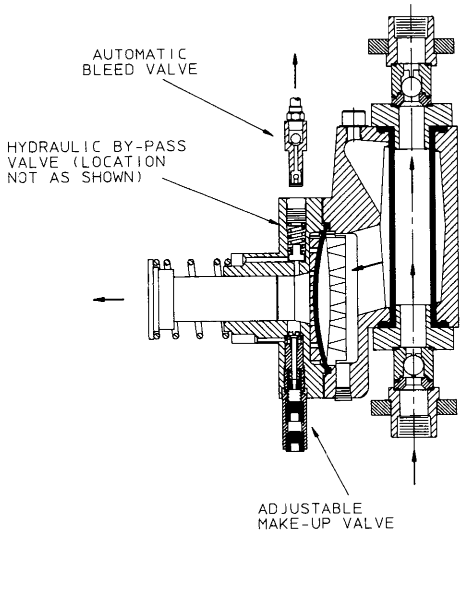
A separate process relief valve should be installed in the process piping to protect piping and sensitive process equipment.

Bleeder Valve

The function of this valve is to release any air or oil vapors from ahead of the piston and maintain a solid hydraulic medium to transmit finite movements of the piston to the diaphragm. In large piston models where adequate oil movement exists the bleed valve functions automatically weeping a minute quantity of oil plus any air or vapor out of the hydraulic system.

Additional detail on the function of these valves will be given as applicable in the Operation, Maintenance and Trouble Shooting Sections.





Installation Tips

Check the Shipment:

A standard shipment includes the pump, PULSAlube oil, wrenches, instruction and parts list packet and replacement parts if ordered. Unpack carefully, check packing list and make sure all parts are received. Check voltage of electric motor against the service to be used.

Locating the 680H Pumps:

Pulsa 680H pumps are designed to operate under indoor atmospheric conditions. It is desirable to provide a hood or covering for outdoor service. External heating must be arranged if ambient temperature will be below 40°F. Fluid temperatures entering the pump must be 40°F or greater.

1. Check level of pump. Shim where necessary.
2. Securely bolt to foundation. Do not distort base.

NOTE: Most 680 models will operate without bolting down. However, it is important to have a solid and level foundation so that a minimum of vibration is evident. Continual vibration can loosen gaskets and pipe connections.

3. Check motor alignment and reagent head and valve bolt tightness before operation. Follow bolt torque readings carefully.

Flooded Suction Desirable:

Installation will be simpler to operate if the liquid will flow to the pump by gravity. Wherever possible the pump should be located below the level of storage vessel.

Discharge Pressure:

All 680 models are designed for continuous service at the rated discharge pressure. To prevent liquid flow through, it is necessary that discharge pressure be at least 5 psi above suction pressure. When pumping downhill a back pressure valve should be placed in the discharge line.

Piping:

Pipe size and length are critical to proper operation of any metering pump. A restricted discharge or starved suction condition spells immediate failure to any metering pump installation. A separate brochure entitled "Designing a Successful Metering Pump Installation" is provided to assist Engineers responsible for piping system design. Copies are available upon request (Technical Sheet 304). Inlet piping must be at least equal in size to pump inlet connection.

Figure A shows the preferred piping configuration for a good metering pump installation. A good piping installation addresses present and future requirements of the metering system. Plan for shut off valves and unions or flanges installed on both suction and discharge lines. This allows inspection of the check valves without draining long runs of pipe. Install a tee in the suction and discharge piping between the pump and the shut off valves. This permits easy installation of a calibration tube for calibration of the pump at start up or any future date. A tee in the discharge piping is a must on a good installation because it permits ease of mounting a pressure gauge to check discharge pressure at the pump and setting the hydraulic bypass valve during start up and future maintenance functions. To prevent strain on the pump fittings use pipe straps and braces. Do not allow the weight of the piping to be supported by a pipe union, the valve fitting or other portion of the pump head or leaks will occur. An air leak at a union or other fitting in the suction piping can severely affect metering accuracy and is extremely difficult to detect. In assembly of piping, use pipe thread tape or a compound compatible with the product handled. If rigid piping is used we suggest bolting the pump to its foundation.

FIGURE A

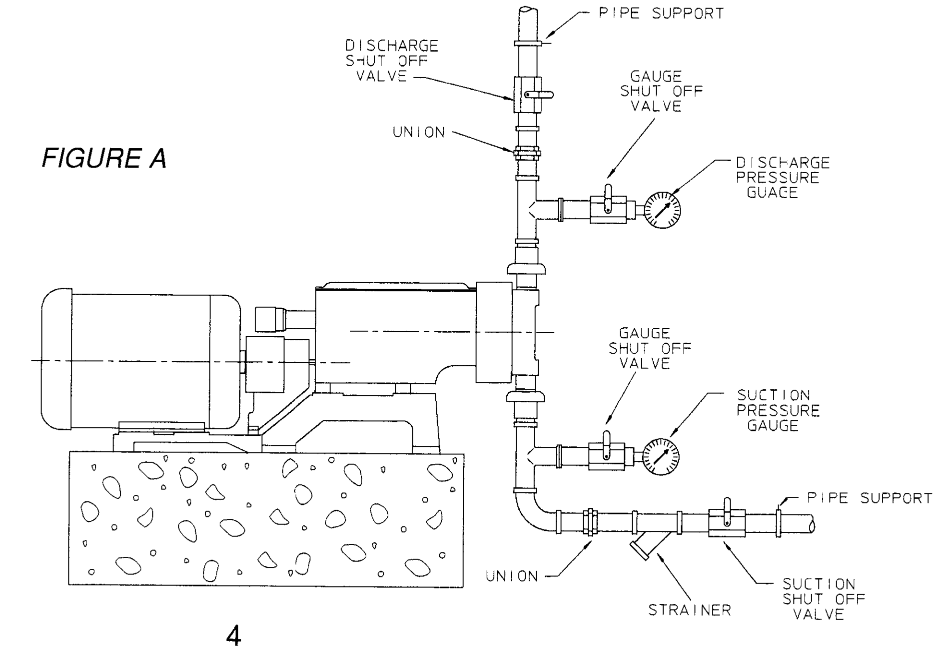


FIGURE 6

Use Strainers:

Pump check valves are susceptible to dirt and other contaminants and any accumulation can cause malfunction. Be sure to use a pipeline strainer in the suction line between the suction shut off valve and the pump suction valve 100 mesh screen is preferred.

Flush Piping System:

Whether new or old piping is used, all lines should be flushed with a clean liquid or air before connecting the pump to carry out pipe scale or other foreign material. Make sure flushing liquid is compatible with the chemical to be pumped.

Metal Reagent Head Models:

The metal reagent head assembly is provided in several alloys. Piping of similar alloy should be selected. Dissimilar materials can cause galvanic corrosion.

Do not backweld piping to the valve housings without first removing the valve housings from the pump as excessive heat can damage the tube and other parts. Tie bars must be positioned on the valve housing *before* welding.

Plastic Reagent Head Models:

Care must be exercised when making connections on plastic reagent head models. Excessive tightening can distort or break the plastic materials. Tubing should be rated for the highest discharge pressure expected. DO NOT USE METAL PIPING.

Start-Up Inspection

Every 680H metering pump is tested for correct capacity at maximum pressure capability of the hydraulic bypass valve before shipment. The diaphragm cavity is fully primed and remains so for shipment. For shipping purposes the gear and hydraulic reservoir oil have been removed. Sufficient fresh PULSAlube oil is included with the shipment for refilling the gear and hydraulic reservoirs.

Warning

1. Do not run pump without oil.
2. Do not remove main gear box cover while pump is running.
3. Do not run pump with coupling guard removed.
4. Do not put hands or fingers in gear box or reservoir when pump is running.

Filling Gear and Oil Reservoirs:

Remove the pump cover and fill both reservoirs with PULSAlube oil to the top of the gear box partition. Do not overfill. PULSAlube oil is compounded to serve as both gear lubricant and hydraulic transfer fluid. Check with factory if substitute oils must be used.

Final Inspection:

Because of the pump's small size and light weight it sometimes receives severe handling during shipment. Though physical damage may not occur, it is always possible for parts to move slightly in adjustment. This situation might occur with motor or pneumatic control alignment.

A quick visual check should be made to assure that motor and control shafts have not shifted severely out of alignment or damage could occur from starting the motor. If unusual vibration should occur after start up realign the motor and coupling.

Start-up:

Since the hydraulic oil system is primed at the factory, priming the process system is all that should be necessary to produce flow. If the hydraulic system has inadvertently been dumped due to starting up with restricted suction or discharge conditions or improper adjustments to compensator or bleed valves, repriming procedures under the maintenance section may have to be followed before pump calibration can begin.

Priming Process Head:

1. Open the suction line and discharge line shut off valves.
2. If the piping system design and the storage tank are such that the product flows by gravity to the pump, no priming is required. If however, the discharge line is under pressure, air will be trapped in the process head and it will be necessary to remove the discharge pressure to enable the pump to prime itself.
3. If the pump must handle a suction lift, it may be necessary to manually prime the reagent head. Remove the discharge valve by unscrewing the two tie bar bolts and then lifting the valve out. Fill the head with process fluid, or a compatible liquid then replace the valve in the same position and retighten the tie bar bolts.

4. The pump is now ready for start-up.
5. Start the pump and increase the control setting to full stroke.
6. Make a brief check to assure that the pump is producing the approximate flow desired at the full stroke setting. Calibration should not be attempted on any model until it has run at least one hour to assure the pump hydraulic and reagent head systems have stabilized.

If the pump does not produce the approximate flow desired at the full stroke setting refer to the Trouble Shooting Section for possible causes and refer to Priming Procedure under the Operation and Maintenance Section.

To Adjust Flow Rate;
Figure B.

The 680 PULSAfeeders are provided with a lock-in place micrometer knob adjustment for changing length of stroke while in operation or idle. Push in on locking device and turn adjustment knob clockwise to increase flow and counterclockwise to decrease flow. These indications can be converted to volumetric or weight units by calibration conversion charts. On earlier model micrometer knobs you may increase the friction on the adjustment or completely lock up the adjustment knob by removing the gear box cover and tightening the friction nut on the adjustment shaft.

Calibration:

All pumps are tested on water at room temperature with 7 foot flooded head at full rated pressure. Any curves supplied by Pulsafeeder would be representative of this test and can only be used as a guideline.

All pumps must be calibrated under actual operating conditions for the operator to know the proper adjustment for particular outputs. A typical displacement chart is shown in Figure C. Note that output is linear with respect to micrometer settings but that increase in discharge pressure decreases output slightly and describes the line parallel to that at atmospheric pressure.

This is caused by compression of hydraulic oil and valve inefficiencies. Capacity at atmospheric pressure will be nearly that of calculated displacement. As the discharge pressure increases there will be a corresponding decrease in capacity at a rate of approximately 1% per 100 psi increase.

Figures D and E show two typical piping arrangements for performing pump calibration. It is desirable to calibrate from the suction side of the pump so the pump will be operating under actual or comparable discharge conditions.

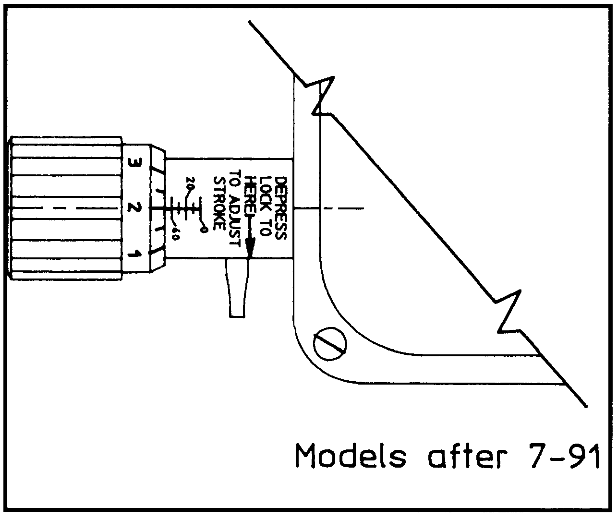


FIGURE B

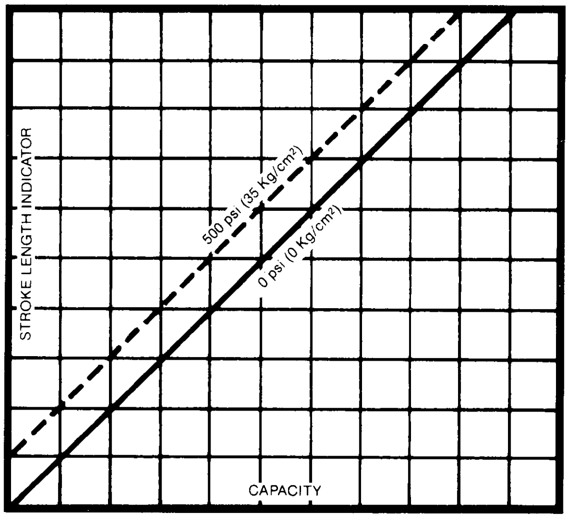


FIGURE C

Check the capacity several times at three different stroke length settings and record them on linear graph paper. For all stable conditions, these points should describe a straight line.

PULSA pumps supplied with automatic controls, either pneumatic or electronic, are accompanied by separate instructions on output adjustment and calibration.

Operation and Maintenance

The preceding instructions have assisted you in proper installation and start-up of your 680H pump. The following sections are arranged to assist in maintaining proper pump operation and trouble shooting any problems that might develop during start-up or thereafter.

Accurate records in the early stages of pump operation will reveal the type and amount of maintenance that will be required. A preventative maintenance program based on these records will insure trouble free operation. It is not possible in these instructions to forecast the life of such parts as the diaphragm, check valves and other parts in contact with the product you are handling. Corrosion rates and conditions of operation affect the useful life of these materials so an individual metering pump must be gauged according to particular service conditions.

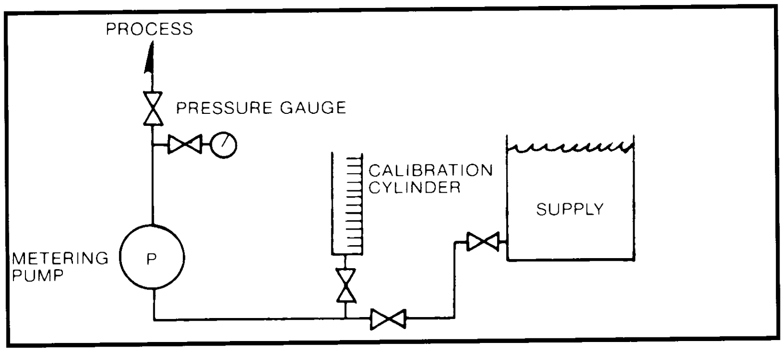


FIGURE D

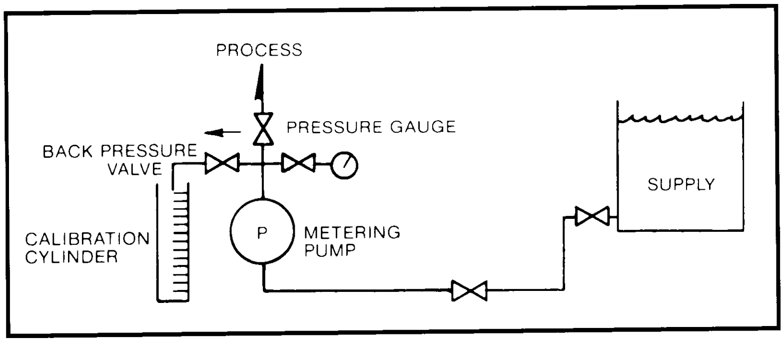


FIGURE E

HYDRATUBE Diaphragm Inspection & Priming Procedures

The HYDRATUBE diaphragm can be damaged by the following:

1. Chemical attack.
2. Mechanical damage from trash or abrasives.
3. High temperature (Maximum 170° - 230°F depending on elastomer).
4. Low temperature (below 40°F Hypalon or Viton, 0°F Nordel).

Service conditions will determine life of the HYDRATUBE and dictate the replacement schedule.

To Remove HYDRATUBE

1. Remove all pressure from the piping system.
2. Lock out motor.
3. Close the inlet and outlet shut-off valves.
4. Break the union or flanges on the piping.
5. Arrange to catch and properly dispose of oil and product leakage that will occur when disassembling head and valving.
6. Remove the top fill and vent plug, the bottom drain plug in the iron housing, and drain intermediate fluid from the chamber.
7. Remove both the top discharge and the bottom inlet valves, the tie bars, and adaptors to drain HYDRATUBE. Use extreme caution if product is hazardous and wear proper protective clothing.
8. Pick up an edge of the HYDRATUBE flange (Figure 3) and push that same edge down throat of the HYDRATUBE. The balance of the flange will fold and follow.

9. Pull the HYDRATUBE out from the bottom of the housing by a combination of twisting and bending sideways.

Inspect the HYDRATUBE for any evidence of damage or abrasion. It is not unusual for a tube to take an elliptical set. If there is no other evidence of failure or damage this tube is considered undamaged and can be reinstalled.

To Install New HYDRATUBE

1. Do not use tools which can cut or distort the tube.
2. Obtain a rubber band of 1/16" to 1/8" section.
3. Fold a point on the edge of the HYDRATUBE flange upward (Figure 4). Push the edge down the throat of the tube. Fold the sides of the flange inward (Figure 5) to form a compact 45° "nose" and wrap tightly with a rubber band (Figure 6).

This wrapped nose should be reasonably compact and secure.

NOTE: Extra care is necessary on PFA HYDRATUBES to insure there is no crimping or creasing during installation.

4. Work the wrapped nose of the HYDRATUBE up through the bottom hole of the housing, rotating gently to work the tube upward to the top of the housing.
5. At this stage, with a slight push at the bottom flange of the HYDRATUBE, guide the nose of the tube to the center and out the top hole in the housing. (Figure 7).
6. Remove rubber band.
7. Unfold the top flange (Figure 8) and center both the top and bottom of the HYDRATUBE.
8. Reassemble the top and bottom adaptor parts pulling the adaptor bolts dead tight. Replace the bottom drain plug.

Repriming Hydraulic System To Check Prime Only on New and Older Models

New pumps are shipped from the factory with the hydraulic and intermediate systems completely primed. If the hydraulic valves have been disturbed or the intermediate fill plug removed, the systems are probably out of balance due to loss of prime. The hydraulic system will reprime itself through the action of the automatic bleed and make-up valve after a period of 5 to 10 minutes running time.

If the intermediate fill plug has been removed and fluid lost, it will be necessary to recheck prime to get diaphragms in phase. It will be necessary to remove the discharge check valve assembly in order to observe the shape of the HYDRATUBE.

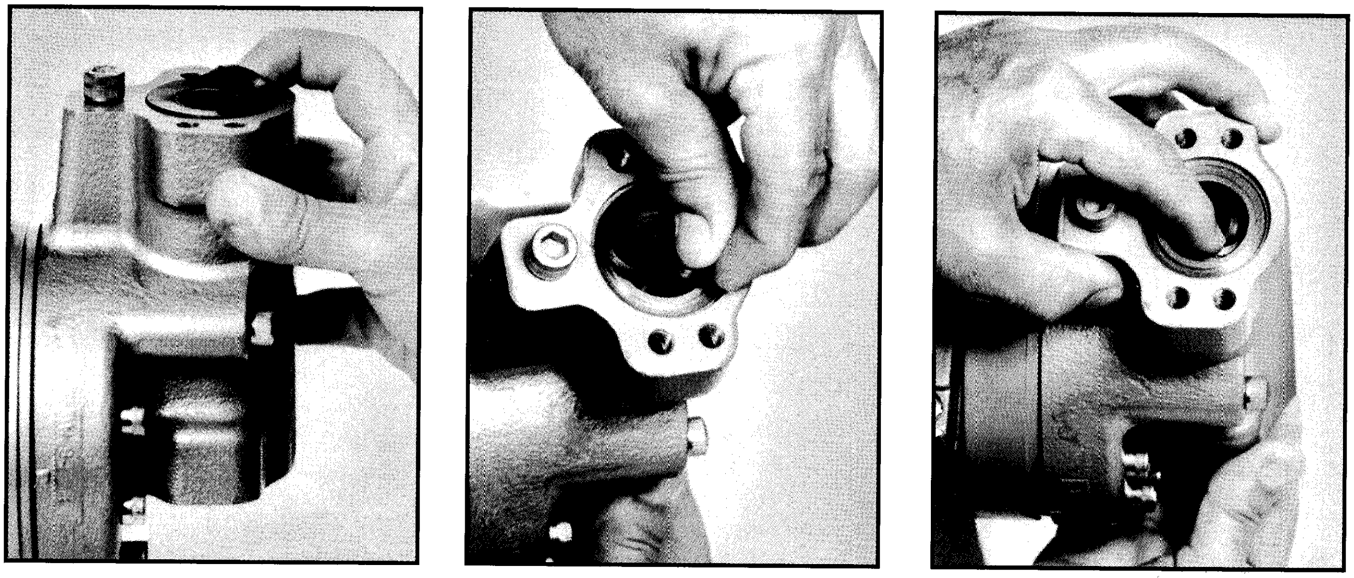


FIGURE 3

If the intermediate system is properly primed the HYDRATUBE is cylindrical in shape when the flat, primary, diaphragm has moved to its maximum rear (suction) position. After the piston hydraulic system is fully primed, follow Steps 1 through 12 to check intermediate prime.

HYDRATUBE PRIMING PROCEDURE

1. Place stroke adjustment to 100% stroke setting.
2. Shut down pump and remove coupling guard.
3. Remove fill plug in reagent head assembly.
4. Remove manual bleed/auto bleed valve assembly from pump head.
5. Place a plastic pipette (i.e., turkey baster, etc.) into threaded hole of pump head where manual bleed/auto bleed valve assembly was removed.
6. Fill pipette with same oil as being used in the gearbox.
7. Turn on pump and run until all air has been burped from pump head (add oil to pipette as required).
8. Shut off pump and manually retract piston to full rearward position.
9. Remove pipette and replace manual bleed/auto bleed valve assembly in the pump head.
10. Manually turn motor shaft assembly until piston has gone to full forward position.
11. If piston sets up, prior to full forward position loosen bypass valve until oil is being pushed through allowing the piston to move forward. (Keep track of number of turns).
12. Manually turn motor shaft until piston is all the way forward. Retighten the bypass valve the number of turns counted earlier.
13. Retract the piston to the rearward position.
14. Fill the intermediate chamber with prescribed fluid and replace the fill plug.
15. Replace the coupling cover and the pump is ready for operation.
16. Prime the wet end of the reagent head with product and turn the pump on.

The last remains of air will then be gradually released through the automatic operation of the automatic air bleed valve.

Repriming Intermediate Chamber

1. Lock out the motor and remove the coupling guard.
2. Remove the intermediate chamber fill plug.
3. Remove the discharge valve assembly (See Fig. 1). DO NOT remove the HYDRATUBE adaptors which seal the tube to the housing.
4. Rotate the motor coupling by hand until the plunger is in the full forward position, fill intermediate chamber and replace fill plug.
5. Manually retract plunger.
6. Loosen the intermediate fill plug and advance the plunger as far forward as possible allowing intermediate fluid to drain out. Retighten the fill plug.
7. Repeat steps 4 and 5 until you are unable to advance the plunger forward.

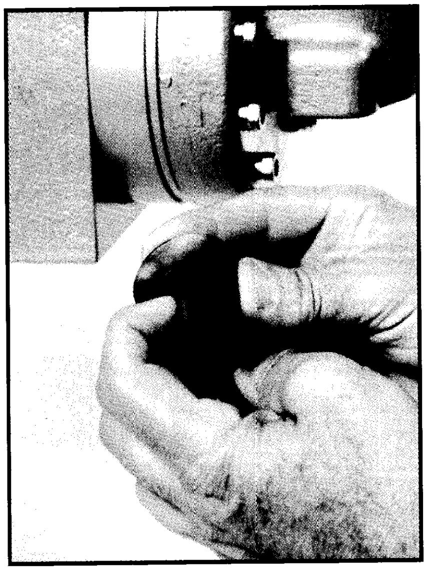


FIGURE 4

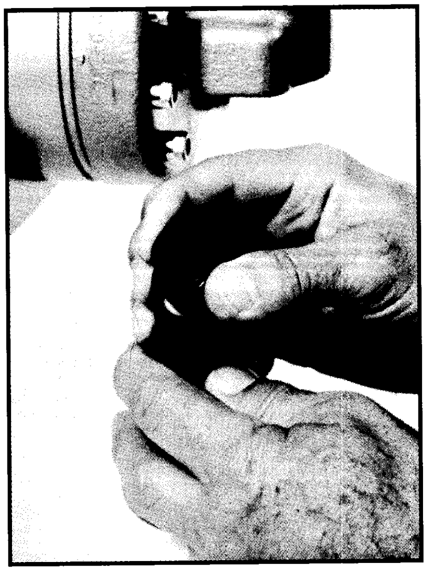


FIGURE 5

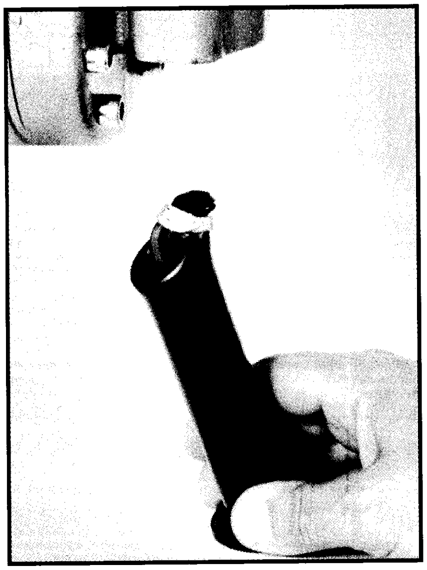


FIGURE 6

8. Keeping pressure on the drive shaft, slowly loosen the hydraulic bypass valve to bleed off hydraulic oil to allow the plunger to advance to its full forward position. Tighten pressure relief back to its original position.
9. Remove intermediate fill plug and manually retract plunger to full back position. Refill intermediate chamber and seal tight.
10. Allow pump to run 5-10 minutes observing action of the HYDRATUBE. It should go from a complete round form at the end of the suction stroke to an elliptical shape at full discharge stroke, but not closing off at the middle.
11. Stop pump, manually retract plunger to full back (suction) position. Remove intermediate fill plug and add liquid if necessary. Very little should be required. Replace fill plug, pump now has a correct intermediate prime and is ready for service.
12. Connect suction and discharge piping. Start motor and prime reagent head. To bleed out any air accumulated under hydraulic bypass valve, counting turns, turn the socket head screw counter-clockwise. Any air present will be expelled from the vent hole located near the edge of the return spring in the hydraulic reservoir as shown in Figure 2. Readjust the valve the same number of turns or to desired setting using pressure gauge in the process line

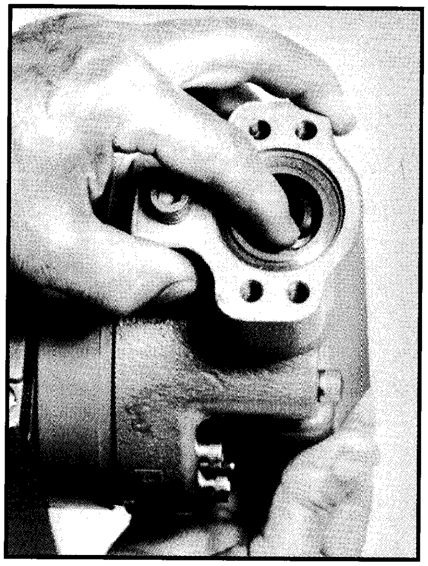


FIGURE 7

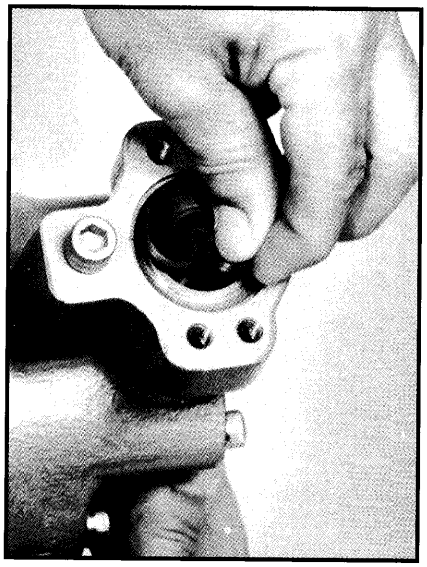


FIGURE 8

Check Valves

Operating experience on thousands of installations has indicated that many metering pump troubles have to do with check valves. Problems usually stem from (a) an accumulation of trash between the valve and seat, (b) corrosion which damages seating surfaces, (c) erosion from high velocity flow, or (d) normal physical damage after extended service.

A valve seat, to function correctly, must have a polished, narrow seating surface. If the valve seats do not show serious wear, it is sometimes possible to rework on a precision lathe. The knife-like edge at the seat surface can be peened. Place a ball of the same size but of harder metal onto the seat. Then tap the ball using a brass rod and hammer. A single sharp blow is usually sufficient.

Hydraulic Make-up Valves

Hydraulic make-up valves are designed to maintain the correct volume of oil in the hydraulic system between the piston and the diaphragm. Pumps are supplied with adjustable valves shown in Figure 13.

Adjustable Valves

Figure 13

This valve is factory set and operator adjustable. Under normal circumstances adjustment is not necessary. The valve requires no routine maintenance and is not considered a normal replacement item. In some situations it is necessary to adjust the valve.

This valve is adjusted by turning the adjusting bolt (Figure 13) to vary the spring tension on the valve. The following procedure is used at the factory for setting the valve:

1) Both set screws and back-up spring are removed. Care should be used when handling the spring. **Do not stretch or compress the spring by hand.**
2) The spring and adjustment screw is re-threaded into the valve body until it bottoms out. It is then backed out (turn counter-clockwise) 4-5 turns.
3) The sealing screw threads are cleaned and 4-6 wraps of teflon tape are applied and inserted in valve.

If more than three tube size bubbles appear in the bleeder line during a four hour pumping period and the pump is new or the make-up valve has been recently re-calibrated - **Do Not** repeat steps 1 through 3 above. Instead, a fine "tune-in" procedure should be undertaken.

1) Disconnect power to idle pump.
2) Tighten Adjustment Screw (turn clockwise) 1 turn.

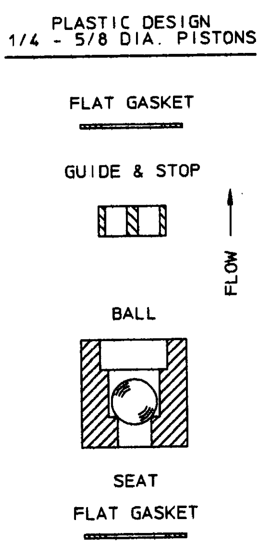


FIGURE 9

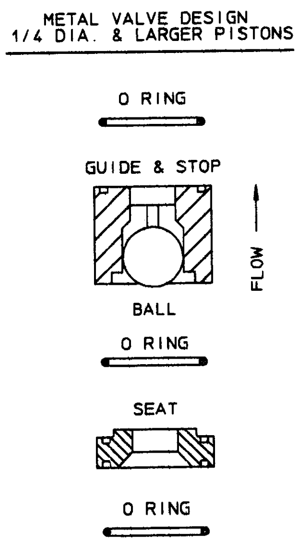


FIGURE 10

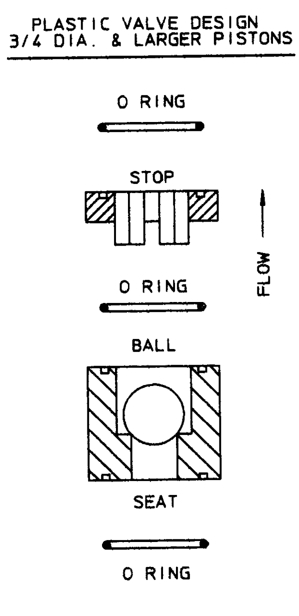


FIGURE 11

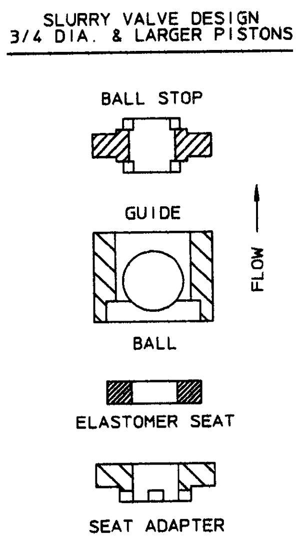


FIGURE 12

3) Allow pump to sit idle for 1-hour to permit entrained air to separate from oil. If it is not possible to shut the pump down the air laden oil can be replaced by manually opening the pressure relief valve (see PRESSURE RELIEF VALVE section) and rotate motor coupling by hand. After the recirculating oil is clear of air the pressure relief valve must be reset
4) The pump should be restarted and check periodically for excessive air exiting from the bleeder valve. The procedure should be repeated as necessary.

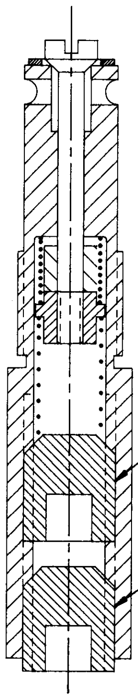


FIGURE 13

Valve removal/replacement can be accomplished by loosening the valve body (turn clockwise) with a ½" wrench. Should the valve assembly require cleaning remove the valve body from the pump head. Remove both screws from the valve body. Carefully remove and retain the spring that is captured by the set screw in the valve body. Insert the long end of a ¼" allen wrench into the valve body to force open the poppet. Be careful to apply only enough pressure to open the valve " maximum. Opening the valve more than " can damage the poppet spring. Rinse the poppet end of the valve in solvent. Blow dry with air.

Hydraulic Bypass Valve

The hydraulic bypass valve is an adjustable spring loaded valve. It is designed to protect the pump against excessive hydraulic pressure. The valve is factory set to the "Hydraulic Bypass Valve Setting" if specified on the specification data sheet or set to allow operation at the maximum pump pressure, indicated on the pump nameplate, without weeping.

To adjust the valve to a lower set pressure, turn counterclockwise.

To check the pressure setting it is necessary to install a gauge in the discharge line between the pump and a shutoff valve. With the pump operating at maximum stroke a gradual closing of the shut off valve will cause the bypass valve to reach its cracking pressure which will be observed on the gauge.

When the bypass valve is set for maximum pump operating pressure (shown on nameplate), cracking pressure is slightly above maximum operating pressure so that it does not weep during normal pump operation. Dead head dumping pressure can be considerably higher than cracking pressure on some large piston, fast stroke rate models, so the internal bypass valve should not necessarily be considered a safety valve for protection of the process piping and instrumentation. A separate process relief valve should be used for this purpose.

It is unusual for a hydraulic bypass valve to operate during normal pump operation. The following conditions will cause valve operation:

1. Excessive pressure buildup in the process which the pump is injecting into.
2. A plugged discharge line or someone shutting off a valve in the discharge line while the pump is operating.
3. Restricted flow to the pump causing the make-up valve to operate. If an inlet strainer is plugged, or someone closes an inlet valve thereby restricting flow of fluid to the pump, the diaphragm is then unable to follow movement of the plunger. The vacuums created between the diaphragm and the plunger upset the make-up valve allowing oil to replace the vacuum condition. This excess oil will be displaced through the pressure relief valve on the discharge stroke of the plunger. Undersized (restrictive) piping must be avoided (see "Piping" page 5).

Any unusual condition in the system which prevents free movement of the diaphragm will cause a recirculating condition between the make-up valve and the pressure relief valve. Continuous oil recirculation against the pressure relief valve will eventually cavitate the hydraulic prime plus introduce unnecessary load conditions within the pump mechanism.

Automatic Bleed Valve
Figure 14

The automatic bleed valve is a gravity operated ball check valve designed to displace a small quantity of hydraulic oil or air on each pump stroke.

Any accumulation of solids can cause malfunction. Unscrew the valve and clean it with kerosene or solvent. If solids cannot be removed the valve must be replaced since there is no means of repair.

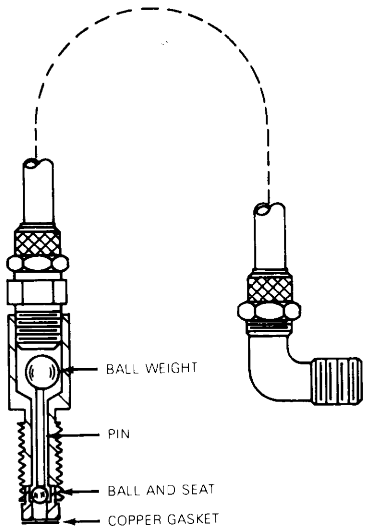


FIGURE 14

Lubricating Instructions

PULSAlube is a custom blend oil with additives for lubrication and hydraulic transfer service. (For emergency requirements, a list of acceptable commercial oils is available). The diaphragm on the cover of the gear box assembly generally protects the oil from contamination for extended periods of time. A periodic six month check should be made for oil level and possible contamination.

Under sustained conditions of high humidity or if water is present, the oil can become emulsified and take on a yellowish color. Change the oil immediately if this occurs and examine the make-up valve and other parts for corrosion.A suction pump similar to a grease gun is useful for removing oil from chambers, or it may be drained from the ports at the side of each chamber.

To establish a maintenance record and routine procedure, check lubricant and drive mechanism at three and six month intervals. At the first six month interval check the condition of the inlet and outlet check valves. These items along with oil seal inspection should be part of a routine service procedure.

Oil Capacity

The standard 680H metering pump requires approximately one quart of PULSAlube oil to fill both chambers and prime hydraulic pump head. PULSAlube oil is available in one gallon containers, five gallon containers or 55 gallon drums.

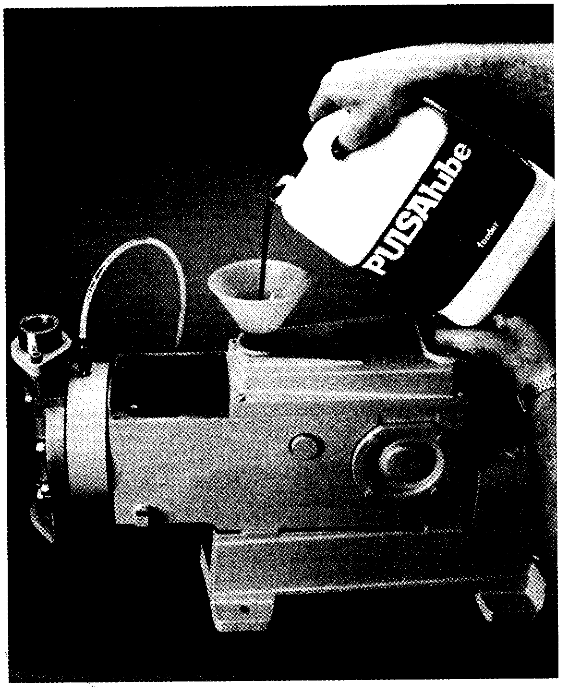


FIGURE 15

STORAGE INSTRUCTIONS
Short Term

Storage of PULSA Series pump for up to 12 months after shipment is considered short term. Under this condition the recommended storage procedures are as follows:

1. The pump should be stored indoors at room temperature in a dry environment.
2. The pump gearbox and hydraulic reservoir is to be completely filled with PULSAlube oil within two months after date of shipment.
3. The gearbox and hydraulic reservoir should be inspected every 3-6 months. Maintain the oil level and assure that no water or condensation is present, follow Procedure II, Step A below.
4. It is recommended that the stroke length of the pump be adjusted to its midpoint and that the piston be manually cycled through 3-6 cycles every 6 months.
5. Prior to start-up, perform a complete inspection and then start up in accordance with instructions in this manual.

Long Term

For storage longer than 12 months in addition to the above, the following procedures should be followed.

1. Every 12 months PULSAlube oil should be drained from the gearbox and hydraulic reservoir. The gearbox and hydraulic reservoir should be flushed with kerosene or petroleum base solvent, thoroughly

dried out with a rag, and then refilled with fresh PULSAlube oil.
2. Every 12 months the motor should be connected to a power source and the pump operated 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 12 months storage Pulsafeeder's warranty cannot cover such items as oil seals, gaskets, piston cups and other items which are subject to deterioration with age. If the pump has been in storage for longer than 12 months it is recommended that these items be replaced prior to going into service. Material and labor to recondition or replace this class of item is the purchaser's responsibility. For a one year service warranty after extended storage the refurbishment and equipment inspection must be done by a Pulsafeeder serviceman.

Maintenance Parts Stock

Pulsafeeder offers a KOPkit which uses a group of recommended spares carried in stock for replacement due to normal wear. The Kit covers such items as diaphragm, diaphragm gaskets if used, inlet and discharge valve parts, a complete set of valve gaskets and hydraulic pump head gasket. The KOPkit part number for your pump is indicated on the nameplate. A sufficient quantity of PULSAlube oil should be on hand for periodic oil changes.

Ordering Parts

When ordering parts always specify:

1. Pump model and serial number (stamped on nameplate).
2. Part number (from parts list), or KOPkit number.
3. Material of reagent head construction (liquid end parts).

Additional Pulsafeeder Services

FIELD SERVICE – Including pump repair or conversion to different services is available at nominal cost.

FACTORY REPAIR – Complete pump reconditioning.

OPERATOR TRAINING SEMINARS – Conducted by experienced factory trained service personnel at the factory in Rochester, NY or in the field. Field trips are available at nominal cost.

Trouble Shooting

Experience drawn from thousands of installations has shown that there are three outstanding areas which contribute to the bulk of operating problems. First and foremost is installation conditions — improper location and supply, inadequate or restrictive piping to and from pump; unsupported piping; lack of strainer in suction piping.

The second major area is check valves. The check valve is the heart of any pump and sees more severe service than any other part of the pump. Opening and closing 40 to 140 times per minute, the valve not only receives a mechanical hammering but receives it under high velocity corrosive, erosive and sometimes extreme temperature conditions. Foreign particles, unlevel mounting, defective seals and improper torquing all too often aggravate even the simplest application.

The third area is a simple lack of a routine service policy. Routine service will catch or avoid simple operating problems which can develop into a crisis if left unattended.

The following is a brief trouble shooting guide to help identify and cure any operating problems you might experience.

Trouble Shooting Chart

Difficulty	Probable Cause	Remedy
Pump Does Not Start	1. Coupling disconnected	Connect and align
	2. Faulty power source	Check power source
	3. Blown fuse, circuit breaker	Replace — Locate overload
	4. Broken wire	Locate and repair
	5. Wired improperly	Check diagram
No Delivery	1. Motor not running	Check power source. Check wiring diagram
	2. Supply tank empty	Fill with liquid
	3. Lines clogged	Clean and flush
	4. Closed line valves	Open pipeline valves
	5. Ball 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 under-primed	Refer to "Repriming Hydraulic System"
	10. Check valves installed upside down	See check valve illustrations
Low Delivery	1. Motor speed too low	Check voltages, hertz, wiring, and terminal connections. Check nameplate vs. specifications
	2. Check valves worn or dirty	Clean, replace if damaged
	3. Bypass valve opening 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 size.
	6. Product cavitating	Increase suction pressure. Cool product as necessary
Delivery Gradually Drops	1. Stroke adjustment creeping	Consult factory. Replace worn parts.
	2. Check valve leakage	Clean, replace if damaged
	3. Leak in suction line	Locate and correct
	4. Fouled bypass or make-up valve	Refer to "Operation and Maintenance"
	5. Strainer fouled	Clean or replace screen
	6. Product change	Check viscosity
	7. Bypass leakage	Correct for bypass valve leakage
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, hertz
	5. Fouled check valves	Clean, replace if necessary **Difficulty**

Difficulty	Probable Cause	Remedy
Delivery Higher Than Rated	1. Suction pressure higher than discharge pressure	Install back pressure valve or consult factory for piping recommendations
	2. Suction piping too small	Increase pipe size — Install PULSAtrol pulsation dampener at pump in suction line
	3. Back pressure valvae set too low	Increase setting
	4. Back pressure valve leaks	Repair, clean, or replace
Pump Loses Oil	1. Diaphragm ruptured	Replace
	2. Leaky oil seal	Replace
	3. Cover gasket leaks	Replace or tighten
	4. Pump head gasket leaks	Replace — tighten pump head bolts. Seal with permatex
	5. Gear box overfilled	Remove excess oil
Air Continuously Bleeds From Automated Air Bleed Valve	1. Oil in reservoir low	Refill to correct level
	2. Hydraulic Bypass valve opening continuously	Refer to "Hydraulic Bypass Valve"
	3. Suction pressure too low	Increase pressure
	4. Breakdown of oil, temperature high	Change oil type, consult factory
Noisy Gearing, Knocking	1. Discharge pressure too high	Reduce pressure or discharge pipe size
	2. Water hammer	Install PULSAtrol
	3. Worn bearings	Replace
	4. Worn gears	Replace gears & check for improper hydraulic bypass valve setting
	5. End play in worm shaft	Consult factory
	6. Eccentric or worm gear	Tighten or replace assembly
	7. Bypass valve set too high	Readjust (see "Hydraulic Bypass Valve")
Piping Noisy	1. Pipe size too small	Increase size of piping, install PULSAtrol
	2. Pipe runs too long	Install PULSAtrol in line
	3. Surge chambers full of liquid	Recharge with air or inert gas, replace diaphragm and recharge
	4. No surge chambers used	Install PULSAtrols — pulsation dampeners
Motor Overheats	1. Pump overloaded	Check operating conditions against pump design
	2. Oil too viscous	Consult factory
	3. Low voltage	Check power supply
	4. Loose wire	Trace and correct. Check no load

SUCTION HEAD REQUIREMENTS

All reciprocating metering pumps require a net positive suction head ($NPSH_R$) as shown in Table 1. The $NPSH_R$ 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 $NPSH_R$ is one of the requirements necessary to assure metering accuracy.

Table 1. $NPSH_R$ values

$NPSH_R$	Pulsar	Pulsa
English (psi)	3	5
Metric (bar)	0.21	0.35

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.

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

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.

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

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

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. 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.)

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

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

MSH	Pulsar	Pulsar*	Pulsa
English, (psia)	5	7.5	9.5
Metric, (bar(a))	0.35	0.53	0.66

*Pulsar Pump with PULSAlarm leak detection diaphragm.

APPENDIX PULSAFEEDER ACCESSORIES

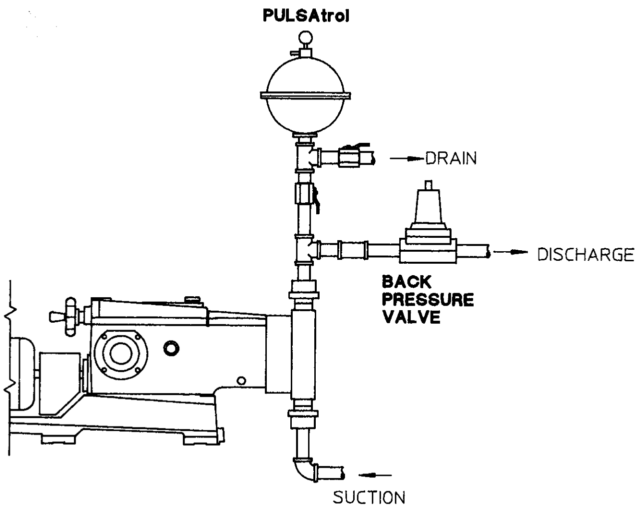
I. PULSATROL INSTALLATION, OPERATION AND REMOVAL INSTRUCTIONS

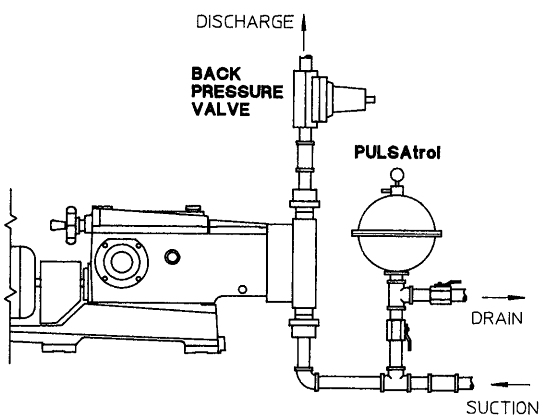
The PULSAtrol is a pneumatically charged diaphragm type chamber that continuously stores energy. Used on the inlet it will improve $NPSH_a$ (Net Positive Suction Head available) characteristics of the suction piping system. On the discharge line it will reduce dangerous peak pressures, eliminate shock waves and if of sufficient volume will reduce pulsating flow to almost linear.

INSTALLATION

Figures 16 a and b

On both discharge and suction lines it is desirable to mount the PULSAtrol as close to the pump connection as possible. It can be mounted in any position, but vertical is preferred for ease of charging, draining and servicing. The air chamber is sealed and will not require replenishing regardless of position. A shut off valve should always be used between the piping system and PULSAtrol, also a drain valve should always be installed directly below the PULSAtrol. If the discharge line is open to atmospheric pressure then a back pressure valve should also be incorporated in the system near the PULSAtrol to assure proper operation.





OPERATION (Charging the PULSAtrol)

PROCEDURE

Pre Charge Procedure for Discharge Installation

1. Calculate the precharge pressure

Mean Line Pressure (PSIG)
+ Atmospheric Pressure
Absolute Pressure (PSIA)
x Precharge Percentage (80% Max.)
Pressure Absolute
- Atmospheric Pressure
Precharge Pressure (PSIG)

= Precharge Pressure

2. Isolate PULSAtrol from line.
3. Carefully drain off process fluid by opening a drain valve (see recommend piping arrangement).
4. Apply precharge pressure (additional liquid may drain as diaphragm moves).
5. Close drain valve.
6. Place PULSAtrol in stream.

PROCEDURE

Pre Charge Procedure for Suction Installation

1. Isolate accumulator from line.
2. Carefully drain off process fluid by opening a drain valve (see recommended piping arrangement, attached).
3. Apply 5-10 psi precharge pressure (additional liquid may drain as diaphragm moves).
4. Close drain valve.
5. Bleed off all pressure on the PULSAtrol.
6. Open the valve to put PULSAtrol in stream.
7. Push in on the stem of the charging valve during the discharge stroke of the pump and release during the suction stroke.
8. Continue this for about 10 times and observe the compound gauge. As accumulator functions, the needle will go from pressure to vacuum.

C. Suction Installation (Suction Lift)

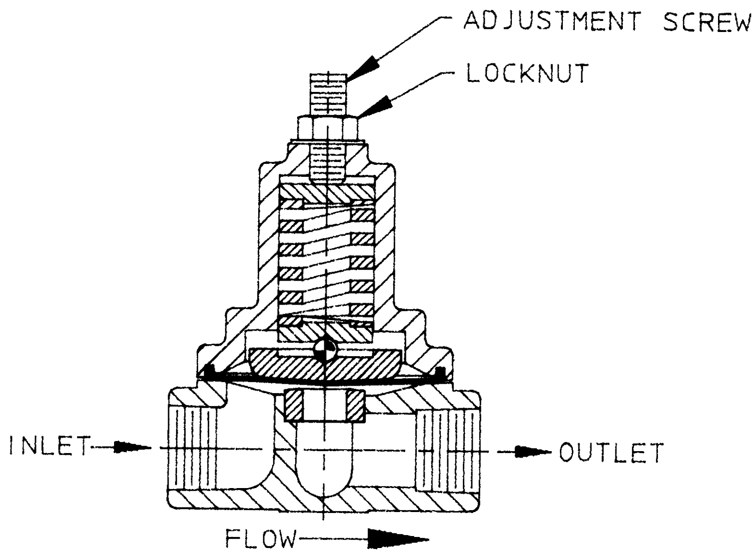
Consult your PULSA Series representative or the factory for details.

II. DIAPHRAGM BACK PRESSURE VALVES

Figure 17

Pulsafeeder diaphragm back pressure valves create a constant back pressure without chatter or cycling. A TFE diaphragm, offering maximum chemical protection and service life, seals spring and bonnet from product. This diaphragm seals directly on a replaceable seat.

Be sure to install with fluid flow in direction of arrow on valve body. If arrow is missing from plastic valve body, install with flow exiting out center hole of valve body.



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