

Microreactor Systems

Using Teledyne Isco Syringe Pumps

Overview

Continuing research at the United States Environmental Protection Agency's National Risk Management Research Laboratory in Cincinnati, Ohio focuses on the development of process-intensified and green reaction strategies for pharmaceutical relevant reactions. Teledyne Isco high precision syringe pumps have been invaluable to this work in demonstrating organic chemistries in the Spinning Tube-In-Tube (STT®) reactor. These synthetic chemistries include the high-conversion synthesis of esters from acid anhydrides and alcohols, of imidazole-based ionic liquids, and of dipyrromethanes.

This fundamental research work is carried out in a reaction system comprised of two Teledyne Isco Model 100DX syringe pumps with the STT® Magellan™ microreactor. The key feature of this microchemical reactor system is the high ratio of surface area to volume. As a result, mass transfer, heat transfer, and mixing are vastly more efficient. Other benefits of this type of system include:

- Increased throughput
- Minimized unwanted by-product formation
- Safer chemistries
- Solventless or decreased solvent usage
- Minimal environmental footprint
- Smaller physical footprint

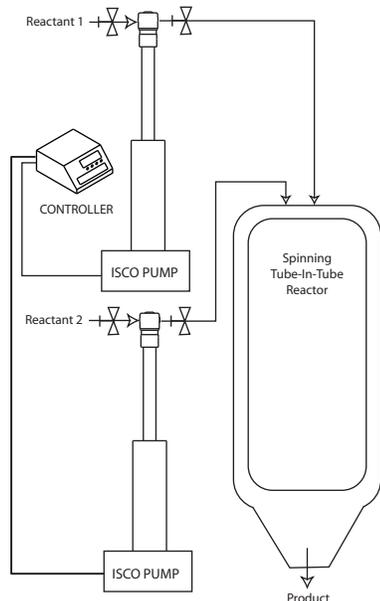


Figure 1: STT Reactor Setup with two Isco pumps operating independently and simultaneously from one controller, in constant flow mode

Setup

Figure 1 shows the configuration of an STT® 1.2ml microreactor with two separately connected Teledyne Isco syringe pumps, each with a manual valve for the inlet and outlet. As shown, each pump is connected separately to the reactor with a manual valve on each inlet and outlet.

Based upon the chemistries employed, the required residence times in the reactor vary from 10 seconds to 5 minutes. This requires the syringe pumps to operate at flow rates from 0.100 ml/minute to up to 10 ml/minute. In order for the reactions to yield the desired conversion and selectivities while minimizing unwanted reaction by-products, the concentrations of the reactants must be precise and kept constant.

Further automation, as seen in Figure 2, can be achieved with a dual-pump, continuous flow system, where reactions can be produced indefinitely.

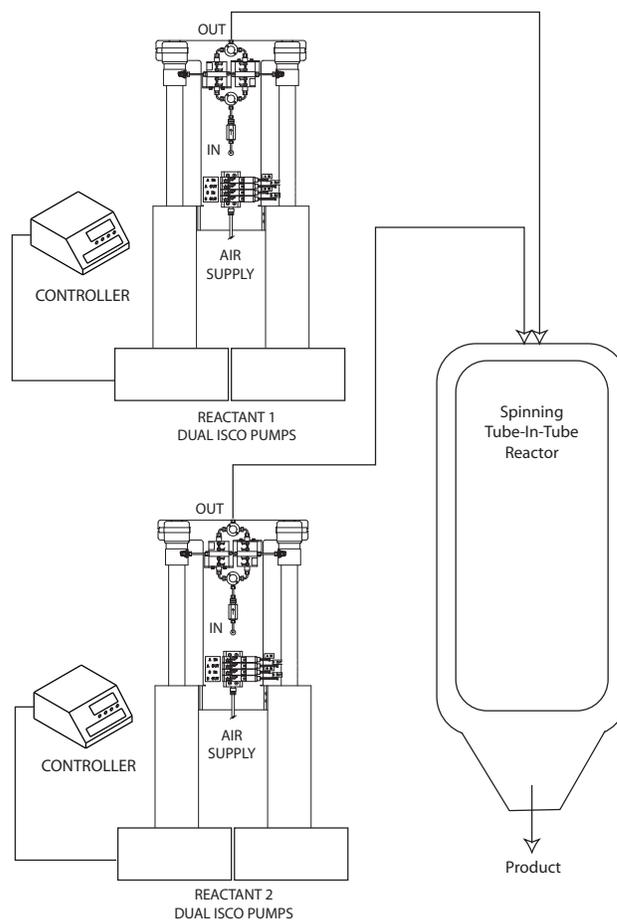


Figure 2: STT Reactor Setup with two dual pump systems for continuous flow

Why Teledyne Isco Pumps?

Teledyne Isco pumps have a flow rate accuracy of $\pm 0.5\%$ or better, and flows are pulse-less. Pulse-less flow means fluid pressure and density are constant, without fluctuation in solvating properties or chemical potential. The pumps can be operated in either constant flow or constant pressure mode, as a stand-alone unit, or via external control. Teledyne Isco syringe pumps also have a flow rate and pressure limits alarm to alert the user to any change in conditions.

In addition, Teledyne Isco Syringe pumps have much larger cylinder volumes (up to 1 L), eliminating the need for refills with most batch runs. For continuous operation, however, dual pump systems deliver pulse-less flow with the same accuracy and precision of single pumps, and can operate unattended.

Other pumps types, such as reciprocating pumps, produce a flow or pressure pulse that affects the quality of the product produced. For reciprocating pumps, the piston-swept volumes are typically small, and thereby require frequent refills, creating periodic pressure drops. Although dual piston reciprocating pumps produce smoother flows than single piston pumps, they cannot produce the pulse-less, accurate flows required for many high performance applications.

Recommended Pumps

Typically, chemical engineers choose to work with the Model 100DM for low flow applications, 500D for most common applications, or the 500HL pump for Hazardous Location environments. Single pumps are most often used in batch applications, while dual pumps are used in continuous flow.

Table 1: Teledyne Isco Pumps

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

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3) Rouhi, A.M. June 2004. *C&E News*. April 2008 <<http://pubs.ac.org/cen/news/8226/8226/earlysci2.html>>

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