Metering Syringe Pumps: Operation Theory and Maintenance

For Teledyne Isco Syringe Pumps

TELEDYNE ISCO
Everywhereyoulook™

Syringe Pump Technical Bulletin
TB15

Overview

For applications where a specific volume of fluid must be delivered, Teledyne Isco Syringe Pumps can be programmed to run in constant flow mode (for delivering a precise and constant rate) or dispense mode (to deliver an exact finite amount).

Continuous, constant flow operation is achieved using two syringe pumps connected with active valves, as described in the technical bulletin Multiple Pump Systems for Continuous Flow or Independent Modes.

Dispense mode operation is achieved using a single syringe pump, and requires custom software for the controller. For further information about running a pump system in dispense mode, refer to the Dispense Mode technical bulletin.

Basic Theory

Teledyne Isco syringe pumps deliver steady, pulse-less feeds at precise flow rates down to the sub-microliter per minute.

Metering applications, such as reactant feed, require the fluid to be pumped at extremely low flows. The flow rate accuracy of a low flow system is dependent upon the right setup for your application, and is highly susceptible to a number of factors. For a comprehensive discussion of these factors, refer to the Low Flow Operation technical bulletin.

This bulletin will focus on elements within the pump itself that impact low flow performance. Refer to Figure 1 for the discussions that follow.

Interior Components and Concepts

In order to demonstrate how various factors affect low flow operation, it is necessary to first identify the components, as well as their functions and concepts within the scheme of operation.

Motor Control

The cylinder full and cylinder empty positions are detected by an upper and lower optical sensor, which function to limit the travel of the piston. The pump has a power amplifier to interface the sensor signals with the DC electric motor.

> ☑ ***Note***
>
> D Series pumps have a copper graphite brush type electric motor. HL Series pumps use a brushless DC motor.

Displacement Resolution

Motor rotation causes the piston to travel via the gear train. Optical readers mark motor rotation in increments of either 800 or 2,000 line transitions per revolution (depending upon pump model).

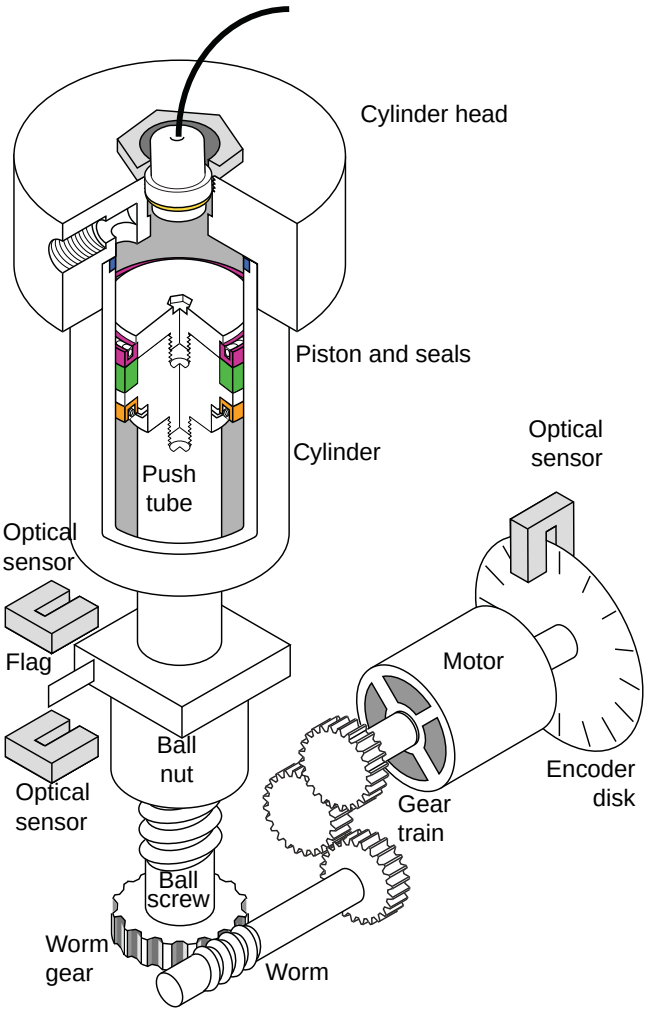

Figure 1: Component identification

Each increment of rotation represents a small but fixed amount of piston travel, which displaces or receives a known volume above the piston.

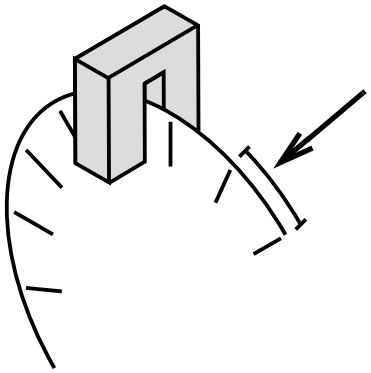

Figure 2: Unit of motor rotation or piston travel

Displacement resolution differs between pump models due to piston surface area, gear reduction, and number of encoder positions.

As a rule of thumb, the smaller the displacement resolution, the greater the pump's accuracy at low flow rates.

Dead Volume

Some fluid will remain in the cylinder at the piston's topmost point of travel. A small amount of clearance prevents damage to moving parts. Additionally, some necessary voids allow pump disassembly and reassembly.

The non-pumped volume that remains is called the *dead volume*, or headspace volume. The opposite of the dead volume is referred to as *swept volume*.

Teledyne Isco syringe pumps are designed for minimal dead volume.

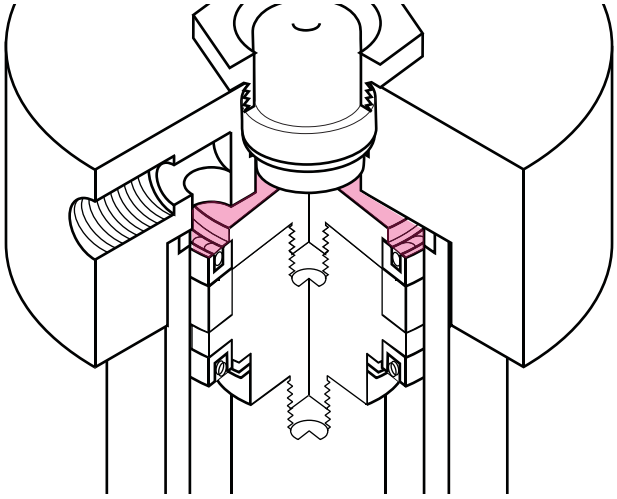

Figure 3: Dead volume remaining at top of stroke (shaded area)

Table 1: Specifications of Isco Pumps

Pump	Flow Rate Range	Pressure Range	Inlet/Outlet Ports	Displacement Resolution	Leakage	Dead Volume
65D	0.01 µl/min to 25 ml/min	0.6895 to 1379 bar	1/4" F-250	2.55 nl/step	≤ 1 µl/min	1.30 ±0.020 ml
65DM	0.01 µl/min to 30 ml/min	0.6895 to 689.5 bar	1/8" Valco			
100DM	0.01 µl/min to 25 ml/min	0.6895 to 689.5 bar	1/8" Valco	4.825 nl/step		
100DX	0.01 µl/min to 50 ml/min	0.6895 to 689.5 bar	1/8" Valco	9.65 nl/step		
260D	0.001 to 107 ml/min	0.6895 to 517.1 bar	1/8" Valco	16.63 nl/step		2.10 ±0.020 ml
500D	0.001 to 204 ml/min	0.6895 to 258.6 bar	1/8" NPT	31.71 nl/step		4.00 ±0.020 ml
1000D	0.100 to 408 ml/min	0.6895 to 137.9 bar	1/4" NPT	25.38 nl/step	≤ 1.5 µl/min	11.0 ±0.70 ml

Wetted Materials

Proper care of the wetted materials within the cylinder is vital to continued smooth operation of the pump. Table 2 on the following page lists internal wetted pump components, as well as standard and optional materials. The pump contains four seals and a wear ring.

Transducer seal – The transducer seal is gold-plated to press into minute gaps between the surfaces of the transducer flange and the shelf of the cylinder cap.

Cylinder cap seal – The cylinder cap seal maintains the pressure within the cylinder.

Piston seal – The piston seal maintains the pressure within the cylinder.

Wear ring – The wear ring supports the seal against movement within the cylinder and keeps the piston centered in the cylinder bore.

Wiper seal – The wiper seal cleans the inside of the cylinder. In the model 1000D pump, the wiper seal faces the same direction as the piston seal to prevent leakage of the wash gland fluid.

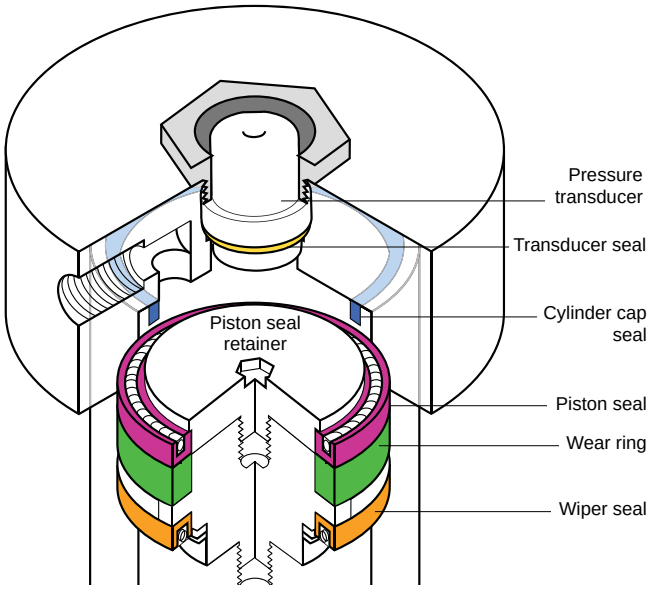

Figure 4: Identification of wetted materials

Table 2: Isco Pump Wetted Materials

Model	Transducer	Cylinder	Cap	Piston	Seals	Wash Gland	Air Valves	Electric Valves	Manual Valves
1000D	Hastelloy (internal)	Nitronic 50 Option: Hastelloy	Nitronic 50 Option: Hastelloy	Nitronic 50 Option: Hastelloy	Graphite/ PTFE	Nitronic 50 Option: Hastelloy	Valves: Hastelloy Tubing: SST304 Fittings: SST316 or SST304 Option: All Hastelloy	All Hastelloy	Stem: 17-4PH Body & fittings: SST316 Tubing: SST304 Option: All Hastelloy
500D	Titanium (internal) Options: Hastelloy (external)								
260D						N/A			
100DM/DX									

Seal Cleaning and Replacement

The piston seal may be cleaned or replaced yearly. Maintenance may be more frequent, depending on the type of use and nature of the pumped fluids. If either the cylinder or seal has been scratched, it must be replaced to maintain flow rate specifications.

⚠ CAUTION

Use great care when handling the pump seals; their surfaces are easily damaged.

Before cleaning or replacing any seals, run the pump at maximum flow rate until the cylinder is empty, then disconnect the power cord. For complete instructions on accessing the cylinder and seals, refer to "Seal Cleaning and Replacement" and "Wear Ring Cleaning and Replacement" in Section 5 of the D Series user manual.

To access the seals, unscrew the piston retainer and remove its seal. Ensure that the seals, and all surfaces that come into contact with them, are clean. Dirt or other solids on the seals can cause leakage. If removed and rinsed with distilled water, a seal may not require replacement. However, if leakage occurs and no foreign material is found on the seal, replacement is necessary.

Gears

The worm, worm gear, and ball screw must be lubricated every two years or every 6,000 strokes, which ever comes first. The pump accessory package includes a lubrication kit (part #60-1244-271) containing ALMASOL 609 and Never-seez lubricants.

The **worm and worm gear** are lubricated by a lubrication wheel. Apply ALMASOL 609 directly to the wheel until it is saturated. Do not substitute any other lubricant.

To lubricate the **ball screw**, run the pump until the ball nut reaches its maximum height. Apply two beads of Never-seez, on opposite sides of the ball screw, down its entire length.

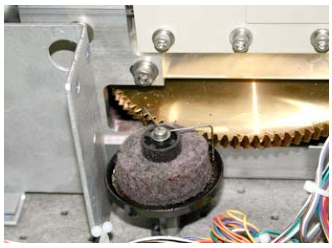

Figure 5: Lube wheel (Saturate with ALMASOL 609)

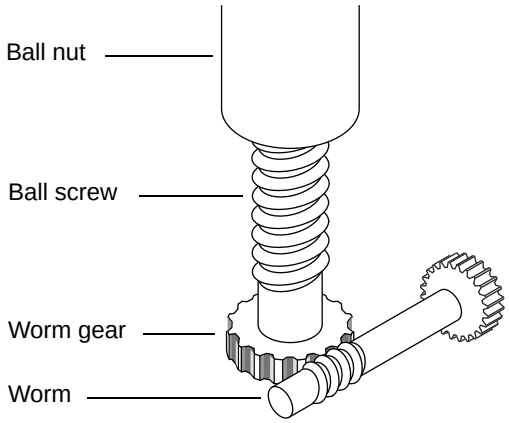

Figure 6: Worm, worm gear, and ball screw (lubricate with Never-seez)

Motor Brushes

Inspect both motor brushes for wear and replace if needed. (Part #60-2254-132 includes package of two (2) motor brushes.)

The brushes are accessed by removing the motor's terminal caps with a flat screwdriver.

☑ Note

D Series pumps have a copper graphite brush type electric motor. HL Series pumps use a brushless DC motor.

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