

Catalysis at high pressure



Application note A052-CM01-0716A

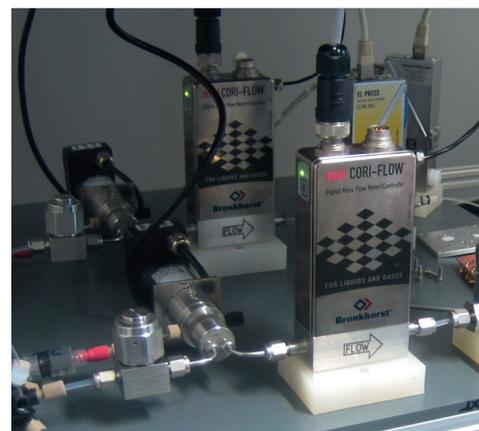


Catalysts are being used to accelerate a chemical reaction without actually being consumed. So a small amount of catalyst is sufficient to obtain a large amount of reaction products.

Solid catalysts are often small, highly porous particles, with a large internal surface area in a small volume. This internal surface contains active sites on which the reaction takes place. Gaseous or liquid chemicals diffuse into the pores of these particles, and react at the catalytically active sites to reaction products that diffuse out of the particle. Often, these reactions occur at extreme process conditions.

An energy research organisation investigates a not-specified catalysed chemical reaction of a mixture of hydrocarbon compounds. As the reactor is operated at a high temperature and pressure, Bronkhorst found a solution for injecting chemicals at a low flow under high pressure conditions.

◆ Liquid catalyst dosing



Bronkhorst setup

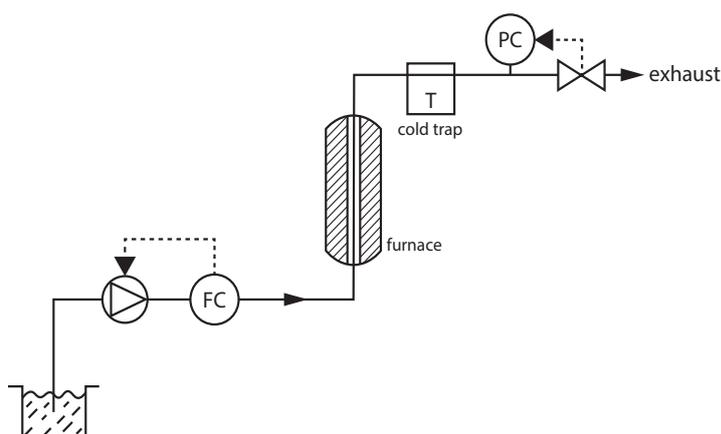
Application requirements

A simple and reliable solution has to be found to inject a liquid flow at a high pressure. This injection has to take place at 30 to 60 bars, and needs to result in a stable flow without pulsation. Furthermore, the liquid flow needs to be controlled accurately, and during the process it has to be known how much liquid actually has been injected.

Important topics

- ◆ Low liquid flow at high operating pressure
- ◆ No pulsation
- ◆ Monitoring of injected liquid

Process solution



Flow scheme

The solution comprises a Coriolis mass flow meter that controls a HPLC piston pump at the inlet side of the reactor and an independently operating back pressure controller at the outlet side. The tested M12 mini CORI-FLOW is a very stable and accurate mass flow meter, however the ML120 has proven to be better in this case. The WADose HPLC pump gives a very stable flow without pulsation. The combination of HPLC pump and mass flow controller works as a mass flow controller. The control valve of the M12 or ML120 is not necessary, as the pump is used as an actuator.

The pump can handle a liquid viscosity of max. 40 mPa.s at the upstream side. The maximum operating temperature is 70 °C. The temperature of the furnace that contains the reactor tube with small catalyst particles is much higher. The pressure at the reactor tube outlet has to remain at a high value. Beyond the outlet there is a cold trap for water or oil condensation, a back pressure controller P-502C with control valve F-033C that can handle pressure differences up to 400 bars and an exhaust to atmospheric pressure. The pressure controller can handle gas and liquid in a very stable controlled flow. Especially at very small flow rates, this pressure controller has a much better control performance than a mechanical pressure reducer. The exhaust is used to remove gas that has been... ►

... produced at the reaction. The pump has three control modes: pressure, volumetric (only the speed of the piston is controlled) and mass flow. The latter is a special feature that can be offered, and is convenient from a chemist's point of view. As the flow can be controlled directly, the exact number of moles injected to the process is known. Control and monitoring occurs via the digital interface. The mass flow measure and setpoint, density, temperature and counter value are visible via this single digital interface.

The success of this setup has been demonstrated by a recent order of three additional pumps. ■



Recommended Products



mini CORI-FLOW ML120

The new Bronkhorst ML120 Coriolis Mass Flow Meters and Controllers offer highest performance at the world's lowest flow rates for both liquids and gases lowest range 50...5000 mg/h up to highest range 2...200 g/h The Coriolis sensor of the ML120 shows little to no variance over a long period of operation, thus reducing the system downtime.

- ◆ Direct mass flow measurement
- ◆ Fast response time
- ◆ High accuracy (0,2% Rd for liquids, 0,5% Rd for gases)
- ◆ Additional density and temperature outputs
- ◆ Compact design with very small internal volume
- ◆ Easy to install (low risk of gas bubble inclusion)
- ◆ Multi-range: easy on-site re-ranging via digital interface (span 1:4000)



mini CORI-FLOW Series M12-M14

The unique design of the miniature Coriolis sensor features unsurpassed performance, even with changing operating conditions in pressure, temperature, density, conductivity and viscosity. Contrary to many other Coriolis flow meters on the market, mini CORI-FLOW offers integrated PID control and close-coupled control valves or pumps.

- ◆ Direct mass flow measurement, for liquids and gases
- ◆ High accuracy, excellent repeatability
- ◆ Cost-effective design
- ◆ Compact design, with integrated PID controller for fast and stable control
- ◆ Now suitable for (very) low flow ranges
- ◆ Digital technology allows fieldbus communication



WADose

WADose is a smart, precise dosing pump for dosing of liquids. The low-pulsation dual-piston pump is accurate driven by an intelligent controller with stepper motor for smallest steps and dosages. The pressure range goes from atm up to 400 bar. The handling goes via graphical touch-display or external analog signals/RS232.

- ◆ Range 0.002... 50 ml/min up to 400 bar
- ◆ Plug & Work with flow meter mini CORI-FLOW
- ◆ Handling over build-in touch display or analog signals, RS232
- ◆ Pump head made of stainless steel or PEEK
- ◆ Integrated pressure sensor with pressure control



EL-PRESS with F-033C Control Valve

The EL-PRESS series digital electronic pressure transducers and controllers have a well-proven compact thru-flow design. The instruments include a diaphragm type piezo-resistive pressure sensor for pressure measurement/control. The so-called Vary-P valve type F-033C can cope with differential pressures as high as 400 bars.

- ◆ Thru-flow design
- ◆ Compact arrangement
- ◆ Stable control, even at varying process volumes
- ◆ High pressure capability up to 400 bar
- ◆ High accuracy and repeatability

Contact information



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CM: Chemical, Metal and Glass

01: Catalysts

T +31(0)573 45 88 00 F +31(0)573 45 88 08
I www.bronkhorst.com E info@bronkhorst.com

