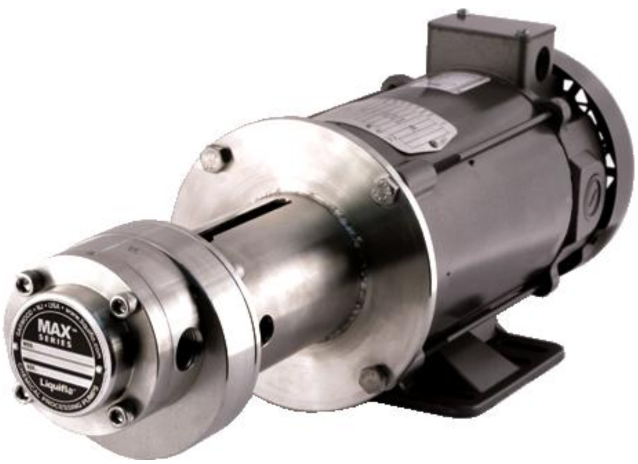
Liquiflo™
Chemical Processing Pumps

INSTALLATION, OPERATION & MAINTENANCE MANUAL

MAX® SERIES

MECHANICALLY-SEALED, CLOSE-COUPLED GEAR PUMPS



Sealed Models M0 thru M4

Sealed Models M5 thru M8

Document No.: 3.20.085

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Introduction

This manual provides instructions for the installation, operation and maintenance of the Liquiflo Max® Series Gear Pumps, Sealed Models M0, M1, M2, M3, M4, M5, M6, M7 & M8. It is critical for any user to read and understand the information in this manual along with any documents this manual refers to prior to installation and start-up.

Liquiflo shall not be liable for damage or delays caused by a failure to follow the instructions for installation, operation and maintenance as outlined in this manual.

Thank you for purchasing a Liquiflo product.

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Section 1: General Information

1.1 General Instructions

This manual covers the Max® Series Sealed, Close-Coupled gear pumps, Models M0 thru M8.

The materials of construction of the pump are selected based upon the chemical compatibility of the fluid being pumped. The user must verify that the materials are suitable for the surrounding atmosphere.

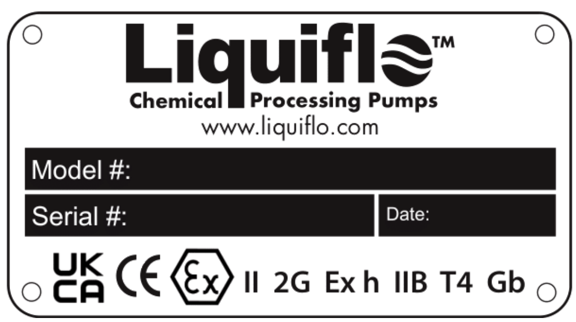
If the fluid is non-conductive, methods are available to mechanically ground the isolated shaft. This is only necessary if the surrounding atmosphere is extremely explosive or stray static charges are present.

Upon receipt of your Liquiflo pump:

A) Verify that the equipment has not been damaged in transit.

B) Verify that the pump *Model Number* and *Serial Number* are stamped on the circular *Stainless Steel Nameplate* on the pump's housing.

C) For UKCA, CE and ATEX certification, verify that the following *Stainless Steel Tag* is attached to the pump:



Refer to **Appendix 4** for meaning of the Tag Certification Markings.

D) Record the following information for future reference:

Model Number:
Serial Number:
Date Received:
Pump Location:
Pump Service:

NOTE: By adding a **K** prior to the pump's Model Number, a **Repair Kit** can be obtained which consists of the following parts: mechanical seal, drive and idler gears, drive and idler shafts, wear plates, bearings, retaining rings, keys, housing alignment pins, bearing lock pins and O-rings.

1.2 Pump Specifications

Table 1: Max® Series SEALED Pump Specifications

Pump Model	M0	M1	M2	M3	M4	M5	M6	M7	M8	Units
Port Size	1/2	1/2	1/2	1/2	3/4	3/4	1	1 ¼	1 ½	in
Port Type	Threaded (NPT/BSPT) or Flanged (ANSI/DIN)									-
Body Material	316 Stainless Steel									-
Component Material Grades	PEEK (Bearing Grade 450FC30); Teflon (PTFE, 25% Glass-filled)[9]; Carbon (Graphitar 114 or equivalent); SiC (Self-sintered); Viton (Type A); Kalrez (4079 std./1050LF optional)									-
Mechanical Seal	Single Internal or Double, Type 9T (316 SS Body/Carbon Face/SiC Seat)									-
Mech. Coupling	L095 (CI/Urethane); 291 in-lb nom.					L099 (CI/Urethane); 477 in-lb nom.				-
Mounting Bracket	Motor-Mounted, 316 SS					Pedestal, Epoxy-Painted Cast Iron				-
Max Speed	1800	1800	1800	1800	1800	1800	1800	1800	1800	RPM
Theoretical Displacement [1]	.00022	.00055	.00138	.00193	.00289	.00491	.00675	.00859	.01105	GPR
Max Flow Rate [1]	0.40	1.0	2.5	3.5	5.2	8.8	12.2	15.5	20	GPM
	1.5	3.8	9.4	13.1	19.7	33.5	46.0	58.5	75	LPM
Max Differential Pressure [2]	350	350	350	350	350	350	350	350	350	PSI
	24	24	24	24	24	24	24	24	24	bar
Max System Pressure [3]	500	500	500	500	500	500	500	500	500	PSIG
	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	(barg)
Max Temperature [4]	500	500	500	500	500	500	500	500	500	°F
	260	260	260	260	260	260	260	260	260	°C
Min Temperature	-40	-40	-40	-40	-40	-40	-40	-40	-40	°F
	-40	-40	-40	-40	-40	-40	-40	-40	-40	°C
Max Viscosity [5]	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	cP or mPas
NPSHR [6]	3	3	2	2	5	5	5	4	3	ft (a)
	0.9	0.9	0.6	0.6	1.5	1.5	1.5	1.2	0.9	m (a)
Suction Lift (dry) [7]	0.5	1	2	4	6	6	7	6	14	ft
	0.15	0.3	0.6	1.2	1.8	1.8	2.1	1.8	4.3	(m)
Approx. Weight [8]	38	38.5	39	39.5	40	42	54	55.5	56	lb
	17.2	17.5	17.7	17.9	18.1	19.1	24.5	25.2	25.4	kg

NPSHR = Net Positive Suction Head Required

FOOTNOTES:

1 Based on new pump operating at Maximum Speed and 0 PSI (bar) differential pressure.

2 Maximum Differential Pressure is dependent upon fluid being pumped. Consult factory.

3 Maximum System Pressure must be derated for flanged pumps, based on the flange type and service temperature.

4 Actual Maximum Operating Temperature depends on materials of construction. The actual maximum surface temperature depends not on the pump but primarily on the temperature of the fluid being pumped. Pump surfaces will be approximately 20°F (11°C) above the temperature of the process fluid.

5 High viscosity fluids may require larger pumps with trimmed gears operating at lower speeds. Consult factory.

6 NPSHR (Net Positive Suction Head Required) is specified @ Maximum Speed and < 150 cP (mPas).

7 Dry Suction Lift is based on water @ room temperature and Maximum Speed with PEEK Gear(s) and Carbon Bearings. For other materials, priming of the suction line is required to prevent wear and possible damage to internal components.

8 Approximate weight of pump with threaded ports, not including motor.

9 Teflon Wear Plates contain 25% Glass Fiber; O-rings are 100% PTFE.

NOTES:

1 The pump is designed to handle fluid temperatures ranging from 32°F (0°C) to 104°F (40°C) with standard components. For temperatures outside this range, gears and bearings may require a trim to compensate for thermal expansion. Reference the pump model code to determine if the pump is trimmed.

2 The operating ambient temperature range depends not on the pump but on the motor, which is a function of motor design, enclosure, insulation class, loading, ventilation and other factors. Refer to motor manufacturer's specifications.

1.3 Model Coding

Table 2: Model Coding for Max® Series SEALED Gear Pumps

Position	Description	Code	Selection	
1	Pump Model	M0	Model M0 Pump	1/2" Ports
		M1	Model M1 Pump	
		M2	Model M2 Pump	
		M3	Model M3 Pump	
		M4	Model M4 Pump	3/4" Ports
		M5	Model M5 Pump	
		M6	Model M6 Pump	1" Ports
		M7	Model M7 Pump	1-1/4" Ports
		M8	Model M8 Pump	1-1/2 " Ports
2	Body Material & Port Type	S	316 SS – Threaded, NPT	
		X	316 SS – Threaded, BSPT	
		L	316 SS – Flanged, ANSI 150#	
		K	316 SS – Flanged, ANSI 300#	
3	Drive Gear	6	316 SS	
		9	17-4 PH SS Integral Gear-Shaft	
		P	PEEK	
4	Idler Gear	6	316 SS	**Pos. 3 = 6**
		9	17-4 PH SS Integral Gear-Shaft	**Pos. 3 = 9**
		P	PEEK	**Pos. 3 = 6 or P**
5	Wear Plates	3	Teflon	
		B	Silicon Carbide (SiC)	
		E	Carbon	
		P	PEEK	
6	Bearings	B	Silicon Carbide (SiC)	
		E	Carbon	
		P	PEEK	
7	Motor Shaft Diameter (Motor Frame Size)	0	5/8 in. (NEMA 56C)	**Pos. 1 = M0-M8**
		1	7/8 in. (NEMA 143/145TC)	
		2	14 mm (IEC 71 – B5 Flange)	
		3	19 mm (IEC 80 – B5 Flange)	
		4	24 mm (IEC 90 – B5 Flange)	
		5	1-1/8 in. (NEMA 182/184TC)	**Pos. 1 = M5-M8**
		8	28 mm (IEC 100/112 – B5 Flange)	
8	Sealing Method	U	Single Internal Mechanical Seal – Carbon/SiC	
		F	Double Mechanical Seal – Carbon/SiC	
9	Bearing Flush Option	0	Standard Housings (without Bearing Flush)	
		2	Internal Bearing Flush	
10	Shafts	0	316 SS (uncoated)	
		1	Chrome Oxide Coated 316 SS	
		2	Tungsten Carbide Coated 316 SS	
		3	17-4 PH SS Integral Gear-Shaft	**Pos. 3 & 4 = 9**
11	O-Rings (Housing - Seal Seat*)	0	Teflon - Viton	
		V	Viton - Viton	
		T	Teflon - Kalrez	
		K	Kalrez - Kalrez	
Suffix	Trim Option		No Trim	
		- 8(T)	Temperature Trim	**T** = Service Temperature in°F
		- 9D	Viscosity Trim, Double Clearance	150 ≤ Visc. < 300 cP
		- 9T	Viscosity Trim, Triple Clearance	Visc. ≥ 300 cP

* Seal Seat design requires elastomer O-ring.

Model Coding Example:

Position:

M4S6PEE1U02V =

Position	Code	Description
1	M4	Model M4 Pump
2	S	316 SS Body & NPT Ports
3	6	316 SS Drive Gear
4	P	PEEK Idler Gear
5	E	Carbon Wear Plates
6	E	Carbon Bearings
7	1	NEMA 143/145TC Motor Frame
8	U	Single Internal Mechanical Seal – Carbon/SiC
9	0	Standard Housings (No Bearing Flush)
10	2	TC-Coated 316 SS Shafts
11	V	Viton O-Rings
		No Suffix (No Trim)

1.4 Repair Kits & Replacement Parts

Repair kits and replacement parts for the pumps can be purchased from your local Liquiflo distributor. Refer to **Appendix 2** for individual parts information.

1.5 Returned Merchandise Authorization (RMA)

If it is necessary to return the pump to the factory for service,

1) Contact your local Liquiflo distributor to discuss the return, obtain a Returned Merchandise Authorization Number (**RMA #**) and provide the distributor with the required information (see RMA Record below).

2) Clean and neutralize pump. Be sure no fluid remains in the pump. **Liquiflo is not equipped to handle dangerous fluids.**

3) Package the pump carefully and include the **RMA #** in a visible location on the outside surface of the box.

4) Ship pump to factory, freight prepaid.

Returned Merchandise Authorization (RMA) Record	
RMA #	(Supplied by Distributor)
Distributor Name	
Item(s) Returned	
Serial Number(s)	
Reasons for Return	
Fluid(s) Pumped	
Time in Service	

NOTE: Pump must be cleaned and neutralized prior to shipment to the factory.

Section 2: Safety Precautions

2.1 General Precautions

- **Always** lock out the power to the pump driver when performing maintenance on the pump
- **Always** lock out the suction and discharge valves when performing maintenance on the pump
- **Never** operate the pump with suction and/or discharge valves closed
- **Never** start the pump without making sure that the pump is primed
- **Never** use heat to disassemble the pump
- Decontaminate pump using procedures in accordance with federal, state, local and company environmental regulations
- Before performing maintenance on the pump, check with appropriate personnel to determine if skin, eye or lung protection is required and how best to flush the pump

Caution!
Failure to observe safety precautions can result in personal injury, equipment damage or malfunction.

Section 3: Pump & Motor Installation

3.1 Installation of Pump, Motor & Base

Refer to the Hydraulic Institute Standards for proper installation procedures of the base, pump and motor.

1) **The pump inlet should be as close to the liquid source as practical and preferably below it.** Even though gear pumps have self-priming and lift capability, many issues can be avoided with a flooded suction arrangement.

NOTE: The Max-Series pumps are close-coupled and no alignment procedure between the pump and motor is required.

3.2 General Piping Requirements

Refer to the Hydraulic Institute Standards for piping guidelines.

1) All piping must be supported independently and must line up naturally with pump ports.

> ***Caution!***
> ***Do not use the pump to support the piping or allow the piping to apply stress to the pump ports.*** *This can distort the alignment of the pump housing with internal parts and lead to rapid wear or malfunction.*

2) Piping that handles both hot and cold liquids require proper installation of expansion loops and joints so that thermal expansion of the piping will not cause misalignment.

3) **Suction and discharge piping should be the same size or larger than the inlet and outlet ports.** This is especially important for viscous services when the pipe diameter has a large effect on friction losses and NPSH available.

4) **Piping runs should be designed to minimize friction losses.** The suction line should be as short and direct as possible, especially for viscous fluids and/or high flow rates. Sharp bends or restrictions in the piping should be avoided. Long sweep elbows should be used when turns are required. Valves should be ball type, which offer minimal resistance to flow when fully open.

5) The piping should be arranged to allow the pump to be flushed and drained prior to the removal of the pump for servicing. Valves and unions should be installed to allow the pump to be isolated during maintenance.

6) Gasket materials used with flanged connections must be chemically and thermally compatible with the fluid and operating temperature.

7) The piping system should be cleaned prior to installation of the pump.

3.3 Relief Valves

A positive displacement pump should have a pressure relief valve (PRV) installed in the discharge line. Operating a gear pump against a closed discharge valve will result in over-pressure and likely failure of the pump or system. Install the relief valve between the pump discharge port and the discharge isolation valve. Ideally, the relief valve should bypass the discharge line back to the supply tank. Where this is not feasible, piping the relief valve back to the suction side of the pump will prevent immediate pump failure from over-pressure. However, continuously running in this condition will cause heating of the fluid.

3.4 Strainers & Solids Handling

1) Liquiflo gear pumps have very close internal clearances and are designed to pump relatively clean fluids. The entrance of foreign material could cause damage or rapid wear to pump components. While occasional small particles may not be catastrophic to the pump, **the use of a strainer on the inlet will prevent large particulates from entering the pump**. Large particulates can become lodged into the roots of the gears, causing a sudden failure. If small, abrasive particles are present, they can get in between the shafts and bearings, which will accelerate or increase wear over an extended period of time. If the strainer clogs with material and is not properly maintained, the pump may be starved of liquid, causing a loss of flow and damaging the pump via dry-running.

2) The maximum particle size capable of being passed by the pumps is 37 microns. **Regardless of particle size, these pumps are intended for relatively clean liquids** where the general concentration of solids is limited to 1% by volume. Higher concentration may cause the wear rate to increase, resulting in a decrease in pump performance. In addition to solids concentration, the specific wear rate also depends on the size, shape and hardness of the particles, the operating speed and the materials used to construct the pump. Since wear rate is proportional to the square of the speed, slower operating speeds will substantially increase the pump's lifetime.

3.5 Pressure Requirements

1) **The pump should be operated with at least 15 PSI (1 bar) differential pressure** to ensure that fluid is forced into the sleeve bearings, which are lubricated by the process fluid. If adequate discharge pressure is not available, a back pressure valve (BPV) can be used to generate sufficient pressure.

2) All pumps require sufficient NPSH (Net Positive Suction Head) to function properly. The NPSH available in the system is the difference between the available suction pressure at the pump inlet and the vapor pressure of the fluid (which depends on the fluid temperature). Each pump model has its own NPSH requirement (see Table 1 on page 4). **The NPSH available in the system must be greater than the NPSH required by the pump** or the pump will go into cavitation, resulting in decreased flow, increased vibration and noise emission, and potential damage to internal components.

3.6 Controlling the Flow

A gear pump is a positive displacement pump, and flow **cannot** be controlled by throttling the discharge valve. **Adjusting the motor speed** using a VFD (Variable Frequency Drive) is the most common method for controlling flow. Fluid viscosity and differential pressure will also have an effect on the flow rate.

3.7 Motor Selection

1) The motor frame size is part of the pump model coding and is selected at the time the pump is ordered. Brackets or pedestals and outer magnet hubs are available to fit NEMA 56C, 143TC, 145TC, 182TC & 184TC, and IEC 71, 80, 90, 100 & 112 (with B5 flange) motor frames. NEMA 182/184TC and IEC 100/112 B5 motor frames require an adapter plate to mount the motor to the pedestal for models M5-M8 (see **Appendix 1**). The adapter plate is provided when required.

2) The motor speed and power rating are usually determined at the time the pump is ordered to meet the specified conditions of service. The power requirement of the application depends on the flow rate, differential pressure and fluid viscosity. Up to 100 cP, the pump performance charts can be used to determine the brake horsepower (BHP) required for the application. Motor sizing and selection is further influenced by: constant torque ratios, coupling method, enclosure requirements and speed limits due to viscosity. For sizing of viscous fluid applications or for more assistance in general selection, contact the local distributor or Liquiflo.

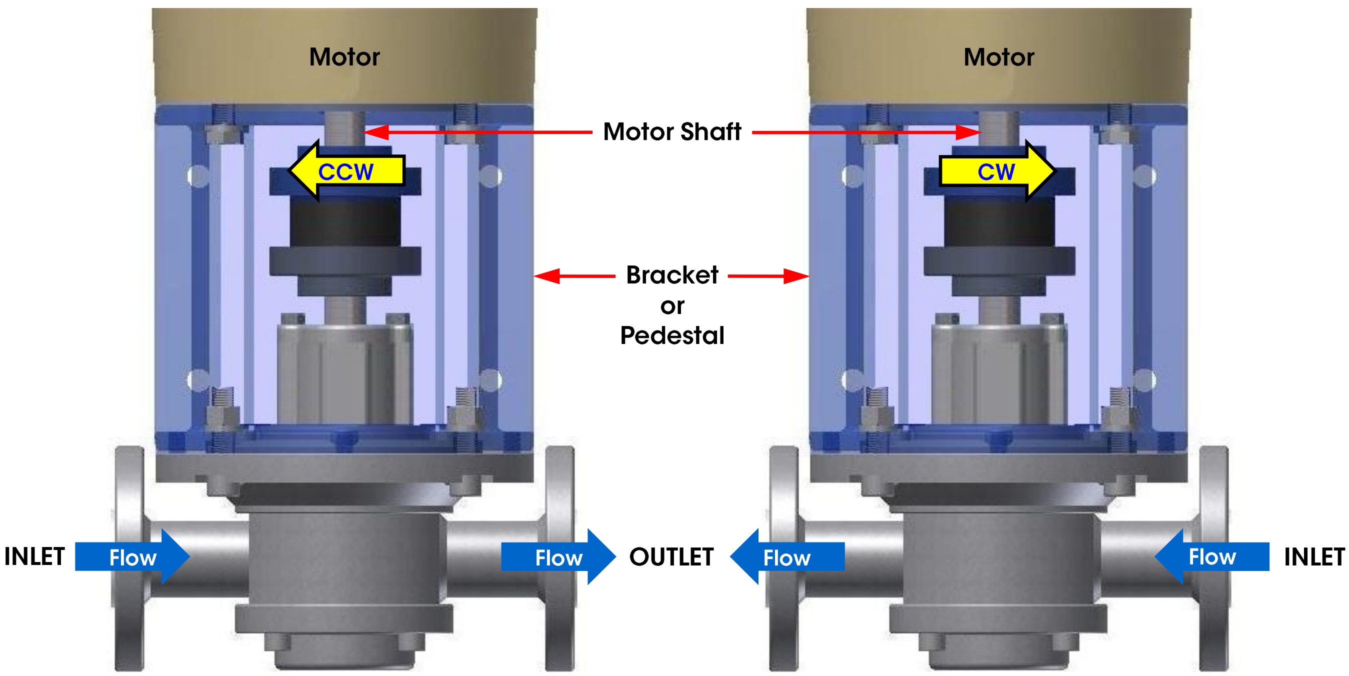
3.8 Motor Hook-Up

Please refer to the motor manufacturer's instructions.

3.9 Motor Shaft Direction

The motor shaft is mechanically coupled to the drive shaft of the pump. Both shafts will turn in the same direction. Because the gear pump is bi-directional, the pump shaft can turn in either direction to produce flow in either direction. The direction of rotation of the motor shaft (same as that of the pump drive shaft) will determine which side of the pump is the *inlet* (suction side) and which side is the *outlet* (discharge side). For the Max-Series pumps, the flow direction will be as shown below:

Top View of Sealed Gear Pump (with Transparent Bracket or Pedestal) Close-Coupled to Motor



Counterclockwise (CCW) Rotation of Motor Shaft:	**Clockwise (CW) Rotation of Motor Shaft:**
Fluid will enter the pump at the left side (inlet) and be discharged at the **right** side (outlet).	Fluid will enter the pump at the right side (inlet) and be discharged at the **left** side (outlet).

Section 4: Start-Up & Operation

4.1 Starting the Pump

1) Verify that the pump and motor are suitable for the conditions of service.

2) Verify that all suction and discharge **valves are open** before starting the pump.

3) **Prime the pump with fluid**.

   NOTE: For a flooded suction, allow the fluid time to enter the pump before starting. Although the pump is capable of pulling a certain amount of dry lift, contact wear will occur during this period. For a suction lift, priming or wetting the internal parts greatly reduces wear, since the components are lubricated by the pumped fluid. Some material combinations, such as PEEK gears and Carbon wear plates and bearings, are much more forgiving to short periods of dry running. Prolonged dry running will cause rapid wear and damage to the bearings and shafts due to overheating and thermal expansion. The interface between the rotating and stationary seal faces of a single mechanical seal are lubricated by the pumped fluid. If run dry, heat can be generated which can crack the seal faces. **As a general rule, sealed pumps should not be run dry for more than 30 seconds**.

4) Jog the motor to check the direction of rotation (see page 10 for diagram).

5) Monitor the pump for several minutes to ensure proper operation.

> ***Caution!***
> *Do not run the pump dry for more than 30 seconds or damage to the dynamic seal and other internal parts may result.*

4.2 Operation & Troubleshooting

A normally operating sealed gear pump will deliver a steady and pulse-less flow without leakage, be relatively quiet and have a predictable flow rate based on the pump speed, fluid viscosity and differential pressure across the pump. Refer to the performance curves of the specific pump model being operated (see Liquiflo Product Catalog or website: www.liquiflo.com).

The **Single Internal Mechanical Seal** is the most common dynamic seal arrangement for chemical applications where leakage needs to be minimized. This type of seal does not need to be adjusted during pump operation and must not be run dry because it depends on the movement of the process fluid to lubricate and remove heat from the seal faces. The standard rotating seal face material is Carbon and the standard stationary seal seat material is Silicon Carbide. When the pump is operating, 3 to 5 drops per day will cross the seal interface as a vapor. This can be a problem for toxic or flammable liquids, or fluids that can crystallize on contact with air. The single seal can tolerate only low levels of abrasives and the fluid viscosity must be limited to a maximum of 5,000 cP.

The **Double Mechanical Seal** arrangement is utilized when complete containment of the process fluid is required, or when pumping hazardous, abrasive, crystallizing or extremely viscous fluids. This type of seal relies on a *barrier fluid lubrication system* to operate effectively. Pressurized fluid from an external reservoir lubricates the outboard and inboard seals and creates a "barrier" inside the seal chamber to prevent the process fluid from crossing the inboard seal interface. The barrier fluid must be non-hazardous and compatible with the process fluid, have a net flow across the seal chamber and be pressurized to at least 15 PSI above the discharge pressure of the pump.

During pump operation, inspect for: (1) Unusual noise, (2) Product leakage, (3) Expected suction and discharge pressures and (4) Expected flow rate based on pump speed, fluid viscosity and differential pressure. If any problems occur, stop the pump and take corrective action. Refer to the Troubleshooting Guide given in **Appendix 3**.

Section 5: Maintenance & Repair

The pump has internal bearings, wear plates, gears, shafts and a mechanical seal that require replacement over time due to physical wear. Standard repair kits are available to facilitate repair of the pump. Repair kits contain all internal wear parts as well as O-rings, retaining rings, keys, bearing lock pins and housing alignment pins. O-rings and retaining rings should never be reused when rebuilding the pump.

Note: The center housing of the pump may also incur physical wear on the suction-side inner surface from contact with the gears caused by extremely worn bearings and shafts.

5.1 Work Safety

Before performing maintenance, review the Safety Precautions given in **Section 2** (see page 7).

5.2 Removal from System

Before servicing, prepare the pump as follows:

> ***Caution!***
> *If the pump was used on hazardous or toxic fluids, it must be flushed and decontaminated prior to removal from the system piping. Refer to the Material Safety Data Sheet (MSDS) for the liquid and follow all prescribed safety precautions and disposal procedures.*

1. Flush the pump.
2. Stop the motor and lock out the electrical panel.
3. Close the suction and discharge isolation valves.
4. Disconnect the pump from the system piping.

   Note: There will be some liquid trapped inside the pump. This liquid can be drained after the pump module is separated from the bracket or pedestal. (See **Section 5.3** on following page.)

> ***Caution!***
> *Some trace fluid may remain in the pump module even after draining.*

5.3 PUMP DISASSEMBLY

Follow the procedure below and refer to the drawings on pages 18-19 for Models M0-M4 or pages 20-21 for Models M5-M8.

Pump Module Removal:

1 **Models M0-M4:** Remove the four bolts (24) and detach the pump module from the bracket (26).

Models M5-M8: Remove the four bolts (24) and detach the pump module and adapter ring (if applicable; see Note below) from the pedestal (26).

Note: Max-Series models M5-M8 manufactured before March 2020 required an **adapter ring** (12) between the pump module and pedestal. The Front Housing (8) for current M5-M8 pumps has a new design and the adapter ring is not required.

Pump Module Disassembly:

2 Loosen the setscrew and remove the coupling flange (29) and key (27) from the drive shaft (19).

3 Remove the seal housing (11) by removing four bolts (13). Discard the O-ring (18).

4 Push out the seal seat (16) from the seal housing. Remove seal seat O-ring (17) and discard

5 Loosen setscrews and remove the mechanical seal (14).

Note: To prevent damage to the Teflon seal wedge, polish off any burrs or sharp edges on the drive shaft before removing the mechanical seal.

6 Remove the seal positioning (retaining) ring (10) from the drive shaft. Some pumps will not contain the seal positioning ring.

Note: If the pump has a double mechanical seal, there will be a second seal seat with O-ring installed on the drive shaft instead of the retaining ring. If this is the case, remove the seal seat and discard the O-ring.

7 Remove the four housing bolts (4) and separate the rear housing (2), center housing (20) and front housing (8).

8 Remove the housing O-rings (5) and wear plates (7). Discard the O-rings.

9 Remove the idler and drive gear-shaft assemblies.

10 Remove the gear (6 or 21) and key (22) from each shaft by removing the retaining rings (10).

Note: This step is not applicable if the gear-shaft components were supplied as integral 17-4 PH SS material.

11 Remove the bearings (3) and lock pins (25) from the front and rear housings.

Note: The bearings have a slip-fit design and can be easily pulled out using a hook-shaped tool.

END OF DISASSEMBLY PROCEDURE

5.4 PUMP ASSEMBLY

Follow the procedure below and refer to the drawings on pages 18-19 for Models M0-M4 or pages 20-21 for Models M5-M8.

Gear-Shaft Assembly: (If required; see **Note** below)

1 **a.** Assemble the drive gear (21) to the drive shaft (19) using one gear key (22) and two retaining rings (10).

b. Assemble the idler gear (6) to the idler shaft (1) using one gear key (22) and two retaining rings (10).

Note: This step is not applicable if the gear-shaft components were supplied as part of a repair kit or as integral gear-shafts in 17-4 PH SS material. For integral gear-shafts, the drive gear has a left hand helix and the idler gear has a right hand helix. For other gear materials (316 SS or PEEK) discrete spur-type gears are used.

Pump Module Assembly:

2 Insert bearing lock pins (25) into the front housing (8) and rear housing (2).

3 Insert bearings (3) into the front and rear housings.

Note: The bearings have a slip-fit design and should slide easily into the bearing bores.

4 Insert two housing alignment pins (23) into the rear housing.

5 Insert housing O-rings (5) into the circular grooves of the center housing (20).
CAUTION: Do not reuse O-Rings.

6 Place center housing onto rear housing and insert two wear plates (7).

Note: The wear plates have relief grooves to minimize hydraulically-induced gear separation forces. These relief grooves must face the gears to operate effectively.

7 Insert the idler and drive gear-shaft assemblies into the center-rear housing.

Note: The drive shaft is located on the pump's centerline.

8 Place the other two wear plates (7) into the center housing with the relief grooves facing the gears.

9 Insert two housing alignment pins (23) into the center housing.

10 Bolt the front housing (8) to the center-rear housing using the housing bolts (4).

Note: Models M0-M4 require four housing bolts; Models M5-M8 require eight housing bolts.

11 Insert O-ring (17) into the groove on the stationary seal seat (16).
CAUTION: Do not reuse O-Rings.

Note: Lubricate the O-ring with a compatible lubricant such as vegetable oil. This will facilitate installation of the seal seat into the seal housing.

12 Press seal seat with O-ring into the seal housing (11).

13 Place O-ring (18) onto the seal housing.
CAUTION: Do not reuse O-Rings.

Caution!
Before installing the mechanical seal, be certain to remove any burrs or sharp edges on the drive shaft to prevent damaging the Teflon seal wedge. Damage to the Teflon wedge can cause the seal to leak. ***Do not handle or scratch the working seal faces.***

SEAL INSTALLATION for Pump with SINGLE Mechanical Seal:

Two drive shaft (Item 19) configurations exist that concern the positioning and setting of the single mechanical seal.

(1) The **First drive shaft type contains a groove for a retaining ring**. This retaining ring is used to set the mechanical seal position in the pump.

(2) The **Second drive shaft type does not contain this retaining groove** and the seal location on the shaft must be manually set to a specific dimension for proper seal compression.

See the two procedures below along with the sectional drawings on pages 19 or 21 for the proper setting of the single mechanical seal.

1. Single Mechanical Seal installation procedure for shaft with retaining ring (positioning) groove:

14 **a.** Insert seal positioning (retaining) ring (10) into the groove on the drive shaft (19).

b. Slide the single Mechanical seal (14) onto the drive shaft and up against the positioning ring. (**Note:** The working face of the mechanical seal must face away from the positioning ring and toward the seal seat.

c. Tighten the setscrews on the mechanical seal body.

d. Attach the seal housing (11) with O-ring (18) to the front housing (8) using four bolts (13). (**Note:** Apply anti-seize compound to the bolts.)

2. Single Mechanical Seal installation procedure for shaft without retaining ring (positioning) groove:

14 **a.** Since the shaft does not contain a positioning ring, the seal location will have to be set using a measuring device. This is normally done with a set of calipers.

b. Slide the single Mechanical seal (14) onto the drive shaft and position the seal on the shaft as shown in the sectional drawings. Models M0-M4 have a setting of .156 (5/32) inches or 4.0 mm. Models M5-M8 have a setting of .300 (19/64) inches or 7.5 mm.

c. Once the seal position on the shaft is set, tighten the set screws on the mechanical seal body.

d. Attach the seal housing (11) with O-ring (18) to the front housing (8) using four bolts (13). (**Note:** Apply anti-seize compound to the bolts.)

SEAL INSTALLATION for Pump with DOUBLE Mechanical Seal:

14. **a.** Insert O-ring (17) into groove on the inboard stationary seal seat (16).
CAUTION: Do not reuse O-Rings.

Note: Lubricate O-ring with a compatible lubricant such as vegetable oil. This will facilitate installation of the seal seat into the front housing.

b. Press the seal seat with O-ring firmly into the front housing (8).

c. Slide the double mechanical seal (14) onto the drive shaft. DO NOT tighten the setscrews on the mechanical seal body at this time.

d. Attach the seal housing (11) with O-ring (18) to the front housing (8) using four bolts (13). (**Note:** Apply anti-seize compound to the bolts.)

e. Tighten the setscrews on the mechanical seal body. (**Note:** The setscrews are accessible by removing the two 1/8" NPT plugs (9) on the seal housing (11).)

NOTE: The Double Mechanical Seal requires a "barrier" fluid inside the seal housing to function properly. The fluid must be compatible with the pumped liquid, have a net flow across the seal housing and be pressurized to at least 15 PSI above the discharge pressure of the pump.

Caution!
The barrier fluid inside the seal housing is required to lubricate and flush the seal faces and pressurize the inboard seal against the pump's hydraulic pressure. Failure to support the seal properly during pump operation can result in seal malfunction or damage, causing leakage.

Coupling Installation:

15 Install the coupling key (27) and coupling flange (29) on the drive shaft. Roughly position the flange so that its inside surface is flush with the end of the drive shaft (19) and then lightly tighten the setscrew.

16 Install the motor key and coupling flange (28) on the motor shaft. Roughly position the flange so that its inside surface is flush with the end of the motor shaft and then lightly tighten the setscrew.

17 Install the coupling spider (30) on the motor coupling flange (28).

Bracket/Pedestal to Motor Assembly:

18 **Models M0-M4:** Bolt the bracket (26) to the motor (12) using four bolts (15).

Models M5-M8: Bolt the motor (31) to the pedestal (26) using four bolts (15).

Pump Module Installation:

19 Bolt the pump module to the bracket or pedestal (26) using four bolts (24).

Note: The former design for models M5-M8 required an **adapter ring** (12). In this case, the adapter ring must be installed between the pump module and pedestal (26). (See drawing on page 20.)

20 Check for proper separation of the coupling flanges using a shim or feeler gauge. The flanges should have a spacing of 1/16 to 1/8 of an inch. If necessary, adjust the spacing of the coupling flanges.

Note: The pedestal (26) for Models M5-M8 is equipped with a removable Stainless Steel door which enables access to the mechanical coupling.

Caution!
Be certain that the coupling flanges are properly spaced and not touching each other. If contact occurs, axial loads can be transmitted to the pump, resulting in premature pump failure.

21 Tighten the coupling setscrews.

END OF ASSEMBLY PROCEDURE

Appendix 1: Fastener Torque Specifications

Maximum Torque Specifications for 18-8 Stainless Steel Bolts

BOLTS for PUMP-BRACKET/PEDESTAL ASSEMBLY:

Function	Pump Models	Bolt Size	Bolt Type	Qty. (per Pump)	Max Torque Specifications (in-lb)	Max Torque Specifications (N-m)
Housing Assembly	M0 - M3	5/16-18 UNC x 2	SHCS	4	132	14.9
	M4	5/16-18 UNC x 2-1/2	SHCS	4		
	M5	5/16-18 UNC x 2-1/2	SHCS	8		
	M6	5/16-18 UNC x 2-7/8	SHCS	8		
	M7	5/16-18 UNC x 3-1/4	SHCS	8		
	M8	5/16-18 UNC x 3-3/4	SHCS	8		
Seal Housing Assembly	M0 - M8	1/4-28 UNF x 5/8	SHCS	4	94	10.6
Pump-to-Bracket	M0 - M4	3/8-16 UNC x 1-1/2	SHCS	4	236	26.7
Pump-to-Pedestal	M5 - M8	3/8-16 UNC x 1-5/8				

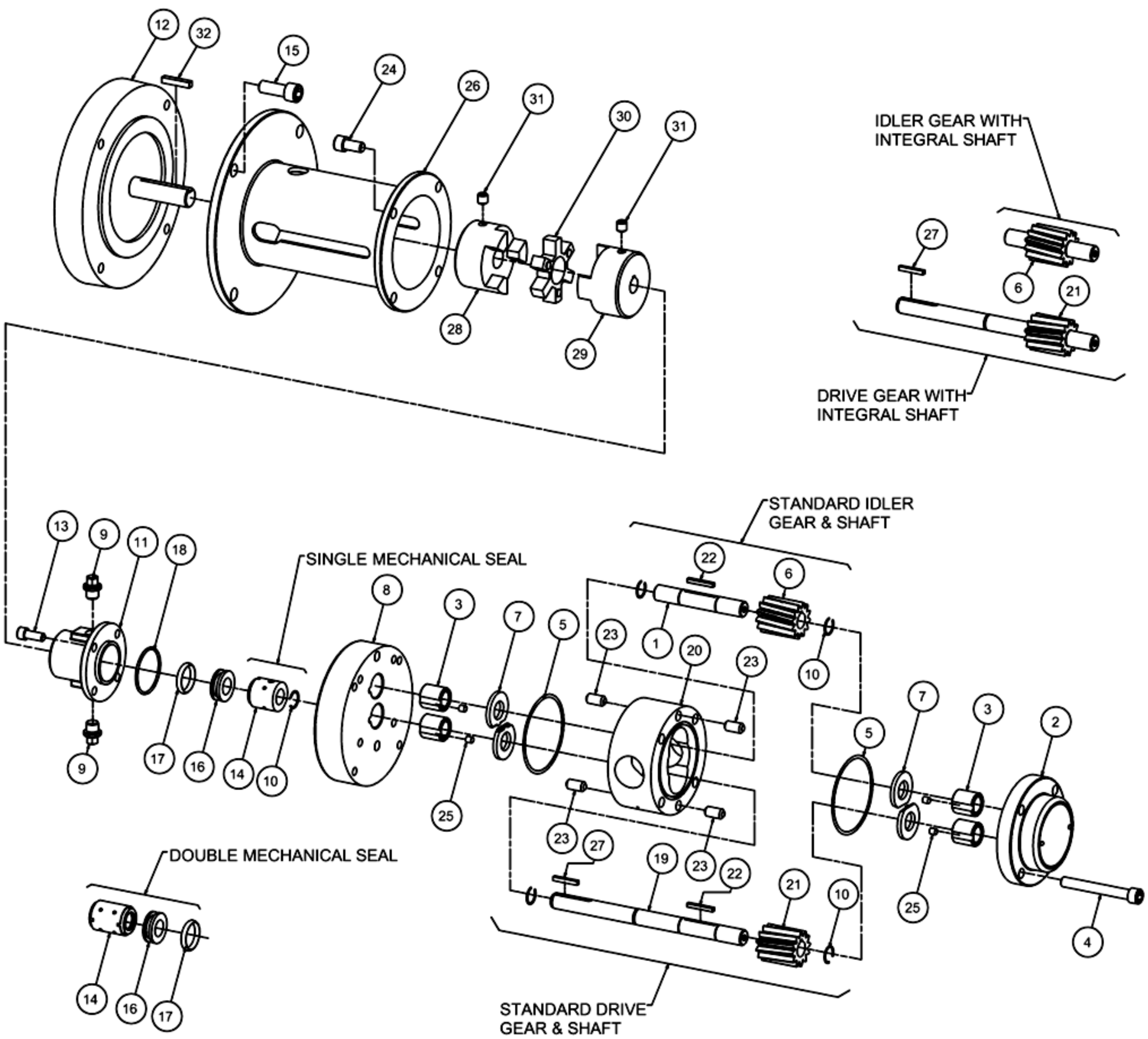
BOLTS for MOTOR-BRACKET/PEDESTAL ASSEMBLY:

Motor Frames	Function	Pump Models	Bolt Size	Bolt Type	Qty. (per Pump)	Max Torque Specifications (in-lb)	Max Torque Specifications (N-m)
NEMA 56C, 143/145TC	Bracket-to-Motor	M0 - M4	3/8-16 UNC x 7/8	SHCS	4	236	26.7
	Motor-to-Pedestal	M5 - M8	3/8-16 UNC x 1				
NEMA 182/184TC	Adapter-to-Motor	M5 - M8	1/2-13 UNC x 1	SHCS	4	517	58.4
	Adapter-to-Pedestal		3/8-16 UNC x 1	SHCS	4	236	26.7
IEC 71 (B5 Flange)	Bracket-to-Motor	M0 - M4	3/8-16 UNC x 1-1/2	SHCS	4	236	26.7
	Motor-to-Pedestal	M5 - M8					
IEC 80/90 (B5 Flange)	Bracket-to-Motor	M0 - M4	M10 x 40 mm	SHCS	4	327	37.0
	Motor-to-Pedestal	M5 - M8					
IEC 100/112 (B5 Flange)	Adapter-to-Pedestal	M5 - M8	3/8-16 UNC x 1	SHCS	4	236	26.7
	Motor-to-Adapter		1/2-13 UNC x 2	FH-SHCS	4	517	58.4

SHCS = Socket Head Cap Screw
FH-SHCS = Flat Head, Socket Head Cap Screw

Appendix 2: Reference Drawings

Exploded View Drawing #1 – Max® Series SEALED Models M0 thru M4

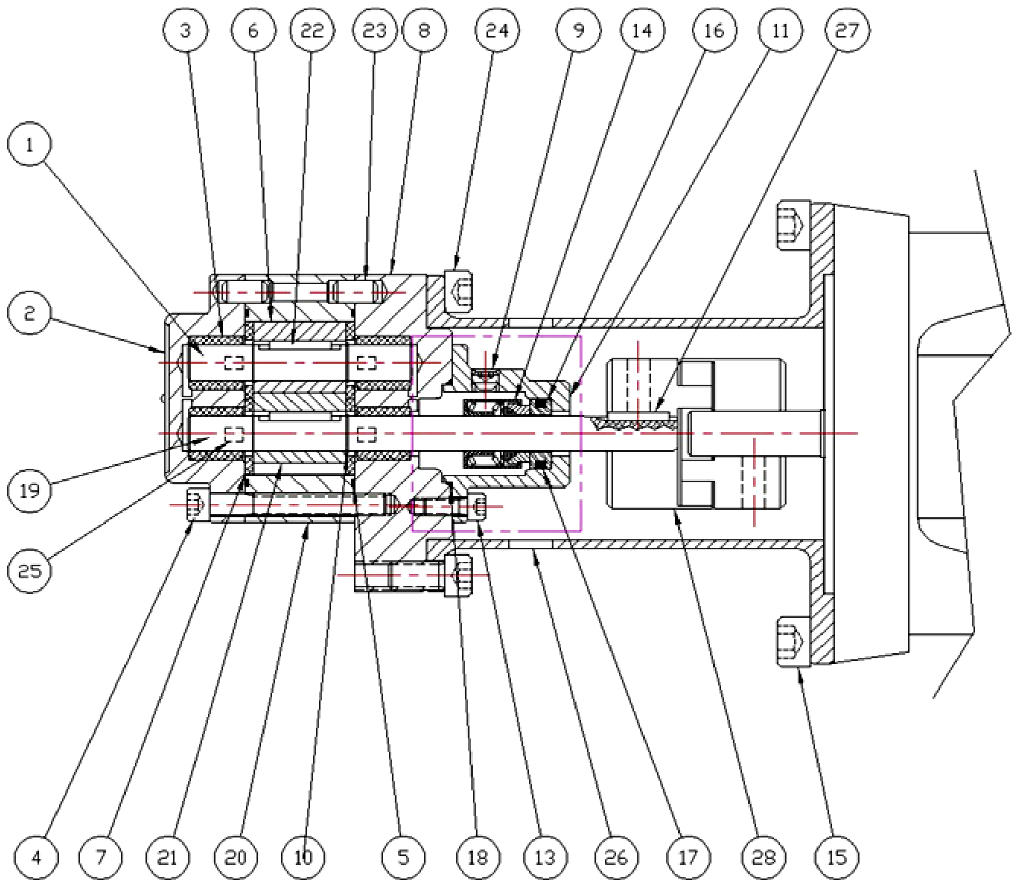


Ref. #	Description	Qty.	Ref. #	Description	Qty.
1	Idler Shaft	1	17	O-ring, Seal Seat	1*
2	Rear Housing	1	18	O-ring, Seal Housing	1
3	Bearing	4	19	Drive Shaft	1
4	Bolt, Housing (5/16-18 SHCS)	4	20	Center Housing	1
5	O-ring, Housing	2	21	Drive Gear	1
6	Idler Gear	1	22	Key, Gear	2
7	Wear Plate	4	23	Pin, Housing Alignment	4
8	Front Housing	1	24	Bolt, Front Hsg. (5/16-18 x 5/8 SHCS)	4
9	Plug, 1/8 NPT (Hex Socket)	2	25	Pin, Bearing Lock	4
10	Retaining Ring	4*	26	Mounting Bracket	1
11	Seal Housing	1	27	Key, Coupling (Pump Side)	1
12	Motor (C-Face)	1	28	Coupling Flange (Motor Side)	1
13	Bolt, Seal Hsg. (1/4-28 x 5/8 SHCS)	4	29	Coupling Flange, 1/2" (Pump Side)	1
14	Mechanical Seal (Assembly)	1	30	Coupling Spider	1
15	Bolt, Motor (3/8-16 x 7/8 SHCS)	4	31	Setscrew, Coupling Flange	2
16	Seal Seat	1*	32	Key, Motor	1

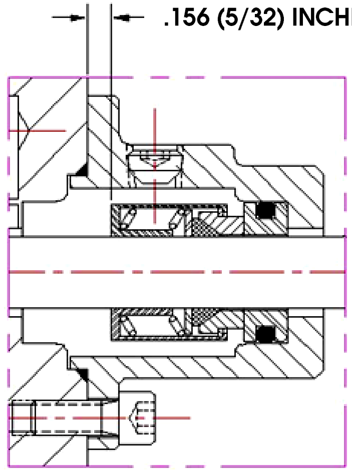
* Pump with Single Mech. Seal may require one additional Retaining Ring; pump with Double Mech. Seal requires 4 Retaining Rings, 2 Seal Seats and 2 Seal Seat O-rings. **Note:** For Liquiflo Part Numbers, refer to Max-Series Consolidated BOM.

Appendix 2: Reference Drawings (Continued)

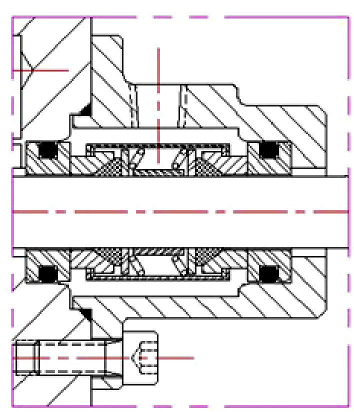
Sectional Drawing #1 – Max® Series SEALED Models M0 thru M4



SINGLE MECHANICAL SEAL POSITION: M0-M4
.156 (5/32) INCHES or 4.0 MM



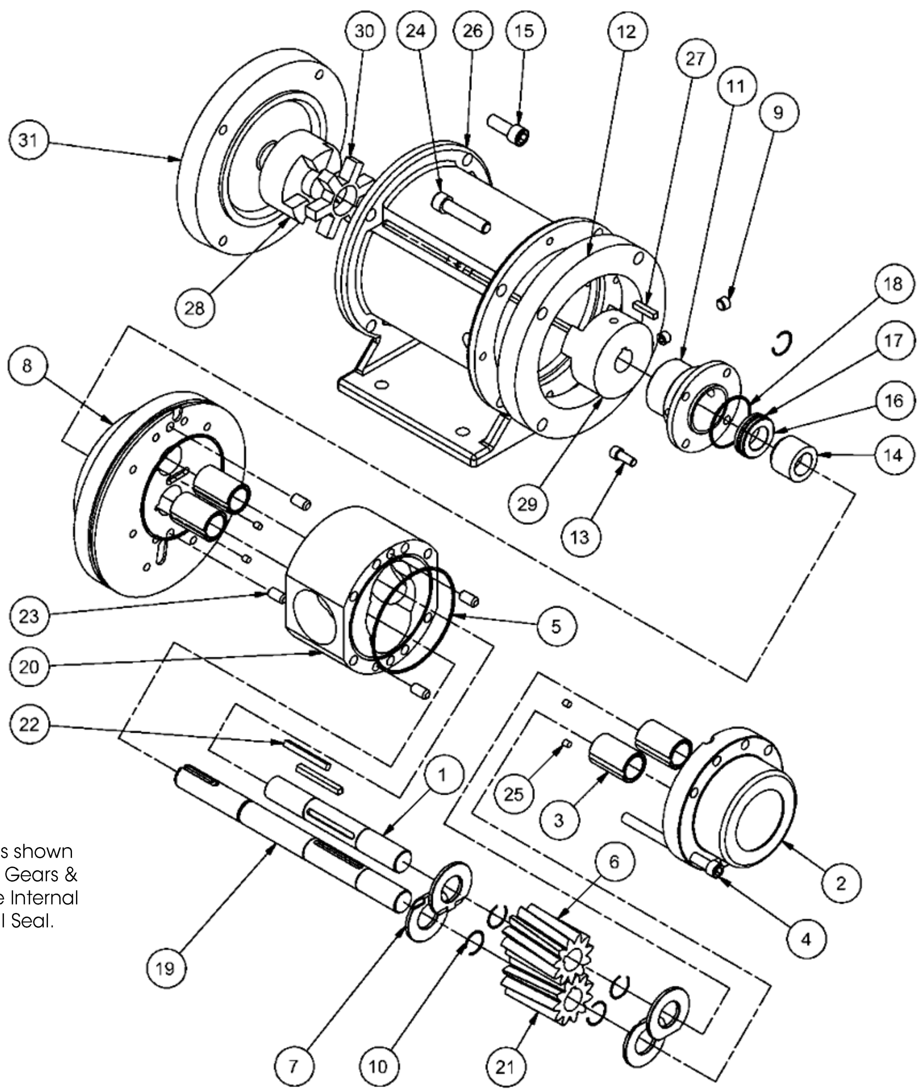
SINGLE MECHANICAL SEAL



DOUBLE MECHANICAL SEAL

Appendix 2: Reference Drawings (Continued)

Exploded View Drawing #2 – Max® Series SEALED Models M5 thru M8



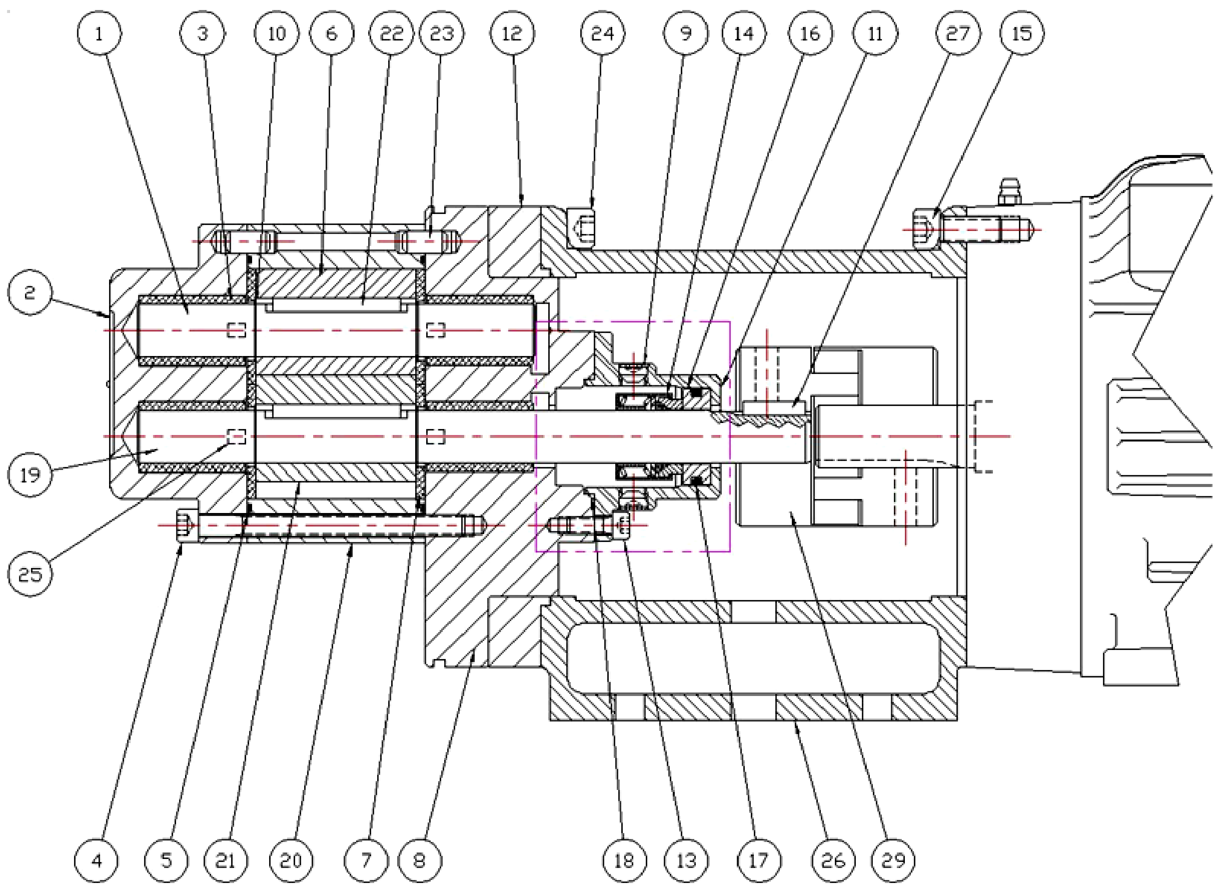
Note: Pump is shown with Standard Gears & Shafts & Single Internal Mechanical Seal.

Ref. #	Description	Qty.	Ref. #	Description	Qty.
1	Idler Shaft	1	17	O-ring, Seal Seat	1*
2	Rear Housing	1	18	O-ring, Seal Housing	1
3	Bearing	4	19	Drive Shaft	1
4	Bolt, Housing (5/16-18 SHCS)	8	20	Center Housing	1
5	O-ring, Housing	2	21	Drive Gear	1
6	Idler Gear	1	22	Key, Gear	2
7	Wear Plate	4	23	Pin, Housing Alignment	4
8	Front Housing	1	24	Bolt, Front Hsg. (3/8-16 x 1 5/8 SHCS)	4
9	Plug, 1/8 NPT (Hex Socket)	2	25	Pin, Bearing Lock	4
10	Retaining Ring	4*	26	Pedestal	1
11	Seal Housing	1	27	Key, Coupling (Pump Side)	1
12	Adapter Ring (Former design only)	1	28	Coupling Flange (Motor Side)	1
13	Bolt, Seal Hsg. (1/4-28 x 5/8 SHCS)	4	29	Coupling Flange, 3/4" (Pump Side)	1
14	Mechanical Seal (Assembly)	1	30	Coupling Spider	1
15	Bolt, Motor (3/8-16 x 1 SHCS)	4	31	Motor (C-Face) with Key	1
16	Seal Seat	1*			

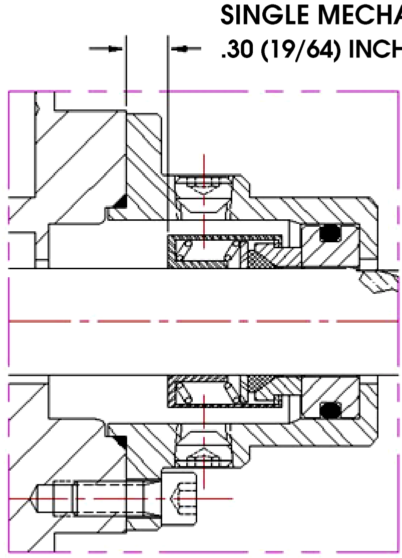
* Pump with Single Mech. Seal may require one additional Retaining Ring; pump with Double Mech. Seal requires 4 Retaining Rings, 2 Seal Seats and 2 Seal Seat O-rings. **Note:** For Liquiflo Part Numbers, refer to Max-Series Consolidated BOM.

Appendix 2: Reference Drawings (Continued)

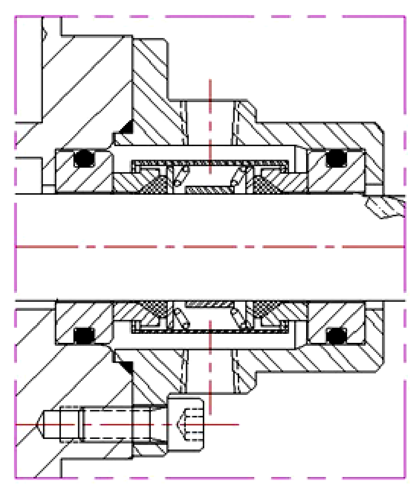
Sectional Drawing #2 – Max® Series SEALED Models M5 thru M8



SINGLE MECHANICAL SEAL POSITION: M5-M8
.30 (19/64) INCHES or 7.5 MM



SINGLE MECHANICAL SEAL



DOUBLE MECHANICAL SEAL

Appendix 3: Troubleshooting Guide

Troubleshooting Guide – Part 1

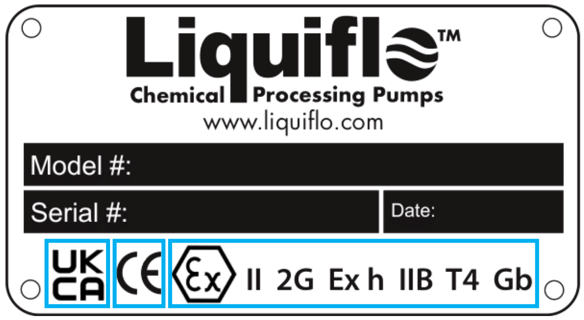
Problem	Possible Cause	Corrective Action
No discharge	Pump not primed	Verify suction pipe is submerged. Increase suction pressure. Open suction valve.
	Wrong direction of rotation	Reverse motor leads.
	Valves closed	Open all suction and discharge valves.
	Bypass valve open	Close bypass valve.
	Air leak in suction line	Tighten connections. Apply sealant to all threads. Verify suction pipe is submerged.
	Clogged strainer	Clean strainer.
	Pump worn or damaged	Rebuild pump.
Insufficient discharge	Suction pressure too low	Increase suction pressure. Verify suction piping is not too long. Fully open any suction valves.
	Bypass valve open	Close bypass valve.
	Partly clogged strainer	Clean strainer.
	Speed too low	Increase driver speed, if possible. Use larger size pump, if required.
	Pump worn or damaged	Rebuild pump.
Loss of suction after satisfactory operation	Pump not properly primed	Reprime pump.
	Air leaks in suction line	Tighten connections. Apply sealant to all threads. Verify suction pipe is submerged.
	Air or vapor pockets in suction line	Rearrange piping as necessary.
	Increase in fluid viscosity	Heat fluid to reduce viscosity. Reduce pump speed.
Excessive power consumption	Fluid viscosity higher than specified	Heat fluid to reduce viscosity. Reduce pump speed. Increase driver horsepower.
	Differential pressure greater than specified	Increase pipe diameter. Decrease pipe run.
	Gear clearances insufficient for fluid viscosity	Purchase gears trimmed for the correct viscosity.
	Plastic gear clearance insufficient for fluid temperature	Purchase plastic gear trimmed for the correct temperature.
	Rotating parts binding or severely worn	Disassemble and replace worn parts.

Appendix 3: Troubleshooting Guide (Continued)

Troubleshooting Guide – Part 2

Problem	Possible Cause	Corrective Action
Rapid pump wear	Abrasives in fluid	Install suction strainer. Limit solids concentration. Reduce pump speed or use larger pump running at lower speed.
	Corrosion wear	Use materials of construction that are acceptable for fluid being pumped.
	Extended dry running	Install power sensor to stop pump.
	Discharge pressure too high	Increase pipe diameter. Decrease pipe run.
Excessive noise and vibration	Suction and/or discharge piping not anchored or properly supported	Anchor per Hydraulic Institute Standards.
	Base not rigid enough	Tighten hold-down bolts on pump and motor or adjust stilts. Inspect grout and regrout if necessary.
	Worn pump bearings	Replace bearings.
	Worn motor bearings	Replace bearings or motor.
	Pump cavitation	Increase NPSH available.
Excessive product leakage	Static seal failure caused by chemical incompatibility or thermal breakdown	Use O-rings or gaskets made of material compatible with fluid and temperature of the application.
	Static seal failure caused by improper installation	Install O-rings or gaskets without twisting, bending or pinching. Use star-pattern torque sequence on housing bolts during assembly. Allow Teflon O-rings to cold flow and seat during tightening. Torque bolts to specification.
	Mechanical seal worn or damaged	Disassemble and replace mechanical seal. Prime pump and avoid dry running.
	Pump port connections not properly sealed	Use Teflon tape or other suitable sealant. Use gaskets compatible with fluid and temperature of the application.
	Crevice corrosion of pump housing material	Only pump chemicals that are compatible with the pump housing material. Decrease temperature to reduce corrosion rate to acceptable value. Flush idle pumps that are used to pump corrosive chemicals. Eliminate contaminants in the fluid that can accelerate corrosion wear.

Appendix 4: Tag Certification Markings



1 2 3 4 5 6 7 8 9

The Liquiflo tag provides important information about the pump's use in potentially explosive atmospheres. Markings 3 to 9 comprise the complete ATEX marking. **NOTE: The tag does not provide information about the motor or other devices used with the pump.** It is the responsibility of the user to confirm that all equipment is safe for use in the intended environment.

No.	Marking	Meaning
1	UKCA	This marking confirms that this pump meets the requirements of the UK Regulation **SI 2016/1107** – The Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations 2016. **UK Conformity Assessed (UKCA) marking** is a certification mark that indicates conformity with the applicable requirements for products sold within Great Britain. The UKCA marking became part of UK law on EU exit day, January 31, 2020.
2	CE	This marking confirms that this pump is compliant with the European Union's **Machinery Directive 2006/42/EC**. **Conformitè Europëenne (CE) marking** (French for "European Conformity") indicates that a product has been assessed by the manufacturer and certified to meet EU safety, health and environmental protection requirements. The CE marking originated in 1985 and is mandatory for any products marketed in the EU and the European Economic Area (EEA).
3	Ex	This marking confirms that this pump meets the requirements of **ATEX 114 "equipment" Directive 2014/34/EU** – Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres (published on March 29, 2014 by the European Parliament). **ATEX** is a codeword which comes from the French description – "Appareils destinés à être utilisés en **AT**mosphères **EX**plosives." The English translation is: "Devices intended for use in explosive atmospheres."
4	II	**Equipment Group II** indicates that this pump is suitable for surface (non-mining) applications and can be used in areas having explosive gases or liquids.
5	2G	**Equipment Category 2 – Gases/Vapors (G)**: This indicates that the pump is suitable for use in Zones 1 & 2: **Zone 1 (gases):** An area in which an explosive mixture is likely to occur in normal operation **Zone 2 (gases):** An area in which an explosive mixture is not likely to occur in normal operation and if it occurs it will only exist for a short time
6	Ex h	This marking indicates **Explosion Protection** of the pump as defined in standard **EN ISO 80079-37**. Protection type is Constructional Design Safety (**c**).
7	IIB	This marking indicates that the pump is suitable for use in atmospheres containing **Ignitable Gases: Group IIB** (e.g., ethylene, ethyl ether or gases of similar hazard).
8	T4	This marking indicates the **Temperature Class** (Maximum Allowable Surface Temperature of the pump) for the Ignitable Gases Group above (**IIB**): **T4** = 135°C (275°F) max
9	Gb	This marking indicates the **Equipment Protection Level** of the pump as defined in standard **EN ISO 80079-36**. **Gb** = High protection level for Zone 1 gases and vapors; the equipment remains safe in normal operation and also when single faults occur.

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