

# Reactant Feed

## Using Teledyne Isco Syringe Pumps

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### Introduction

The petrochemical, fine and specialty chemical, resin, and polymer industries, of which reaction feed is a part, are highly competitive. To remain competitive, chemical companies must continually update existing equipment, build new plants, and develop new products or chemical processing techniques. However, before implementing any changes or new products on full-scale equipment, chemical engineers must first conduct simulation tests to develop and prove the concept.

Testing and/or optimizing a new product or manufacturing process using actual full-size equipment would be prohibitively expensive. Instead, chemical engineers first use smaller “laboratory scale” or “bench scale” chemical reactors, and then proceed on to larger “pilot plant” reactors. Only after development is complete will the process be scaled up to full-size.

In order to produce a product of high quality and purity, it is important that reactants be delivered to a reactor smoothly and in exact volumes. For this reason, the choice of delivery pumps is particularly important. When the highest possible performance is required, Teledyne Isco pumps are often used, as they are excellent Reactant Feed pumps.

### Types of Chemical Reactors

There are many different kinds of chemical reactors used for varied purposes. The three most common types are: batch or semi-batch (BR), continuous stirred tank reactor (CSTR), and tubular or plug flow (PFR).

Batch Reactors (BR) consist of a tank where components are fed or pumped in predetermined amounts, and then remain in the tank until the reaction is complete. The final product or batch is then removed.

The continuous flow tank reactor (CSTR) is the most common type of reactor, and consists of a tank, a stirring mechanism, and feed pumps. Components are continuously fed into the reactor, and the product is continuously removed. After initial startup, steady-state must be reached before a quality product is produced.

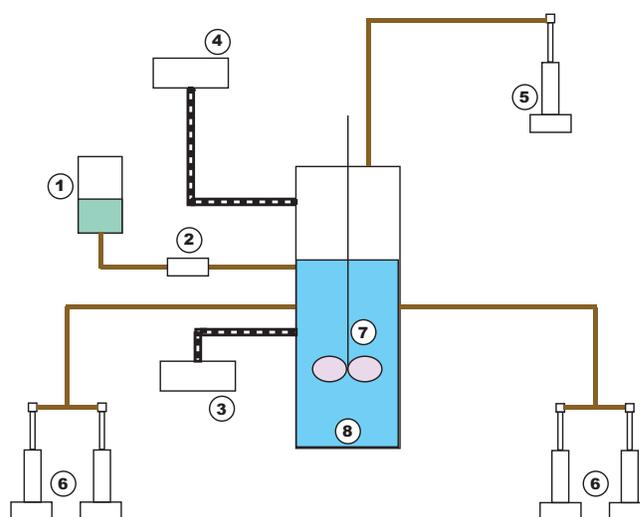
Tubular, or plug flow reactors (PFR), consist of a tube through which reactants are continuously fed. The reaction takes place as the components move down the length of the tube, and the completed product exits the outlet. As with CSTR, steady-state must be reached before a quality product is produced.

The reactors above may be custom built by the lab that uses them, or they can be purchased from manufacturers.

### Reactant Feed Setup

A wide variety of fluids are used in reactors, including acids, bases, catalysts, initiators, hydrocarbons, organic solvents, ammonia, extremely viscous liquids, heated or cooled liquids, and liquefied gases.

The schematic below illustrates either a continuous flow or semi-batch reactor. In either case, components can be pumped or fed in by different types of pumps.



**Figure 1: Reactor Schematic:** Continuous Flow or Batch

1. Pressure Pot
2. Flow Meter
3. Reciprocation Pump
4. Diaphragm Pump
5. Teledyne Isco Single Pump
6. Teledyne Isco Dual Pump
7. Stirrer
8. Tank

The choice of pump depends on cost, performance, reliability, and the type of fluid being pumped. The best pumps are those that deliver fluid accurately, reliably, and with pulseless flow. Some pumps, such as reciprocating pumps, are not pulseless, as they deliver fluid in small amounts and then refill. During the refill step, flow is stopped and feed pressure decreases. This results in changes in reactant concentration, which lower the quality and purity of the product. Also, pumps of this type depend on check valves to properly close during

refill. Check valves can be unreliable, particularly when pumping catalysts or other fluids containing particulates.

Pressure pots consist of a container that uses a pressure head from an inert gas to push the fluid out. Flow rate is controlled by a motorized valve with feedback from a flow meter. While flow meters offer acceptable flow rate accuracy, they do not use positive displacement, so actual fluid delivery is uncertain. Also, the control loop between the flow meter and valve can cause the flow rate to oscillate, resulting in an unstable flow.

Reciprocating pumps use a small sliding piston with piston seals and check valves. The most common pumps are usually HPLC pumps, and the flow rate accuracy is usually  $\pm 1$  to 2%. Due to the piston's small volume, the flow rate is not pulseless, and the use of check valves can make it unreliable. Fluids with particulates shorten piston seal life and cause further problems with the check valves.

Diaphragm pumps use an oscillating diaphragm instead of a piston to pump the fluid. Since diaphragms do not have piston seals, they are better than reciprocating pumps when pumping fluids with particulates.

However, these pumps still have check valves, and can therefore still be unreliable.

## Why Use Teledyne Isco Pumps?

Teledyne Isco's non-reciprocating syringe pumps deliver steady, pulse-less feeds at precise flow rates down to the sub-microliter, maintaining scaled proportions with ease. Teledyne Isco pumps can be custom fitted to your application, with many options and accessories to choose from, including those for high temperatures, and viscous and corrosive fluids.

## Recommendations for Teledyne Isco Pumps

Typically, chemists and chemical engineers who do the reactant feeding choose to work with a model 500D pump, but sometimes they purchase a Model 260D, Model 100D, or 65D in order to achieve higher pressure and/or more accurate flows. For low flows, either the 65D, 65DM, or 100DM is recommended.

Single pumps are most often used in batch reactors, while dual pumps are used in continuous flow.

**Table 1: Commonly Recommended Reactant Feed Pumps**

	Model	Wetted Materials Option for corrosive agents	High Temperature Option for lowering reagent viscosity	External Control Option
Single Pump	500D	Hastelloy	200 °C	Labview Driver
Continuous Flow Pump	A500	Hastelloy	200 °C	Labview Driver

**Table 2: Recommended Low Flow Isco Pumps**

	100DM	65DM	65D
Flow Range (ml/min)	0.00001 - 30	0.00001 - 30	0.00001 - 25
Pressure Range (psi)	0 - 10,000	0 - 10,000	0 - 20,000

**Table 3: Isco Pump Models Available**

	1000D	500D	260D	100DX	100DM	65DM	65D
Flow Range (ml/min)	0.100 - 408	0.001 - 204	0.001 - 107	0.00001 - 60	0.00001 - 30	0.00001 - 30	0.00001 - 25
Pressure Range (psi)	0 - 2,000	0 - 3,750	0 - 7,500	0 - 10,000	0 - 10,000	0 - 10,000	0 - 20,000

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Teledyne Isco is continually improving its products and reserves the right to change product specifications, replacement parts, schematics, and instructions without notice.

