

# Low Flow Operation

## With Teledyne Isco Syringe Pumps

### Overview

Many laboratory applications in which syringe pumps are used require delivery at very low rates of flow (i.e., 0.001 to 100 ml/min), such as:

- Microreactor Systems (see application note [AN18 Microreactor Systems](#) for more information)
- Reactant Feed (see application note [AN02 Reactant Feed](#) for more information)
- High Pressure Liquid Chromatography (see application notes [AN06 High Pressure Liquid Chromatography](#) and [AN04 Ultra HPLC System Configuration](#) for more information)

### Considerations for Low Flow Operation

The performance of a low flow system depends upon the right setup for your application. To this effect, several factors become crucial when configuring a system.

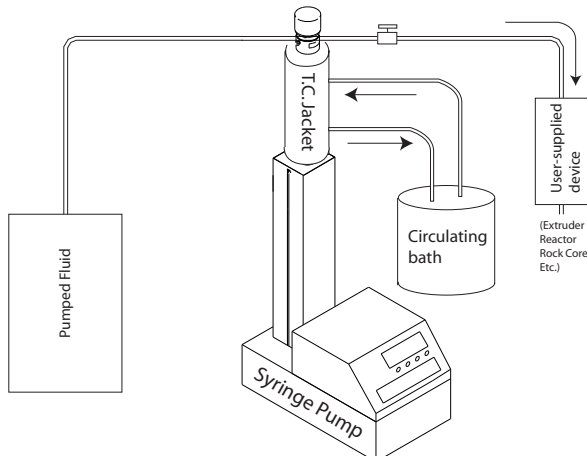
#### Expansion / Contraction of Fluid

At low flows, even slight fluctuations in temperature can cause the fluid in the pump to expand (increasing the flow rate) or contract (decreasing the flow rate). There are a number of methods of protection against the effects of temperature fluctuation:

**Ambient Temperature** – The room temperature must be maintained at a steady temperature.

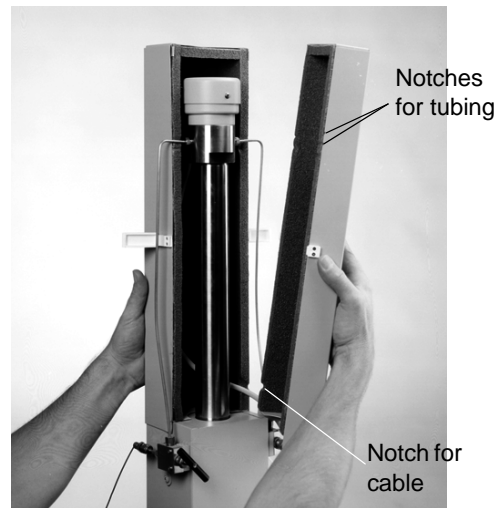
**Other Fluids** – Be aware of temperature differences in any fluid added to the system from the reservoir.

**Temperature Control Jacket** – The optional temperature control jacket from Teledyne Isco encircles the pump cylinder. Connected to a user-supplied, temperature-controlled circulating bath, it maintains the temperature of the pumped fluid inside the cylinder, as shown in Figure 1. For full details about the temperature control jacket, refer to technical bulletin [TB07 Temperature Control Setup Guide](#).



**Figure 1: Temperature Control Jacket installed on pump** with circulating bath

**Insulating Cover** – The optional insulating cover from Teledyne Isco consists of a two-piece enclosure that fits around the cylinder (see Figure 2 on next page) to stabilize temperature by dampening the effects of ambient temperature fluctuation in the room. The cylinder cover is not compatible with dual pump continuous flow systems, or 1000D and 65D pumps.



**Figure 2: Cylinder insulation cover**

Notches in the cover provide openings for the inlet and outlet tubing and for the pressure transducer cable.

#### Installation:

1. Install the back cover.
2. Route the cable around the tubing through the appropriate notches.
3. Install the front cover and secure the side latches.

Cylinder cover for Model 500D:  
part #68-1247-085

Cylinder cover for Models 260D, 100DM/DX:  
part #68-1247-081

#### Temperature of New Gas or Liquid

When a new container of the pumped gas or liquid is brought into the lab, ensure that its temperature is equal to what is already in the system. Before using a new container, allow the fluid temperature to equalize (or expedite the process with temperature control).

### Back Pressure Effects

A high-quality back pressure regulator is recommended to prevent fluctuating line resistance due to changes in downstream pressure and its effects, such as oscillation and plugging of capillary tubing.

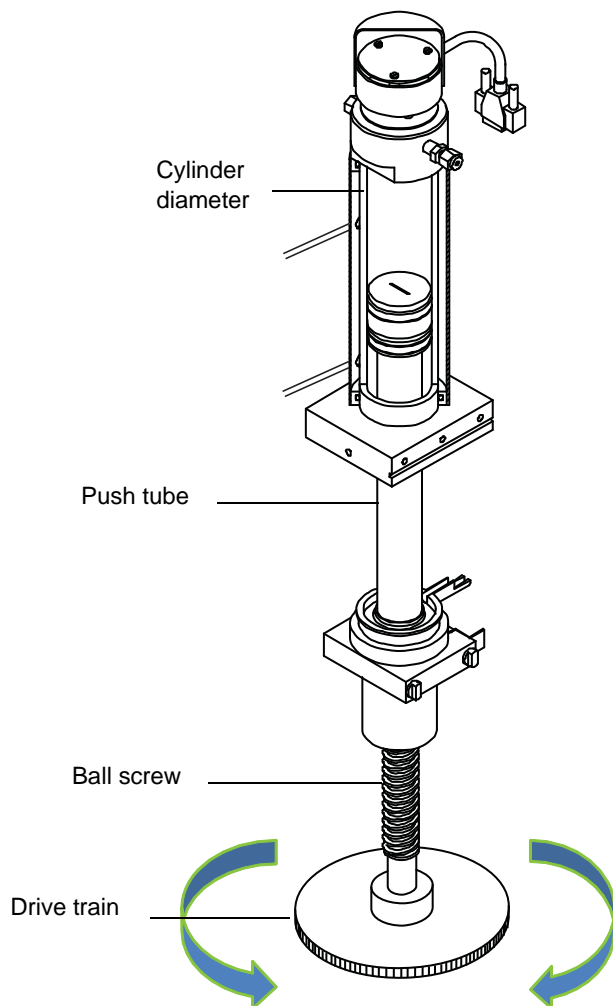
### Cylinder Diameter

In addition to back pressure effects, the motion of some individual pump components can add up to a significant noise factor in relation to flow.

The diameter of the pump piston magnifies any flow noise error. Because of this, pump models with smaller cylinder sizes are preferable for low flow applications.

### Mechanical Effects

The flow rate accuracy should always fall within the pump's given specifications. For low flows, accuracies within this range are influenced by pump cylinder diameter, as well as the mechanical components that move the piston within the cylinder.



**Figure 3: Pump components that can affect flow noise**

### Choosing the Correct Pump for the Job

For low flow applications, Teledyne Isco recommends pump models with a **smaller cylinder diameter** for greater accuracy, such as the 65D, 100DM, or 100DX. These pumps offer **smaller displacement resolution** and lower seal leakage specifications.

Displacement resolution is the quantity of liquid dispensed with respect to revolutions of the pump motor, or volume dispensed per pump step. As a rule of thumb, the smaller the displacement resolution, the greater the low flow accuracy of the pump.

**Leakage specifications** are listed in Table 1 on the following page.

#### Note

You should always verify the actual leakage rate of your pump. For verification procedures, refer to technical bulletin [TB05 Field Verification Checklist](#).

For complete technical specifications of all Teledyne Isco pumps, refer to your D-Series syringe pump user manual.

### Lowest Flow for Your Pump

As previously discussed, the accuracy with which fluid is pumped at extremely low flows can be influenced by a number of factors.

In order to determine the lowest flow rate at which your system can accurately dispense, the actual leakage rate and mechanical effects must be considered.

## Web Document Links

Listed below are links to all documents mentioned in this bulletin.

[AN02 Reactant Feed](#)

[AN04 Ultra High Pressure Liquid Chromatography](#)

[AN06 High Pressure Liquid Chromatography](#)

[AN18 Microreactor Systems](#)

[TB05 Field Verification Procedures](#)

[TB07 Temperature Control Jacket Setup](#)

[D-Series Syringe Pump Manual](#)

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**Table 1: Specifications of Isco Pumps**

Pump	Flow Rate Range	Flow Rate Accuracy	Displacement Resolution	Leakage
65D	0.01 $\mu$ l/min to 25 ml/min (any pressure up to 1379 bar)	$\pm 0.3\%$ of setpoint	2.55 nl/step	$\leq 1 \mu$ l/min
65DM	0.01 $\mu$ l/min to 30 ml/min (any pressure up to 689.5 bar)			
100DM	0.01 $\mu$ l/min to 25 ml/min (any pressure up to 689.5 bar)		4.825 nl/step	
100DX	0.01 $\mu$ l/min to 50 ml/min (any pressure up to 689.5 bar)	9.65 nl/step		
260D	0.001 to 107 ml/min	$\pm 0.5\%$ of setpoint	16.63 nl/step	
500SP	0.001 to 204 ml/min		31.71 nl/step	
500D	0.001 to 204 ml/min			
1000D	0.100 to 408 ml/min		25.38 nl/step	$\leq 1.5 \mu$ l/min

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