Combined Mass Flow – Pressure Control Solution

for safe and automated reactor pressure control

> Introduction

Bronkhorst High-Tech BV has developed a specialised combination of electronic pressure and thermal mass flow controllers for automated pressure control of reactor vessels. This standard solution can be applied for low flow lab reactor systems as well as for high flow industrial applications as for instance in hydrogenation processes in the food and pharma industry or at chemical plants, at either low or (very) high pressure (up to 400 bar).

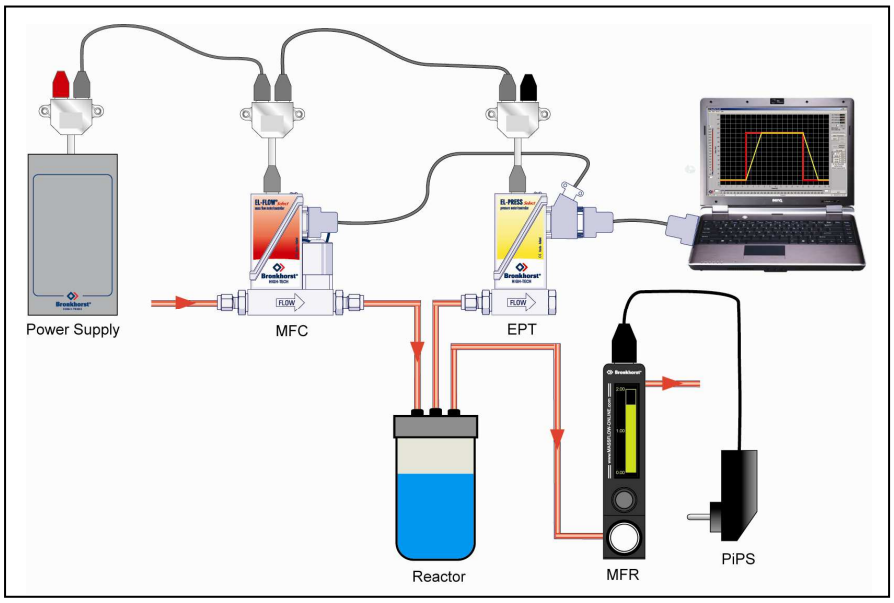
> Principle of operation

The set-up of a Combined Mass Flow – Pressure Control System may slightly vary per application, since the concept can be applied for analog or digital (RS232 or fieldbus) systems. Furthermore the instruments used may be in 'laboratory style' (EL-FLOW / EL-PRESS) or with rugged industrial housing, IP65 protected and optionally with ATEX Zone 2 approval (IN-FLOW / IN-PRESS). To illustrate the solution, uniquely offered by Bronkhorst® please see below illustration. At the inlet of the reactor, a Mass Flow Controller (MFC) takes care of the process gas delivery, whilst an Electronic Pressure Transmitter (EPT) measures the reactor pressure. At the outlet of the system there is a flow restriction which could simply be a (needle) valve or, as shown in the illustration, a Mass Flow Regulator (MFR) with local display.

The reactor pressure is controlled by giving a setpoint to the pressure transmitter. In the illustration this is done via RS232 by a script programmed into a PC. The integrated PID-controller of this pressure meter (Master) controls the valve position of the MFC's control valve (Slave). When building up the pressure in the reactor, the maximum inlet flow is restricted by the MFC, thus preventing a flow peak. By using the 'slave factor' option, the maximum flow can be adjusted. When the process pressure has reached the desired value, this pressure is maintained whilst the required amount of reaction gas is controlled with a constant and pulse-less flow. It is also possible to pre-set the total amount of reaction gas allowed into the system by using a batch control function. Once the total amount is reached, the set-point for the MFC can be programmed to be set back to zero, thus switching off the gas supply. This will be independent of the pressure in the process.

> Benefits

- No flow overshoot
- Programmable setpoint script
- Accurate measurement of pressure and consumption of reaction gases (e.g. H_2, Ethylene or Propylene)
- Alarm, totalizer and batch control functions



Typical set-up of a combined Mass Flow – Pressure Control system

Example of a compact lab reactor system; (Büchi Glas picoclave)

BRONKHORST HIGH-TECH B.V. Nijverheidsstraat 1a, 7261 AK Ruurlo, The Netherlands
Telephone: +31 573 458800 Telefax: +31 573 458808 Internet: www.bronkhorst.com, E-mail: sales@bronkhorst.com

> Specifications

Accuracy	Pressure: ±0,5% of Full Scale
	Mass flow: ±0,5% of Reading plus ±0,1% of Full Scale (based on actual calibration; conversions will introduce extra inaccuracy)
Reproducibility	0,1%
Pressure rating	Depending on selected models PN64, PN100, PN200 or PN400
Wetted parts	Stainless steel 316 or equivalent
Seals	Standard Viton, optional EPDM or Kalrez (other on request)
Temperature	-10°C...+70°C (fluid and ambient temperature)
Turndown ratio	1:50 (this corresponds to 2%...100% of Full Scale value)
Signals	0...20 mA., 4...20 mA, 0...5 V or 0...10 V, RS232, various fieldbus options
Supply voltage	100....240 Vac / 50 Hz for Power Supply box and PiPS (Plugin Power Supply) The Mass Flow and Pressure Meters / Controllers require +15…24 Vdc

> Application example

Hydrogenation in the food industry

The process of hydrogenation involves the addition of hydrogen (H_2) to produce a chemical reaction with organic compounds (hydrocarbons). It is hugely important and widely used in the food industry where, for example H_2 molecules are added to unsaturated vegetable oils and fats. Complete hydrogenation converts unsaturated fatty acids into saturated ones for use in products like margarine. In order for the process to be successful, catalytic hydrogenation has to take place under elevated temperature or pressure.

By means of Bronkhorst's Mass Flow – Pressure Control System, the desired process pressure is maintained within the vessel where the reaction takes place. Simultaneously, the required amount of reaction gas is controlled at a constant flow rate. Due to the use of thermal mass flow meters the gas flow measurement is virtually independent of both pressure and temperature variation. Furthermore, this eliminates the need for data manipulation and correction factors as direct totalization of the level of consumption is made.

The electronic pressure transducer with integral PID controller receives its setpoint from a PC/PLC. The mass flow controller (MFC) receives a similar setpoint for the maximum quantity of reaction gas. This gas is bled into the reactor and the process pressure will start to rise. When the desired pressure is reached, the MFC will control just as much flow as necessary for the reaction, automatically keeping the pressure constant. Finally, as the saturation phase of the reaction is reached, the gas consumption will decrease.