INSTRUCTION MANUAL

FOR INSTALLATION
OPERATING, AND
MAINTENANCE.

Dosing Pump PRIMEROYAL ®

Packed Plunger

This manual should be made available to the person responsible for installation, operating and maintenance.
## CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section 1</td>
<td>Description</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Principle of Operation</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Safety Precautions</td>
<td>4</td>
</tr>
<tr>
<td>Section 2</td>
<td>Installation</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Unpacking</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Mounting</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Piping</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Service Connections</td>
<td>8</td>
</tr>
<tr>
<td>Section 3</td>
<td>Operation</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Initial Start-Up</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Initial Adjustments</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Preventive Maintenance</td>
<td>10</td>
</tr>
<tr>
<td>Section 4</td>
<td>Troubleshooting Guide</td>
<td>11</td>
</tr>
<tr>
<td>Section 5</td>
<td>Corrective Maintenance</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Packing Replacement</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Check Valve Disassembly</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Check Valve Reassembly</td>
<td>15</td>
</tr>
</tbody>
</table>
LIST OF ILLUSTRATIONS

PrimeRoyal Metering Pump ................................................................. 3
Figure 1. Packed Plunger Liquid End .................................................. 3
Figure 2. Recommended Valve Locations ............................................. 6
Figure 3. Check Valve Assembly ......................................................... 15
Figure 4. Packed Plunger Liquid End Assembly .................................. 16
Section 1

PRINCIPLE OF OPERATION

The drive unit moves the pump plunger to draw liquid into the liquid end on the suction stroke and to expel the liquid on the subsequent discharge stroke. In packed plunger liquid ends, the plunger contacts the process liquid, therefore a packing lubricant may be necessary depending on the fluid being pumped. Accurate flow control is achievable only if the discharge line pressure (discharge head) is greater than the suction line pressure (suction head). For aid in determining acceptable piping performance, please refer to Milton Roy’s NPSH calculator, available online at www.miltonroy.com.

Figure 1. Packed Plunger Pump.

As the plunger reciprocates in the liquid end, the pumped liquid is alternately drawn into and discharged from the liquid end. Each suction (rearward) stroke of the pump plunger creates a negative pressure in the displacement chamber. The pressure of the liquid in the suction line unseats the suction ball-checks and liquid flows into the displacement chamber. On the discharge stroke, the plunger moves forward and pressurizes the liquid which unseats the discharge ball-checks to flow out the discharge port. On each suction stroke, the discharge ball-checks are seated, and on each discharge stroke, the suction ball-checks are seated (pressure in pump head is greater than suction line pressure). This mode of operation prevents back flow and ensures liquid movement from the suction port, through the liquid end, and out the discharge port.
SAFETY PRECAUTIONS

When installing, operating, and maintaining the PrimeRoyal keep safety considerations foremost. Use proper tools, protective clothing and eye protection when working on the equipment and install the equipment with a view toward ensuring safe operation. Follow the instructions in this manual and take additional safety measures appropriate to the liquid being pumped. Be extremely careful in the presence of hazardous substances (e.g., corrosives, toxins, solvents, acids, caustics, flammables, etc.).
SECTION 2

INSTALLATION

UNPACKING

Pumps are shipped f.o.b. factory and title passes to customer when carrier signs for receipt of pump. The customer, therefore, must file any damage claims with the carrier.

Carefully examine the shipping crate upon receipt from carrier to be sure there is no obvious damage to contents. Open the crate carefully, as accessory items fastened to the inside of the crate may be lost or damaged. Examine all material inside crate and check against packing list to be sure that all items are accounted for and undamaged.

General Rules

Never connect a rigid pipe to plastic liquid ends; rather, use flexible connections to both suction and discharge.

Use piping materials that will resist corrosion by the liquid being pumped. Use care in selecting materials to avoid galvanic corrosion at pump liquid end connections.

Use piping heavy enough to withstand maximum pressures.

Size piping to accommodate peak instantaneous flow. Because of the reciprocating motion of the pump plunger, pump delivery follows an approximate sine curve with a peak instantaneous flow $\pi (3.14)$ times the average flow. Therefore, piping must be designed for a flow $3.14$ times the pump capacity; this means that a pump rated for 88 gallons per hour requires piping sufficient for 88 gph (333.1 L/hr) $3.14$ (or 276) gph (1044.7 L/hr). Please refer to Milton Roy’s NPSH calculator, on line at www.miltonroy.com

To minimize viscous flow losses, pipe viscous liquids with line up to four sizes larger than the pump port.

Remove burrs, sharp edges and debris from inside piping. Flush and blow out all pipe lines before making final connections to pump.

Provide for pipe expansion when hot liquids are to be pumped. Support piping so that pipe weight is not placed on the pump. Never spring piping to make connections.
Piping should be sloped to prevent vapor pockets, because vapor in the liquid end will cause inaccurate pump delivery.

When pumping suspended solids (such as slurries), install plugged crosses at all 90 degree line turns to permit line cleaning without dismantling piping.

**Suction Piping**

It is preferable to have the suction of the pump flooded by locating the liquid end below the lowest level of the liquid in the supply tank. Installing a hold-up tower or supply vessel on the suction line close to the pump can help ensure a flooded suction line. (Consult the Milton Roy Company, Flow Control Division for assistance in such applications.)

Avoid negative suction pressure conditions (suction lift), as such conditions adversely affect metering accuracy. If such conditions are unavoidable, contact Milton Roy Flow Control Division for recommendations.

When pumping a liquid near its boiling point, provide enough suction head to prevent the liquid from “flashing” into vapor when it enters the pump liquid end on the suction stroke.

If possible, use metal or plastic tubing for the suction line because tubing has a smooth inner surface and can be formed into long, sweeping bends to minimize frictional flow losses.

A strainer should be used in the suction line to prevent foreign particles from entering the liquid end. This and any other measures which prevent debris from entering and fouling the ball-checks will give increased maintenance-free service.

Keep suction piping as short and straight as possible.

When suction piping is long, and particularly at stroke speeds above 70 strokes per minute (spm), piping size should be larger than the liquid end suction fitting to prevent pump starvation.

If long suction lines are unavoidable, install a float box or auxiliary feed tank (stand pipe) near the suction side of the pump. The float box may be calibrated and used to check pump capacity by measuring the time required for pumping a specific quantity of liquid from the box. In many cases, installing an accumulator or pulsation dampener at the pump suction connection will promote flooded suction even when the suction line is long. Consult Milton Roy Flow Control Division for details.
Suction piping must be absolutely airtight to ensure accurate pumping. After installation, test suction piping for leaks with air and soap solution.

**Discharge Piping**

Install pipe large enough to prevent excessive pressure losses on the discharge stroke of the pump. Maximum pressure at the discharge fitting on the liquid end must be kept at or below the maximum pressure rating shown on the pump data plate.

The pump will not deliver a controlled flow unless the discharge line pressure is greater than the suction line pressure. Piping should be arranged to provide at least 5 psi (35 kPa) positive pressure differential between the discharge side and the suction side. There are a number of ways to create an artificial discharge pressure, such as by installing a vented riser or a back pressure valve. (Please consult Milton Roy Flow Control Division for recommendations to increase back pressure in slurry applications.)

When pumping water-treating chemicals directly into boiler drums, use one liquid end assembly for each boiler drum. Discharging into a manifold having the slightest pressure difference between its several discharge connections can diminish metering accuracy as the outlet with the lowest pressure will receive more liquid than the other outlets.

**Vented Risers**

A vented riser is simply a vertical extension of the discharge pipe into an open tee. The other side of the tee goes to the process. Practically maintenance-free, this device prevents siphoning and provides an artificial discharge head; however, a clogged or closed line may cause the riser to overflow. Therefore, substitute a pulsation dampener and back pressure valve for a vented riser when pumping hazardous liquids.

**Check Valves**

A check valve should be installed at the point where the discharge line enters a boiler or other high-pressure vessel. This will prevent back flow through the discharge piping and will isolate the pump discharge from system pressures (a safety consideration).
Shut-Off Valves

Provide shut-off valves in both suction and discharge lines next to the pump. Locate discharge line shut-off valve downstream from the inlet connection of the safety valve.

Back Pressure Valves

A Milton Roy back pressure valve should be installed in the discharge line near the pump to ensure sufficient discharge head pressure for proper pump metering action. Normally, the valve should be located near the pump; however, back pressure valves for large pumps with long and extremely small discharge lines may have to be installed near the point of discharge into the process (to minimize siphoning tendencies). Contact Milton Roy Company for sizing recommendations.

Accumulators (Surge Chambers)

An accumulator, surge chamber, surge suppressor, or pulsation dampener should be used with the back pressure valve in the discharge line to absorb the flow peaks between the pump and the back pressure valve (see figure 2). Without the pulsation dampener the valve mechanism will snap open and closed with the surge from each pump stroke. The pulsation dampener will allow the back pressure valve to oscillate about a partly-closed position, thus minimizing wear on the valve. Discharge line pulsation dampeners offer the further advantage of limiting the flow and pressure variations characteristic of this kind of pump. Installing a properly sized pulsation dampener will improve pump performance and may reduce system costs dramatically by permitting the substitution of smaller piping. Please contact Milton Roy Company for further information on pulsation dampeners.

Safety Valves

Motor-driven positive displacement pumps can develop tremendous discharge pressures long before thermal overload devices interrupt the motor electrical circuit. To prevent a blocked discharge line from causing damage to the pump, piping, or process equipment, install a Milton Roy Safety Valve in the pump discharge line. This valve is designed and sized to handle system flow rates and pressures safely while resisting corrosion by the process liquid.

Install the safety valve in the discharge line between the pump and the nearest shut-off valve. (This will prevent pump damage from accidental valve closure.) Pipe the safety valve outlet back to the suction tank or to drain, but in either case ensure that the pipe end is continuously visible so safety valve leakage may be detected. See figure 2 for construction and installation.

Piping Concentrated (95-100%) Sulfuric Acid

Packed plunger pumps are not recommended for this service. Diaphragm style liquid end are more suited for this application.
SECTION 3
OPERATION

INITIAL START-UP
Follow the start up directions in the "Drive" manual (56968) and those listed below.

INITIAL ADJUSTMENTS

NON-ADJUSTABLE TYPE PACKING
"Non-adjustable" Plunger Packing (specified in the pump model number; see Section 1, Model Code) is preset by internal spring pressure and is complete once the Gland Cap (1660 in fig. 4) is fully tightened. No adjustments possible.

Capacity Calibration

After the first 12 hours of operation, the pump may be tested and calibrated to find the exact pump capacity under specific operating conditions.

Usually, calibrating the pump at only 100, 50, and 10 percent capacity settings is enough to indicate pump performance throughout the adjustment range.

The pump can be calibrated by one of two methods carried out in a given time:

1. Measure the decrease in liquid level pumped from a calibrated vessel.

2. Collect and measure pumped liquid at the pump discharge port. (It may be necessary to create a discharge head (back pressure valve) at the liquid take-off point; otherwise pump will not operate properly. See Section 2 for ways to do this.)

The first method is recommended for hazardous liquids because it eliminates operator contact with the liquid.

Filling Pumping System

It is especially important that pump suction and discharge lines be free of entrained air. To ensure this condition, operate the pump under no discharge pressure and fill the entire pumping system with liquid before starting pressure tests.

If the pump is idle for long periods, temperature changes in the process liquid may produce air in the system. To discharge the air, install a valve in the discharge line which will allow the process liquid to be pumped to exhaust when starting the pump.
PREVENTIVE MAINTENANCE

PrimeRoyal pumps are carefully designed, manufactured, assembled and quality tested to give reliable service with minimal maintenance. However, a daily maintenance check is recommended to visually confirm proper operation of the pump.

Packing

If an automatic oiler is used, monitor normal lubricant consumption and refill the reservoir before it becomes empty.

If other external lubricant is used, lubricate the plunger packing daily with a lubricant compatible with the liquid being pumped. Do not add any other kind of lubricant to the packing.

Check Valves

Check valve assemblies are designed to be self-cleaning by pumping a hot detergent solution for 15 minutes, followed by water flushing.
<table>
<thead>
<tr>
<th>SYMPTOM</th>
<th>CAUSES</th>
<th>REMEDIES</th>
</tr>
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<tbody>
<tr>
<td>Pump will not operate.</td>
<td>Low liquid level.</td>
<td>Add liquid.</td>
</tr>
<tr>
<td></td>
<td>Blocked discharge line.</td>
<td>Clear line.</td>
</tr>
<tr>
<td></td>
<td>Frozen liquid.</td>
<td>Thaw liquid throughout pumping system.</td>
</tr>
<tr>
<td></td>
<td>Pump not primed.</td>
<td>Allow suction line and pump head to fill with liquid before pumping against pressure.</td>
</tr>
<tr>
<td>Insufficient delivery.</td>
<td>Incorrect capacity adjustment.</td>
<td>Readjust capacity setting.</td>
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<tr>
<td></td>
<td>Incorrect pump speed.</td>
<td>Match line voltage and frequency to pump motor data plate.</td>
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<tr>
<td></td>
<td>Starved suction.</td>
<td>Increase piping size or suction head.</td>
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<tr>
<td></td>
<td>Leaky suction piping.</td>
<td>Repair piping.</td>
</tr>
<tr>
<td></td>
<td>High suction lift.</td>
<td>Rearrange equipment to decrease lift.</td>
</tr>
<tr>
<td></td>
<td>Liquid near boiling.</td>
<td>Cool liquid or increase suction head.</td>
</tr>
<tr>
<td></td>
<td>Leaky packing.</td>
<td>Adjust or replace packing.</td>
</tr>
<tr>
<td></td>
<td>Leaky safety valve in discharge line.</td>
<td>Repair or replace safety valve.</td>
</tr>
<tr>
<td></td>
<td>High liquid viscosity.</td>
<td>Reduce viscosity (e.g., heat or dilute liquid).</td>
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<tr>
<td></td>
<td>Worn or dirty check valve seats.</td>
<td>Clean or replace.</td>
</tr>
<tr>
<td>SYMPTOM</td>
<td>CAUSES</td>
<td>REMEDIES</td>
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</tr>
<tr>
<td></td>
<td>Leaky packing.</td>
<td>Adjust or replace packing.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Repair or replace safety valve.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Raise suction tank level or pressurize tank.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cool liquid or increase suction head.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clean or replace.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clean strainer.</td>
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</tbody>
</table>
SECTION 5
CORRECTIVE MAINTENANCE

PACKING REPLACEMENT:

Packing Replacement
(Spring loaded, Non-Adjustable packing type only, Figure 4).

The V-Type (Chevron style) packing rings are provided as a set. The set includes the lantern ring, V-rings, seal ring, o-ring and spring. In some cases, a separate kit of V-rings and other soft seal parts (not including the metal parts) may be purchased.

The liquid end must be removed from the pump to replace the packing set. Flush liquid end of process liquid. Disconnect suction and discharge lines. The hex head pipe plug (1720) in the end of the liquid end connects to the process cavity, and need not be removed (the hole connects to the packing cavity providing continuous venting).

1. Unscrew the plunger adapter (1610) and move it away from the crosshead, and the bolts fastening it to the pump housing.

2. Measure and record the length of plunger protruding from the liquid end.

3. Withdraw plunger from liquid end. Inspect plunger and the inside of the liquid end. Both areas must be free from streaks (longitudinal groves) and other irregularities. Also replace any scored or corroded plungers.

4. Clamp the liquid end in a vise and loosen the packing follower retaining nut (1660), expecting the internal spring to push the packing parts outward.

   CAUTION, the spring force may suddenly loosen stuck packing, causing it to fly out of the liquid end. (The same precaution must be used during the re-installation).

5. Thoroughly clean the liquid end body of old packing, contamination and lubricant.

6. The metal parts: lantern ring, spring etc. may be re-used if they are in good condition. The V-rings and seals are typically replaced.

7. IT IS IMPORTANT TO PACKING LIFE to soak the packing rings in the normal packing lubricant prior to installing them in the pump, to reduce friction and aid the break-in process. If packing grease is used, work some grease into each ring before assembly. Also coat the inside of the liquid end with the same lubricant.

8. Replace ALL packing parts as shown in figure 4. Proper packing compression and minimized leakage require use of the packing components as designed. Begin assembling the components one ring at a time.
9. When installing the gland cap, anti-seize lubricant must be applied to the threads. Thread the gland cap onto the liquid end and tighten it until it bottoms out against the packing follower. Note: once the gland cap is tightened the compression on the spring loads the packing. NO OTHER ADJUSTMENT WILL BE NECESSARY.

10. Coat the plunger with lubricant and insert it into the liquid end far enough that it extends from the liquid end the distance measured in step 2, plus 1/8”(3 mm).

**Liquid End Installation:**

1. Install liquid end to pump casing, guiding the plunger adapter(1610) into the crosshead(365). Seat and tighten the plunger adapter, and guide the liquid end to its mounting place on pump housing.

2. The plunger adapter will not clamp tight on the plunger, but allow it to have a small amount of angular and radial clearance. Rotate the plunger, to be sure that the plunger is not clamped tight. Foreign material captured with the end of the plunger may eliminate the needed clearance and cause premature packing failure. The plunger should have less than 1/64” axial movement when tightened in the crosshead.

3. Install and tighten bolts(1750) to hold liquid end to pump housing.

4. Install the tubing as provided.

**Check Valves**

Check valve assemblies are designed to be self-cleaning and should seldom need servicing. Fouled check valves can usually be cleaned by pumping a hot detergent solution for 15 minutes, followed by water flushing.

**Check Valve Disassembly**

The pump may be dismantled for parts replacement through the following procedures. (Numbers in parentheses are part identifiers from figures at back of manual.)

**Check Valves**

To disassemble check valves (e.g., to replace balls and seats), refer to figure 3

1. Unscrew and remove check valve assembly (1760) from liquid end (1620).
2. Screw upper check valve body into a pipe coupling. Invert assembly and place coupling on work surface.
3. Using an arbor press or a mallet and a brass rod just large enough to cover the exposed (lower) seat, press the cartridge parts out of the cartridge body (221-K).
4. Remove limit pins (292) from seats.
Figure 3. Check Valve Parts.

Disassembly:

1. Disconnect motor power supply.
2. Remove covers. Drain oil from pump casing.
3. Unbolt and remove gland.
4. Loosen plunger adapter.
5. Remove liquid end from pump drive. (Step 1 of “Packing Replacement”).

Check Valve Reassembly

Reassemble check valves as follows.

1. Install O-rings (225) in grooves in each seat (224-B). Make sure the ends of split rings overlap in the seat grooves.
2. Place a ball-check (407-D) in one seat.
3. Install limit pin (292) in seat with ball-check. This assembly will be the lower seat assembly.
4. Coat seat O-rings with Teflon® spray or other lubricant. Position lower seat assembly in the top of the check valve body (221-K) with the limit pin at top. Press lower seat assembly into check valve body till it is flush with top of valve body.
5. Place a ball-check in the remaining seat and install the limit pin in this seat.
6. Position second (upper) seat assembly in top of check valve body with limit pin at top and press this upper seat assembly into check valve body (forcing lower seat further down under it) till it is flush with top of valve body.
7. Place a piece of bar stock equal to the inside diameter of the check valve body on top of the upper seat. Press bar stock to drive both seats down into the check valve body until lower seat bottoms in valve body counterbore. (Top seat will be recessed slightly from top of valve.)
Figure 4. High Pressure "Bar Stock" Liquid End Assembly Drawing