Liquiflo™
Chemical Processing Pumps

INSTALLATION, OPERATION & MAINTENANCE MANUAL

MAX® SERIES

MAGNETIC-DRIVE GEAR PUMPS

Mag-Drive Models M0 thru M8

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Section 1: General Information

1.1 General Instructions

This manual covers the Max® Series Mag-Drive 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.

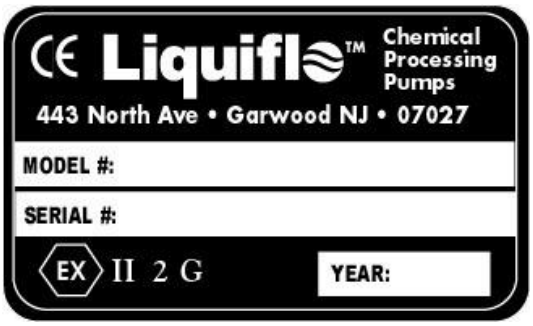
Upon receipt of your Liquiflo pump:

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 ATEX certification, verify that the following *Stainless Steel Tag* is secured to the pump:

Explanation of ATEX Tag	
Group II	Explosive atmospheres
Category 2	Equipment provides a high level of protection. Explosive atmospheres are likely to occur.
Category 3	Equipment provides a normal level of protection. Explosive atmospheres are unlikely to occur.
D	Dust
G	Gas



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: 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

Max® Series MAG-DRIVE 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									**–**
Mounting Bracket	Pedestal, Epoxy-Painted Cast Iron									**–**
RMS [1]	1800	1800	1800	1800	1800	1800	1800	1800	1800	**RPM**
Theoretical Displacement [2]	.00022	.00055	.00138	.00193	.00289	.00491	.00675	.00859	.01105	**GPR**
Flow Rate @ RMS	0.40 (1.5)	1.0 (3.8)	2.5 (9.4)	3.5 (13.1)	5.2 (19.7)	8.8 (33.5)	12.2 (46.0)	15.5 (58.5)	20 (75)	**GPM (LPM)**
Max Differential Pressure [3]	350 (24)	350 (24)	350 (24)	350 (24)	350 (24)	350 (24)	350 (24)	350 (24)	350 (24)	**PSI (bar)**
Max System Pressure [4]	500 (34.5)	500 (34.5)	500 (34.5)	500 (34.5)	500 (34.5)	500 (34.5)	500 (34.5)	500 (34.5)	500 (34.5)	**PSI (bar)**
Max Temperature [5]	500 (260)	500 (260)	500 (260)	500 (260)	500 (260)	500 (260)	500 (260)	500 (260)	500 (260)	**°F (°C)**
Min Temperature	-40 (-40)	-40 (-40)	-40 (-40)	-40 (-40)	-40 (-40)	-40 (-40)	-40 (-40)	-40 (-40)	-40 (-40)	**°F (°C)**
Max Viscosity [6]	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	**cP or mPas**
NPSHR @ RMS	3 (0.9)	3 (0.9)	2 (0.6)	2 (0.6)	5 (1.5)	5 (1.5)	5 (1.5)	4 (1.2)	3 (0.9)	**ft (m)**
Suction Lift (dry) @ RMS	0.5 (0.15)	1 (0.3)	2 (0.6)	4 (1.2)	6 (1.8)	6 (1.8)	7 (2.1)	6 (1.8)	14 (4.3)	**ft (m)**
Approx. Weight [7]	38 (17.2)	38.5 (17.5)	39 (17.7)	39.5 (17.9)	40 (18.1)	42 (19.1)	54 (24.5)	55.5 (25.2)	56 (25.4)	**lbs (kg)**

RMS = Recommended Maximum Speed
NPSHR = Net Positive Suction Head Required

FOOTNOTES:

1 Under special conditions, Models M0 thru M4 can be operated up to 3600 RPM. Consult factory.

2 Based on new pump operating at RMS and 0 PSI differential pressure.

3 Maximum differential pressure is dependent upon fluid being pumped. Consult factory.

4 Must be derated for flanged pumps, based on the flange and temperature of the application.

5 Pump may require trimmed parts depending on the materials and temperature. Consult factory.

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

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

NOTES:

1 The actual maximum surface temperature depends not on the pump but primarily on the temperature of the fluid being pumped. Temperature class can be controlled with the use of thermal sensors. Pump surfaces will be approximately 20 °F (7 °C) above the temperature of the fluid being pumped.

2 Pump is designed to operate within the ambient temperature range of -4 °F (-20 °C) to 104 °F (40 °C).

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 without safety devices installed
- **Never** operate the pump with suction and/or discharge valves closed
- **Never** operate the pump out of its design specifications
- **Never** start the pump without making sure that the pump is primed
- Inspect the entire system before start-up
- Monitor the system during operation and perform maintenance periodically or as required by the application
- 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
- Pay special attention to all cautionary statements given in this manual

Caution!

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

2.2 Special Precautions for Magnetic-Drive Pumps

Magnetic-drive pumps contain strong magnets, which pose health risks. Based on this the following must be observed:

Caution!

- *Individuals with cardiac pacemakers should avoid repairs on these units*
- *Individuals with internal wound clips, metallic wiring, or other metallic prosthetic devices should avoid repairs on these units*
- *Strong magnetic fields can cause tools and parts to slam together, injuring hands and fingers*

Strong magnets will attract iron, cast iron, carbon steel and some types of stainless steel. Keep magnets away from credit cards, computers, computer discs and watches.

Section 3: Pump & Motor Installation

3.1 Installation of Pump, Motor & Base

The following guidelines should be observed for proper installation of the pump and motor assembly:

A) The foundation area should be rigid and level for maintaining the alignment of the pump with the system piping.

B) The pump and motor assembly must be securely fastened to the base, and the base must be securely attached to the ground.

C) The pump and motor should be accessible for inspection and servicing.

D) The pump inlet (suction port) should be as close to the liquid supply as practical and preferably below it.

E) The piping should be properly supported. DO NOT use the pump as a pipe hanger.

F) Install valves and unions to isolate the pump during maintenance.

G) Suction and discharge piping should be the same size or larger than the inlet and outlet ports.

H) Clean piping as necessary to remove dirt, grit, weld slag, etc.

I) For further instructions on mounting or installing your pump, refer to the Hydraulics Institute Handbook.

J) A positive displacement pump should have a **pressure relief valve** installed in the discharge line. The relief valve should be the closest valve to the discharge port of the pump and should bypass the discharge line back to the supply tank.

K) The maximum particle size capable of being passed by the pump is 37 microns. A **filter** of at least 400 U.S. Mesh should be installed in the suction line. Concentration of solids exceeding 1% by volume is not recommended as wear rates will increase to unacceptable levels.

L) Clean the pump and motor periodically to prevent the build-up of dust.

NOTE: The Max Series pumps are close-coupled and no alignment procedures between the pump and motor are needed.

Section 4: Start-Up & Operation

4.1 Start-Up

A) Open all suction and discharge valves before starting the pump.

B) Prime the pump and jog the motor to check the direction of rotation. As viewed from the pump end, a clockwise rotation of the motor will result in fluid discharge to the left. Counterclockwise rotation will result in fluid discharge to the right.

> ***Caution!***
> *Do not operate the pump dry for more than 30 seconds or damage to internal parts can result.*

C) The pump should be operated with at least 20 PSI (1.4 bar) differential pressure.

D) The pump is capable of pulling a dry lift, but it is still recommended to prime the pump prior to start-up.

E) A **pressure relief valve** should be installed in the discharge line to protect the pump and other system components from any type of line blockage including the inadvertent closing of an isolation valve.

F) If the fluid contains suspended solids, a **filter** of at least 400 U.S. Mesh should be installed in the suction line.

4.2 Operation of Pump

During pump operation, inspect for:

1) Unusual noise
2) Product leakage
3) Expected suction and discharge pressures
4) Product flow

If any problems occur with the above items, stop the pump and take corrective action. For help with problem solving, refer to the Troubleshooting Guide on Pages 12 & 13.

Section 5: Maintenance & Repair

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

5.1 Work Safety

Before performing maintenance, review the Safety Precautions given on Page 4 and pay special attention to the cautionary statements given in the following sub-sections.

> ***Caution!***
> *The magnetic couplings used in these pumps are extremely powerful. Observe the Special Precautions given in Section 2.2.*

5.2 Removal from System

> ***Caution!***
> *If the pump was used to move 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.

> ***Caution!***
> *Be certain the pump's motor switch is in the OFF position and the power to the motor is locked out.*

3 Close the suction and discharge isolation valves.

4 Disconnect the pump from the system piping.

5 Remove any residual liquid remaining in the pump.

5.3 Pump Disassembly

Follow the procedure below and refer to the Exploded View Drawing given on Page 11.

1 Remove the four sets of bolts (26), nuts (25) and lockwashers (29) that secure the front housing (8) to the pedestal (16).

2 Remove the **pump cartridge** from the pedestal by pulling it straight out. (Note: Force will have to be applied to overcome the magnetic attraction between the outer and inner magnets.)

> ***Caution!***
> *Do not place hands or fingers between Cartridge and Pedestal.*

3 Remove the six containment can screws (18) and separate the containment can (12) from the front housing.

4 Discard the O-ring (19).

5 Remove the inner magnet assembly (11) from the drive shaft (20) by removing the end retaining ring (27).

6 Remove the inner magnet and key (13).

7 Remove the housing bolts (4) and separate the rear housing (2), center housing (21) 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 22) and key (23) from each shaft by removing the retaining rings (27). (Note: This step is not applicable if the gear-shaft components were supplied as integral 17-4 PHSS material.)

11 Remove the bearings (3) and lock pins (28) 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.) This completes the disassembly of the pump cartridge.

Outer Magnet Removal:

12 Remove the pedestal (16) from the motor or power frame by removing the four bolts (15).

13 Loosen the two setscrews (17) on the hub (30) of the outer magnet assembly (10).

14 Remove the outer magnet from the motor shaft.

END OF DISASSEMBLY PROCEDURE

5.4 Pump Assembly

Follow the procedure below and refer to the Exploded View Drawing given on Page 11.

Part A: Pump Cartridge Assembly

1 Assemble the drive gear (22) to the drive shaft (20) using the gear key (23) and two retaining rings (27). Assemble the idler gear (6) to the idler shaft (1) using the gear key (23) and two retaining rings (27). (Note: This step is not applicable if the gear-shaft components were supplied as part of a repair kit or as integral 17-4 PHSS material. The drive gear has a left hand helix and the idler gear has a right hand helix.)

2 Insert bearing lock pins (28) into the front housing (8) and rear housing (2).

3 Insert bearings (3) into the front and rear housings. (Note: Bearings have a slip-fit design and should easily slide into the bearing bores.)

4 Insert two housing alignment pins (24) into the rear housing.

5 Insert housing O-rings (5) into the circular grooves of the center housing (21).

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 hydraulic separation forces. These relief grooves must face the gears to operate properly.)

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. When the pump is in its normal horizontal orientation, the idler gear will be above the drive gear.)

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 (24) 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 Install retaining ring (27) for the inner magnet in the inside groove on the drive shaft.

12 Insert inner magnet key (13) into keyway of drive shaft.

13 Slide inner magnet (11) onto drive shaft and lock in place with retaining ring (27).

14 Insert containment can O-ring (19) into the circular groove of the front housing.

Caution!
Do not reuse O-rings.

15 Attach containment can (12) to front housing using six bolts (18).

16 Install the 1/8" NPT drain plug into the front housing (8). (Note: Apply Teflon tape to the threads of the plug prior to installing.) This completes the **pump cartridge** assembly.

Part B: Cartridge-Pedestal Assembly

17 Slide the pump cartridge into the pedestal (16) and bolt in place using four sets of bolts (26), nuts (25) and lockwashers (29).

Part C: Outer Magnet Installation to Motor

18 Insert the motor key into the keyway on the motor shaft and then apply a small amount of anti-seize compound to the motor shaft. Align the keyway of the outer magnet's hub with the key on the motor shaft and then slide the outer magnet onto the shaft and position the hub as follows:

a) For NEMA 56C and IEC 90 (B5 Flange) motors, the end of the motor shaft must be flush with the inner surface of the outer magnet's hub.

b) For NEMA 143/145TC motors, the end of the motor shaft must protrude 1/16 in. (1.6 mm) past the inner surface of the outer magnet's hub.

c) For IEC 71, 80, 100 & 112 (B5 Flange) motors, the outer magnet is positioned by a snap ring installed in the hub. The end of the motor shaft must contact the snap ring.

d) For NEMA 182/184TC motors, an **adapter plate** is required to mount the motor to the pedestal. The outer magnet is positioned by a snap ring installed in the hub. The end of the motor shaft must contact the snap ring. (Note: Complete pumps ordered for use with these motor frames will be supplied with the **adapter plate** (P/N SP0046) and **adapter mounting bolts** (P/N 641105).)

Once the outer magnet is in position, tighten the two setscrews (17) on the hub (30).

Part D: Pump-Motor Assembly

19

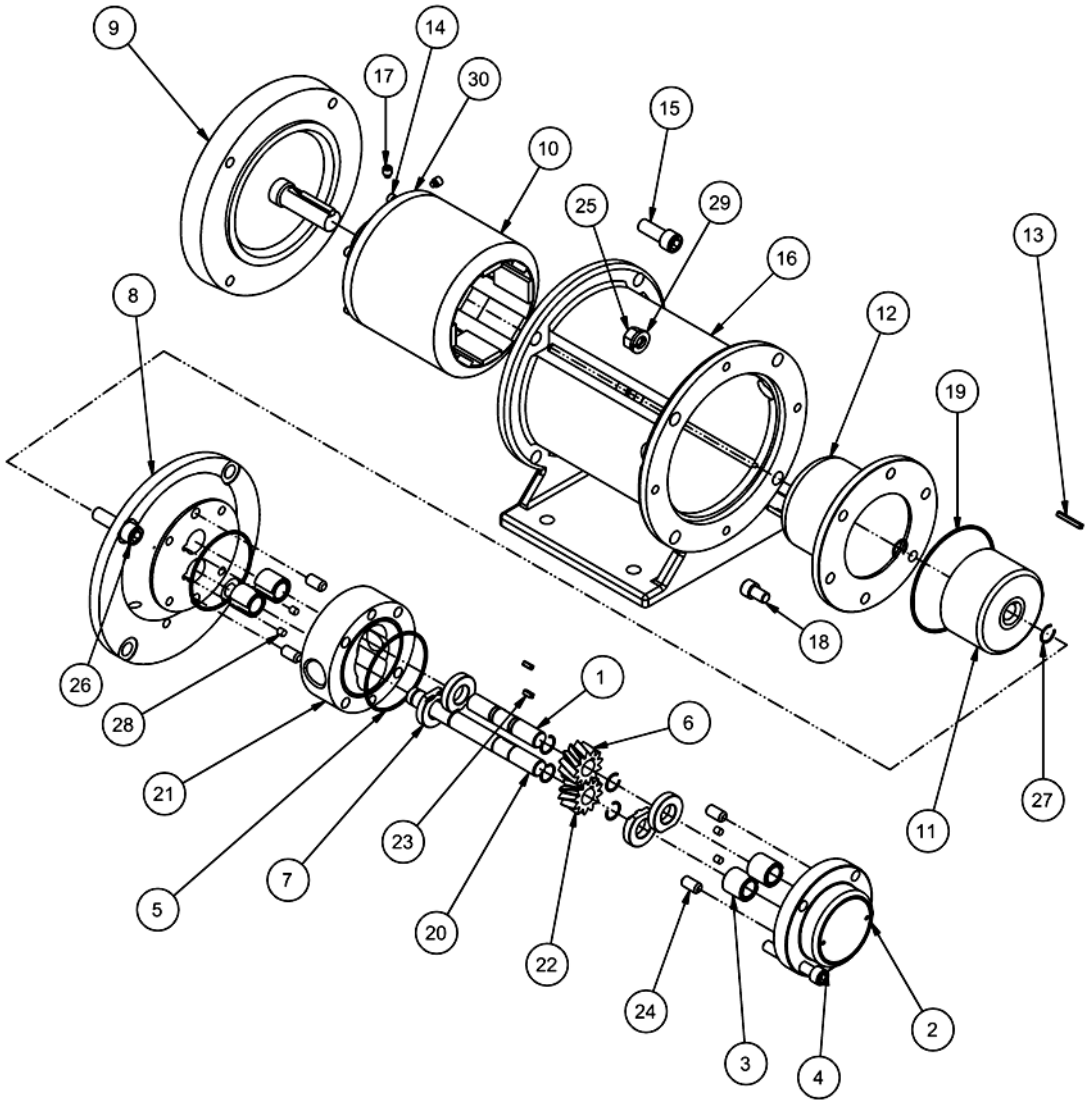
Caution!
Do not place hands or fingers between Pedestal and Motor C-faces. The Outer and Inner Magnets will suddenly pull together with significant force.

Install the motor-outer magnet assembly to the pump cartridge-pedestal assembly using four bolts (15). (Note: Align the outer and inner magnets when assembling. The motor and pedestal C-faces should mate freely and mount flush.)

END OF ASSEMBLY PROCEDURE

Section 6: Exploded View Reference Drawing

Max® Series Mag-Drive Pump – Models M0 thru M8



Ref. #	Description	Qty.	Ref. #	Description	Qty.
1	Idler Shaft	1	16	Pedestal	1
2	Rear Housing	1	17	Setscrew (1/4-28 SHSS)	2
3	Bearing	4	18	Bolt, Cont. Can (5/16-24 x ½ SHCS)	6
4	Bolt, Housing (5/16-18 SHCS)	4 or 8 *	19	O-ring, Containment Can	1
5	O-ring, Housing	2	20	Drive Shaft	1
6	Idler Gear	1	21	Center Housing	1
7	Wear Plate	4	22	Drive Gear	1
8	Front Housing with Drain Plug	1	23	Key, Gear	2
9	Motor (C-Face) with Key	1	24	Pin, Housing Alignment	4
10	Outer Magnet (Assembly)	1	25	Nut, Front Housing (3/8-16 Hex)	4
11	Inner Magnet (Assembly)	1	26	Bolt, Front Housing (3/8-16 SHCS)	4
12	Containment Can	1	27	Retaining Ring	6
13	Key, Inner Magnet	1	28	Pin, Bearing Lock	4
14	Screw (#8-32 x 5/8 SHCS)	6	29	Lockwasher, Front Housing (3/8)	4
15	Bolt, Motor (3/8-16 x 1 SHCS)	4	30	Hub, Outer Magnet	1

* 4 for Models M0-M4; 8 for Models M5-M8. **Note:** For Liquiflo Part Numbers, refer to Max-Series Consolidated BOM.

Section 7: 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.
	Magnetic coupling has decoupled	Stop driver and check temperature and viscosity of fluid. Verify position of outer magnet. Consider stronger magnetic coupling.
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.

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 or bending. 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.
	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.