System solutions: Flow control

The smart choice of Fluid Control Systems

bürkert
Fluid Control Systems

Contents

The flow control loop

More and more stringent requirements made on the quality of products and the increasing level of automation in machinery and systems necessitate automatically running processes, processes with constant, reproducible parameters. Closed-loop control systems are used to guarantee uniform process parameters.

The task of a closed-loop control system is to maintain a specific variable (e.g. a temperature or a flow rate) at a preset value, even when subject to the action of interference.

At first glance, this task appears very simple, but in practice, there are often a whole host of problems. When setting up a closed-loop control system, it is necessary to know both the interrelationships in the control loop as well as the external influences.

The individual elements of a control loop, the measuring instrument for detecting the variable to be controlled (referred to as the "actual value"), the controller itself and the final control element or actuator on which the system to be controlled (referred to as the "controlled system") acts, must be matched to each other and to the system to be controlled. The most important factors to be taken into consideration here are:

- for selection of the measuring instrument:
  - the measuring method
  - the measuring range
  - the properties of the medium
  - the ambient conditions
  - the pressures and temperatures obtained in the controlled system

- for selection of the controller:
  - the structure and principle of operation
  - the controller parameters

- for selection and rating/dimensioning of the final control element or actuator:
  - the nominal diameter (kv value)
  - the properties of the medium
  - the pressures and temperatures obtained in the controlled system.

1. Flow-rate measuring instruments

Depending on the required measuring range, medium, medium properties and the pressures and temperatures obtained, it may be necessary to use differing measuring instruments or measurement principles. The following table provides an overview of the most conventional measuring methods and when they can be used.

Measuring method	Measurement in fluids	Measurement in gases
Paddle wheel and turbine	Measuring method involving contact with the medium. Can be used in electrically non-conductive fluids, suitable for media without large solids proportions, e.g. sand, granulates and fibers. Due to the materials, also suitable for use in very aggressive media. Nominal diameters: DN 1 to DN 300 Measuring range: up to 2,000 m^3/h Temperature: up to 100 °C Pressure: up to 16 bar Only suitable in special cases for high-viscosity or contaminated media or media containing solids and which form coatings.	
Magnetic inductive flow sensor (MID)	Universal measuring method without moving parts in electrically conductive measured media. With or without wetted electrodes, depending on the circumstances. Broad range of application from clean to contaminated to pasty media. Depending on design, suitable for sterile applications in the pharmaceutical and food sector. Nominal diameters: DN 4 to DN 300 and above Measuring range: up to 6,000 m^3/h Temperature: up to 130 °C Pressure: up to 40 bar Only restrictedly suitable with gas formation or foaming media and with strongly vibrating pipes.	

Measuring method	Measurement in fluids	Measurement in gases
Vortex	Universal measuring method with wetted shedder bar. For low flow velocities. Relatively insensitive to pipe vibrations. Also suitable for steam flow rate measurements. Nominal diameters: up to DN 150 Measuring range: up to 700 m^3/h Temperature: up to 400 °C Pressure: up to 40 bar Conditionally suitable in the case of highly viscous media, media forming coatings, media containing solids or contaminated media.	Universal measuring method with wetted shedder bar. For low flow velocities. Relatively insensitive to pipe vibrations. Nominal diameters: up to DN 150 Temperature: up to 400 °C Pressure: up to 40 bar
Coriolis	Non-contact method for direct measurement of the mass flow rate. Volume flow rate accessible due to simultaneous measurement of the medium density. Also suitable for measurement with steam. Easy to use with media containing solids and media tending to outgas. Depending on design, suitable for sterile applications in the pharmaceutical and food sector. Nominal diameters: up to DN 100 Measuring range: up to 250 metric ton/h Temperature: up to 150 °C Pressure: up to 40 bar Conditionally suitable in the case of media forming coatings and in strongly vibrating pipe systems. In some cases, vibration-absorbing assembly sets are required for installation.	Non-contact method for direct measurement of the mass flow rate. Volume flow rate accessible owing to simultaneous measurement of the medium density. Nominal diameters: up to DN 100 Measuring range: up to 250 metric ton/h Temperature: up to 150 °C Pressure: up to 40 bar Can be used only at high gas densities (medium pressure > 3...4 bar). Conditionally suitable in strongly vibrating pipe systems. In some cases, vibration-absorbing assembly sets are required for installation.
Thermal	Measuring method for low flow rates. No moving parts in the measured medium. All wetted parts made of stainless steel. Measuring range: up to 1 l/h Temperature: up to 150 °C Pressure: up to 40 bar	Measuring method for directly determining the mass flow rate. High measuring dynamics in the case of main flow measuring principle. Broad measuring span (100:1). Nominal diameters: up to DN 1000 Temperature: up to 150 °C Pressure: up to 40 bar Only conditionally suitable for contamin. media.
Oval gear	Measuring method involving contact with the medium. Can be used in fluids without a solids proportion or with very small solids particles. Particularly suitable for highly viscous and also aggressive media. Nominal diameters: up to DN 400 Measuring range: up to 1,200 m^3/h Temperature: up to 290 °C Conditionally suitable at low upstream pressures (liquid columns) and with contaminated media or very thin-bodied media.	

2. Controllers

The task of the controller is to maintain the variable to be controlled, the actual value, at the given set-point value, even if it is re-adjusted. In most applications however, the controller operates with a fixed set-point value. In this case, it is only required in order to compensate for or eliminate the effects of disturbances acting on the control loop. In addition, the control loop must operate stably.

A distinction is made between two groups of controllers: On/Off or switching controllers and continuous-action controllers.

On/off controllers (2-point and 3-point controllers) operate in the same way as a switch. If, on the 2-point controller, the actual value drops below the set-point value, the controller switches on the output. If the actual value rises above the set-point value, the output is switched off. The activated final control element or actuator is either switched on or opened, or is switched off or closed. 2-point controllers can also be operated with the reverse circuit function. A 3-point controller is a combination of two 2-point controllers.

Continuous-action controllers (P, PD, PI and PID controllers) are used for demanding control tasks. Unlike on/off controllers, the output signal of continuous-action controllers may assume any value within the manipulating range (this is the range between the maximum and minimum possible values of the output signals, e.g., in the case of a control valve, between the “closed” and “open” positions). The controllers respond to any change in the actual value by comparison with the set-point value.

A controller matching the controlled system must be selected in order to comply with the requirements made of a closed-loop control system. The following evaluation of the suitability of the various controller types for use in a flow-rate control system is based on practical experience.

On/off or switching controllers	
2-point	**3-point**
Unsuitable	Unsuitable

Continuous-action controllers			
P	**PD**	**PI**	**PID**
Permanent control deviation		No permanent control deviation	
Unsuitable	Unsuitable	Suitable	Over-dimensioned

Controlled flow systems show different responses depending on construction. Based on the application, different requirements are made of the closed-loop control system. For this reason, the controller parameters must be matched to the controlled system.

Our “Competences” brochure describes how the controller parameters can be obtained or determined.

3. Control elements or actuators, selection and rating

It is mainly process valves, in a very wide variety of designs, which are used as final control elements or actuators for open-loop control and closed-loop control of fluid streams in installations.

Pilot valves which have only two or a few circuit states are used for open-loop control tasks. Control valves that are able to continuously set fluid streams are used for closed-loop process control tasks. Pilot valves and control valves have very different tasks in some cases, so that the rating and selection of both valve types necessitates greatly different procedures.

3.1. Rating and selection of pilot valves

Pilot valves can either open or close a line (on/off valve) or can switch over a material stream from one line to another.

The first important criterion for the valve being selected is to ensure that the required fluid quantity be able to flow through the valve at a given pressure differential, i.e. the valve cross-section must be adequately large. The following rule of thumb often applies: line cross-section is equal to valve (connection) cross-section. A subsequent requirement is that the valve be able to switch against the maximum pressure differential, i.e. that the valve actuator be adequately powerful. The max. switchable pressure differential is specified in the data sheet. Once the type of auxiliary energy (electrical or pneumatic) has been defined and the material suitability checked, a specific valve type can be defined and the specific valve selected.

3.2. Rating and selection of control valves

Control valves are able to constantly change their operating cross-section and thus continuously influence fluid streams. Control valves must be rated and selected in line with their specific task in order to be able to ensure correct closed-loop control function.

Initially, the connection nominal diameter must be defined in accordance with the medium and the related efficient flow velocity. The following guideline values apply in this case: 2 m/s for liquids, 20 m/s for gases and 45 m/s for steam. At minimum, the anticipated flow velocity should be checked.

The nominal pressure stage arises from knowing the valve material, the operating temperature and the max. operating pressure, e.g. from DIN 2401, or from a valve data sheet.

The actual closed-loop control function, i.e. setting a fluid flow rate of the given temperature and given pressure while simultaneously producing a defined pressure loss, is determined by the flow characteristic, the kv value. The kv value is a reference variable and is defined as follows: kv value = quantity in m^3/h of cold water (+5 ... +35 °C) which flows through the valve at 1 bar differential pressure across the valve and at stroke s. The kvs value is the quantity at stroke s = 100 % (valve fully open). Analogous to this, the flow-rate coefficient cv is described in the American literature and defined as follows: the cv value (in US gal/min) is the flow rate of water at 60 °F which passes through at a pressure loss of 1 psi with the relevant stroke s.

The kv value must be calculated for the current operating data. A distinction must be made between maximum load:
maximum quantity Q_{max},
minimum $\Delta p_{(min)} \rightarrow kv_{max}$
and minimum load:
minimum quantity $Q_{(min)}$,
maximum $\Delta p_{(max)} \rightarrow kv_{min}$.

The following applies to cold water:

$$kv = Q \cdot \sqrt{\frac{1}{\Delta p}}$$

Q: Volumetric flow rate in m^3/h
Δp: Pressure differential at the valve in bar

The following applies to liquids in general (sub-critical):

$$kv = Q \cdot 0{,}032 \cdot \sqrt{\frac{\rho_1}{\Delta p}}$$

ρ_1: Density of the medium in kg/m^3

The following applies to saturated steam (sub-critical, i.e. $p_2 > \frac{p_1}{2}$):

$$kv = \frac{G_S}{22{,}4\sqrt{\Delta p \cdot p_2}}$$

G_S: Saturated steam quantity in kg/h
p_1: Pressure upstream of the valve in bar absolute
p_2: Pressure downstream of the valve in bar absolute

The following applies to saturated steam (super-critical, i.e. $p_2 < \frac{p_1}{2}$):

$$kv = \frac{G_S}{11{,}2 \cdot p_1}$$

The following applies to gases (sub-critical, i.e. $p_2 > \frac{p_1}{2}$):

$$kv = \frac{Q_N}{514} \cdot \sqrt{\frac{\rho_N \cdot T_1}{\Delta p \cdot p_2}}$$

Q_N: Volumetric flow rate in Nm^3/h
ρ_N: Standard density in kg/m^3 (standard state: 0 °C and 1013 mbar)

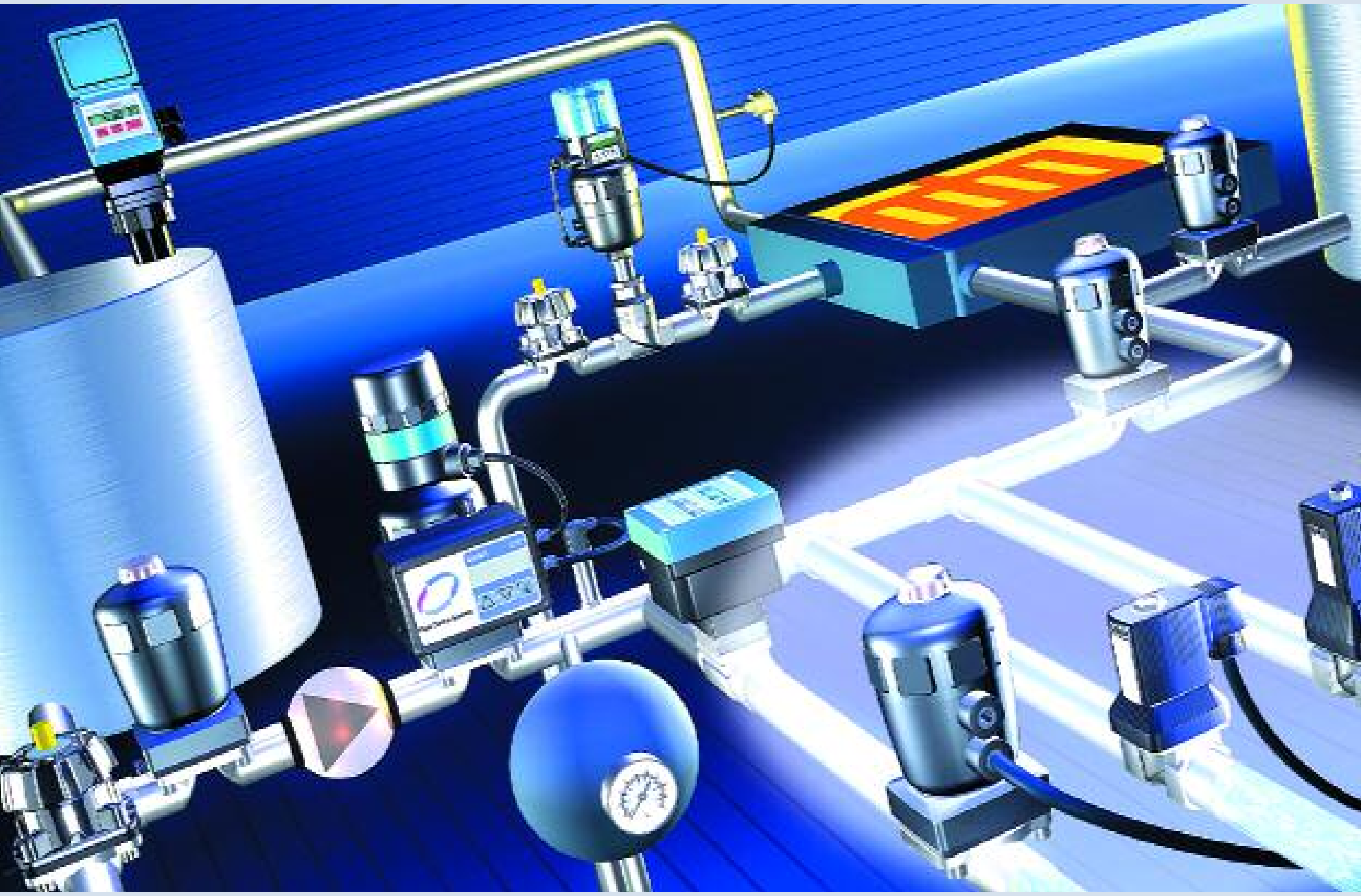
The following applies to gases (super-critical, i.e. $p_2 < \frac{p_1}{2}$):

$$kv = \frac{Q_N}{257 \cdot p_1} \cdot \sqrt{\rho_N \cdot T_1}$$

T_1: $T_1 = 273 + t_1$

After calculating the kv values, the kv_s value is determined with the aid of the tables in the data sheets. The kv_s value should only be slightly higher than the kv_{max} value. Excessive kv_s values diminish the usable rangeability and thus the control response when subject to a weak load. The kv_{min} value must be able to be reached with the selected control valve, i.e. it must lie within the rangeability. If kv_{min} lies below this limit, it should be considered whether to split the quantity over two differently sized valves, whereby the kv_s value of the smaller valve should be approx. 10 % of the kv_s value of the larger valve.

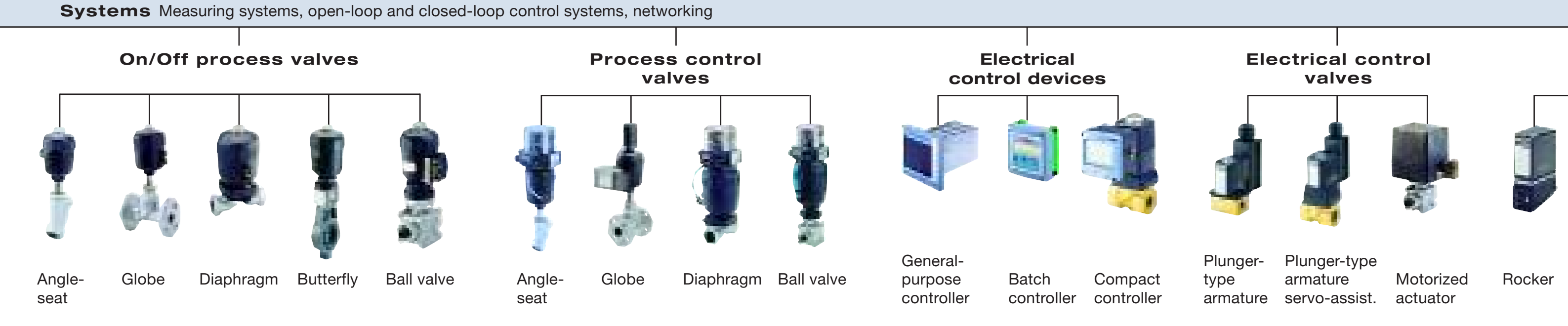
Cut costs, systematically



Innovative automation engineering can only be as good as the economic benefits implemented by it. Even those who promise “everything possible” cannot avoid this equation. There is a good reason why Bürkert always also aims its system technology at economic benefits for the customer. Individually aligned services complement efficient components or complete solutions to form a whole, which, cleverly and systematically, combines what is technically possible with economic success in the long term.

With this in mind and from a user standpoint, optimum components are characterized by the fact that they cannot only be used universally, but that they can also be combined to form a powerful system using standard, simple interfaces. The electrical and fluidic interfaces of our products meet this requirement by allowing an uncomplicated combination of distributed systems which, in turn, feature standard interfaces to the outside world.

Systems Measuring systems, open-loop and closed-loop control systems, networking



The result is maximum efficiency at minimum cost.
This is a systematic approach – and one also based on the experience of a technology leader who is, not purely by chance, acknowledged worldwide as a specialist in the sector of future-orientated automation solutions. Our definition of proximity to the customer is: technology and service for your success!

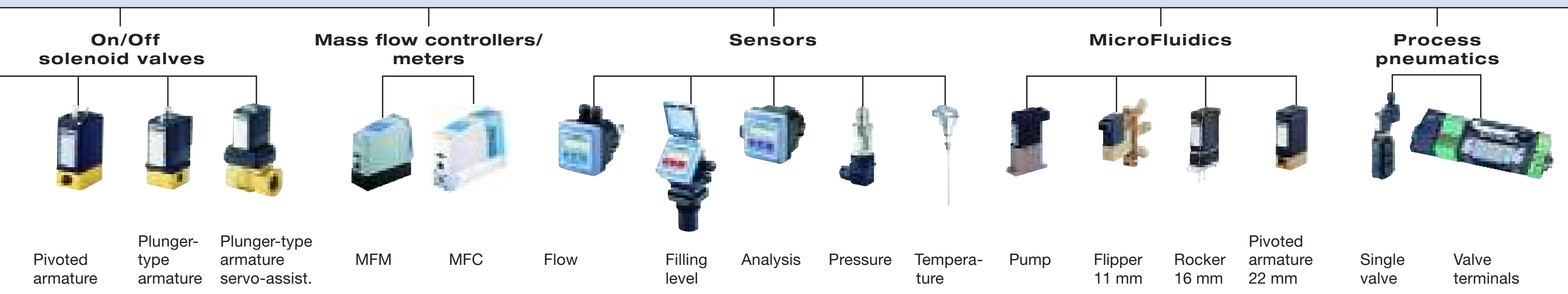
The smart choice
of Fluid Control Systems

This brochure is intended to help you to select the right system solutions from Bürkert. Here as well, you should be aware that knowing what is possible necessitates knowing what you are dealing with. For this reason, we summarize the state-of-the-art technology in order to find a joint basis for promising, systematic solutions.

Sequences are controlled with open-loop control systems and flow rates, temperatures, filling levels and pressures must be controlled with closed-loop control systems. Conductivities, pH values and other chemical variables must be set. These are all the various requirements put on a modern closed-loop flow-rate control system. By way of example, we shall demonstrate how a system can be implemented technically and systematically – with products from our range:

- Sensors
- Controllers
- Control systems
- Control elements and actuators.

A detailed presentation of the efficiency of our system components technically bears witness as to exactly how Bürkert efficiently passes on its competence to the user. Experts may therefore skip through many basic parts of the text but, nevertheless, they cannot overlook one thing: Bürkert technology means more than just technology for flow-rate control. We also keep your costs under control.



Paste production

Task

Three components – two fluids and one powder – are required for manufacturing a paste. The flow rate of the two fluids must be controlled in a specific ratio. The powder is added in proportion to the flow rate.

Solution

The quantity of fluid 1 is detected by means of a flow-rate measuring instrument and controlled continuously by a globe control valve. The lower quantity of fluid 2 is also measured and controlled by a second globe control valve in a given ratio with respect to the flow rate of fluid 1. Fluids and powder are mixed in a mixing vat. The quantity of the paste pumped from the mixing vat is detected with a magnetic inductive flow meter and controlled by a general-purpose controller with a stainless steel diaphragm valve.

The set-point values of the closed-loop flow-rate control system for fluid 1, the feed velocity of the powder, the speed of rotation of the agitator and the paste dose are output via an electric/pneumatic automation system. The set-point value of the closed-loop flow-rate control system for fluid 2 is generated directly in the positioner of the control valve as a function of the flow rate of fluid 1. The flow rate of fluid 2 is controlled in the required ratio via the process controller integrated in the positioner. In addition, pneumatically operated on/off valves controlled directly by the automation system are fitted in all of the system's delivery lines.

I N G

Type 8045

MID flow transmitter

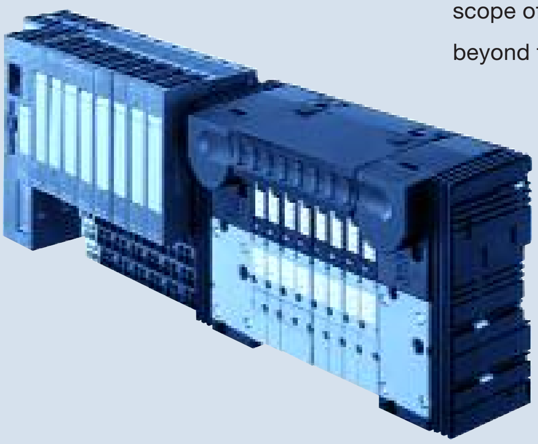
The magnetic inductive flow transmitter has no moving parts and is thus also suitable for use in contaminated media containing solids. In the range of large nominal diameters, the transmitter is simply plugged into a welding socket fitted beforehand and is then screwed on to provide an excellent price-performance ratio that is independent of nominal diameter.

Flow sensors

	Function		Field of application					Indication		Output				Material		
Measuring method	Continuous measurement	Flow switch	For fluids	Highly viscous media	For gases	Measuring range (fluids) in l/h	Temperature range in °C	Flow indication	Quantity indication	Dosing function	4 ... 20 mA	Pulse output	Limit value output	Brass	Stainless steel	Plastics
Float	•		•		•	1.5 ... 60000	0 ... 100	•					•			•
Paddle		•	•			400 ... 4500	0 ... 100						•	•	•	•
Paddle wheel for low flow rates	•		•			1.5 ... 250	-10 ... 80	•	•	•	•	•	•			•
Paddle wheel	•	•	•			60 ... 4.5 mio	0 ... 160	•	•	•	•	•	•	•	•	•
Magnetic inductive	•		•			10 ... 4.5 mio	0 ... 150	•	•	•	•	•	•		•	•
Oval gear	•	•	•	•		2 ... 21000	0 ... 120	•	•	•	•	•	•		•	•

Bürkert process pneumatics

	Function		Circuit function				Body material						
	direct-acting	servo-assisted	3/2-way	4/2-way	5/2-way	5/3-way	Aluminium	Plastic	Brass	Flow rate	Pressure range	Ex approval	Field bus-enabl.
Pilot valves for direct mounting	•		•					•	•	up to 120 l/min	0–10 bar	•	
Single valves	•	•	•	•	•	•	•	•		up to 1,600 l/min	Vacuum up to 10 bar	•	•
NAMUR valves	•	•	•	•	•	•	•	•		up to 1,600 l/min	0–10 bar	•	•
Valve blocks	•	•	•	•	•	•	•	•		up to 1,300 l/min	Vacuum up to 10 bar	•	
Valve terminals	•	•	•	•	•	•	•	•		up to 1,300 l/min	Vacuum up to 10 bar	•	•



Type 8644

AirLINE electrical and pneumatic automation system

The AirLINE electrical/pneumatic automation system is a modular-design, distributed input/output system for electrical and pneumatic signals. Its scope of performance extends well beyond that of a valve terminal.

Besides pneumatic modules, an extensive, cross-manufacturer range of electrical input/output modules, safety modules, actuator modules and control modules, is available.

Both the electrical modules and the pneumatic modules can be interconnected by a very simple snap-on mechanism. There is no need for cross-wiring, drastically cutting installation costs and the number of possible fault sources.

Flow-rate control on an industrial automat

Task

An industrial automatic wash system must be filled with a preset quantity of wash water. In addition to the wash water, it is necessary to provide rinse water at a constant volume flow.

Solution

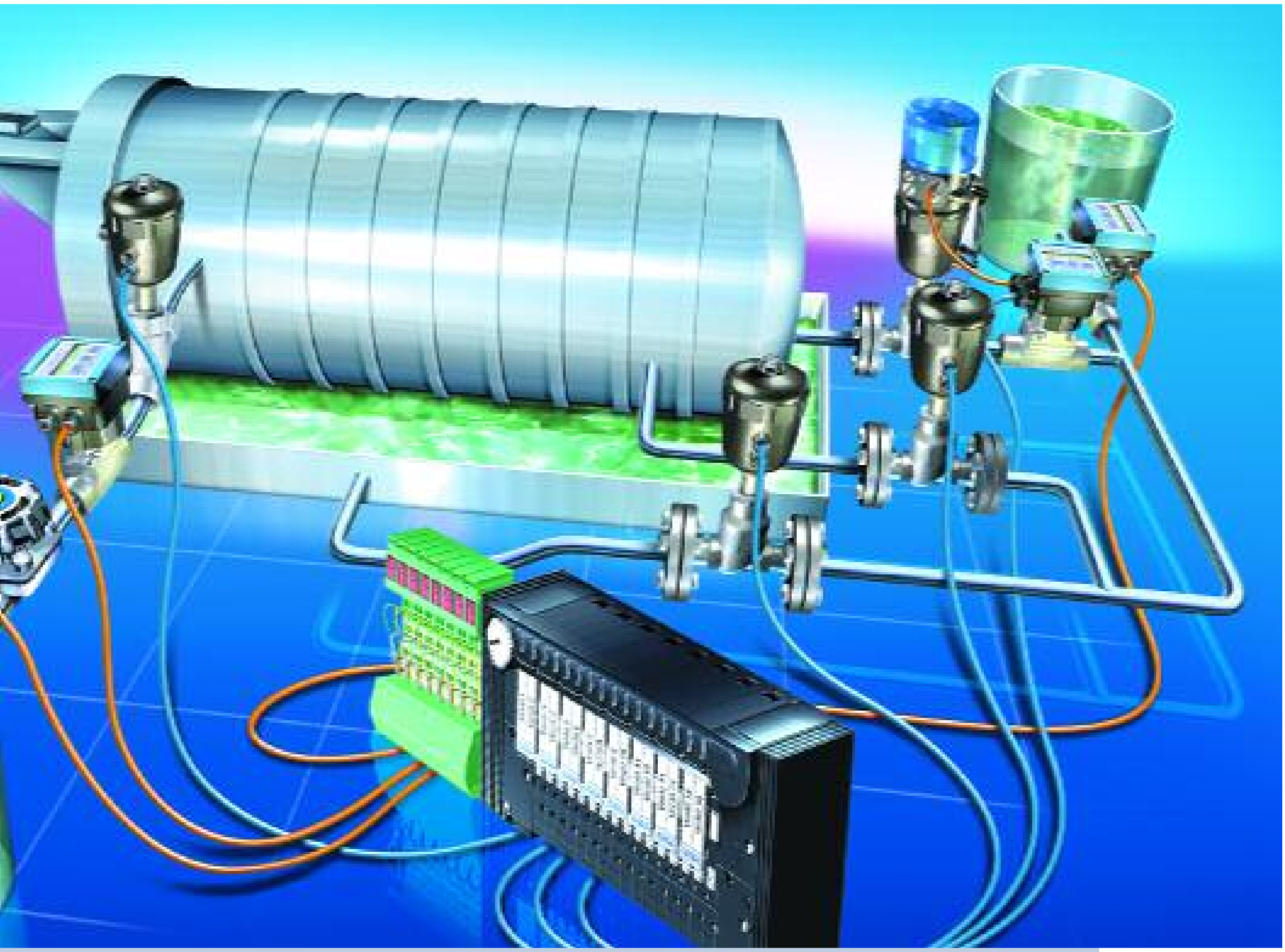
The washing drum of an industrial automatic wash system is embedded in several washing chambers and transports the linen to be washed from chamber to chamber by rotation.

A preset wash water stream is added to the first chamber via an angle-seat valve. The wash water is supplied from a supply tank whose fluid level is monitored by means of an ultrasonic level transmitter. The quantity of water flowing is detected by means of a magnetic inductive flow transmitter.

Rinse water is added in reverse flow to the direction of the wash water via the last chambers. A partial stream is supplied uncontrolled via a globe valve. The second partial stream of rinse water is controlled via a globe control valve so that the total stream pumped from a supply tank and required by the wash process is achieved. The controlled partial stream and total stream of water are measured via magnetic inductive flow transmitters. The overflowing water from an overflow tank is admixed to the rinse water via a globe valve, thus achieving a closed rinse circuit.

D O S

ic wash system



I N G

Bürkert process valves

	Nominal diameter	Oper. press.	Function		Mode of actuation					Body material				EEx
	mm	bar	on/off	continuous	pneumatic	electropneum.	solen. actuator	motor. actuator	manual	SS	Brass	Casting	Plastic	Approval
Diaphragm	8–100	10	•	•	•	•			•	•			•	•
Globe	0.3–100	16	•	•	•	•	•		•	•	•	•		•
Angle-seat	13–65	16	•	•	•	•	•		•	•	•			•
Butterfly	50–100	10	•	•	•	•		•		•		•	•	•
Ball valve	8–80	64	•	•	•	•		•	•	•	•		•	•

Type 2712/8630

Pneumatically operated globe control valve with digital TopControl Continuous positioner

The control response and adaptation of the TopControl Continuous intelligent electropneumatic positioner are optimized for combination with the globe control valve. Autotune function and the following options

- integrated process controller (PID response)
- analog feedback
- binary inputs and outputs
- integrable limit switches

round out the range of features. It can be interfaced to field bus communication with PROFIBUS DP and DeviceNet protocols.

Bürkert positioners/control heads

	Digital electronics	2-wire device	3-wire device	Display	Process controller (PID)	Stand. signal (4...20mA)	Feedback indicator	Analog feedback sign.	Binary input/output	Field bus	HART protocol	Bürkert process valves	Explosion protection
Positioners for lift actuator													
single-acting	•	•	•	•	•	•	•	•	•	•	•	•	•
double-acting	•	•	•	•	•	•	•	•	•	•	•	•	•
Positioners for swivel actuator													
single-acting	•	•	•	•	•	•	•	•	•	•	•	•	•
double-acting	•	•	•	•	•	•	•	•	•	•	•	•	•
Control head* for lift actuator													
single-acting							•			•		•	•
double-acting							•			•		•	•
seat lift							•			•		•	
Control head* for swivel actuator													
single-acting							•			•		•	•
double-acting							•			•		•	•

* Electrical/pneumatic control unit

Type 2012

Pneumatically operated globe control valve

Only 316L stainless steel is used for the body of the globe control valve. A virtually unlimited range of application is achieved by the fact that it can be equipped with all popular connection variants and can be customized, and that in addition, these customized versions can be combined. Various seat reductions per nominal connection diameter allow optimum adaptation of the valve to the relevant process.

Pressure control in a fuel cell

Task

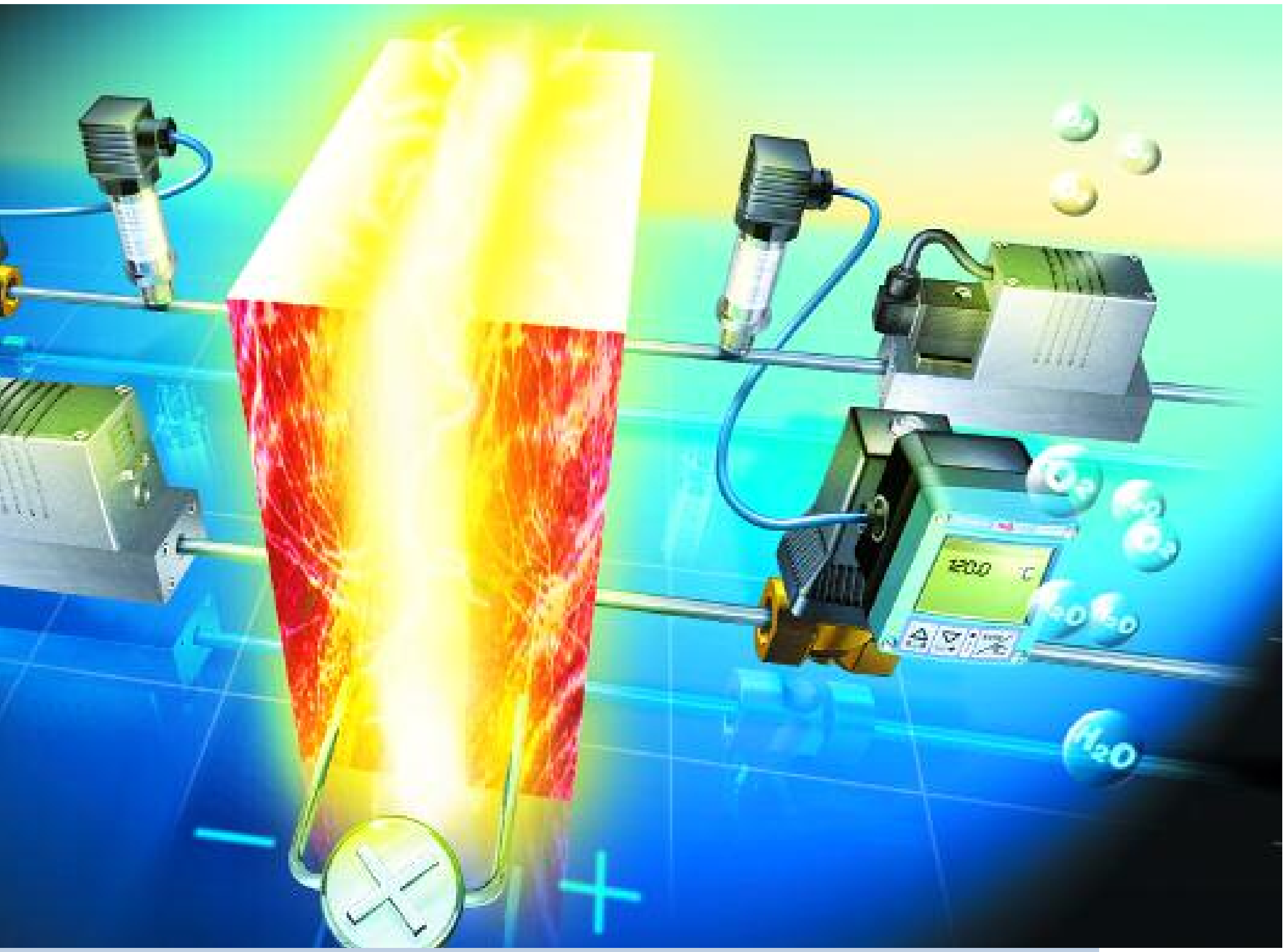
Electrical power is obtained from hydrogen and oxygen in a fuel cell. The two gases have to be controlled depending on current demand and the fuel cell pressure.

Solution

The fuel cell requires hydrogen and oxygen in order to produce energy. Oxygen is obtained from the air. More or less hydrogen is consumed depending on current demand. This quantity is measured by means of a mass flow meter at the inlet to the cell. The air quantity must be readjusted on the basis of the stoichiometric ratio of the process equation. This is made possible by a mass flow controller at the oxygen or air inlet to the cell whose set-point value results from the actual hydrogen quantity. Both gases are then available in the right ratio in the fuel cell. When the cell is in idle state, a minimum hydrogen flow must always be guaranteed, which is implemented by an additional mass flow controller at the outlet of the cell.

Two closed-loop pressure control systems with proportional valves and compact pressure controllers are subordinate to these closed-loop flow-rate control systems. This pressure control system maintains the pressures for hydrogen and air at the same level, ensuring that the cell's separating membrane is not destroyed and that the cell is maintained at its operating pressure. The pressure control for hydrogen is performed at the inlet to the cell while the air is controlled at the outlet.

C O N



T R O L

Type 8716/8706

Mass flow control and mass flow measurement of gases

The mass flow meters/controllers for nominal flow rates up to 1,500 lN/min measure/control neutral, non-contaminated gases, such as air, O_2, N_2, CO_2, H_2, noble gases, hydrocarbons or ammonia, thermally and directly in the main flow. The measuring principle results in incomparably high dynamics and low sensitivity to contamination and dirt. An electronic zero switch-off function and the valve design allow a hermetically sealed function. Besides conventional accuracy, this mass flow controller also provides high reproducibility. The option for integration in a field bus system simplifies installation planning.

Bürkert electronic open-loop controllers and measuring instruments

	Controller				Input					Output				
	PID controller	P-/PI controller	2-point contr.	3-point contr.	Stand. signal	Binary	Frequency	Temperature	Ext. set-point	Stand. signal	Binary	PWM	Pulse	Relay
Controllers														
General-purpose	•	•			•	•	•	•	•	•		•		•
Temperature	•	•	•	•				•	•			•		•
Flow rate		•					•		•			•		
Flow pressure		•			•				•			•		
pH value	•	•	•	•				•		•			•	•
Conductivity			•	•				•						•
Open-loop control														
Dosing control						•	•		•		•			•
Time control						•								•

Type 6023/ 8624

Flow-pressure controller

The flow-pressure controller, consisting of a PI controller and solenoid-operated positioning valve, serves the purpose of closed-loop pressure control of flowing gases and fluids. The set-point value can be preset via buttons or an analog input signal. The unit can be easily programmed and scaled and features an analog actual value input for the pressure sensor signal. An adjustable zero switch-off function and a soft seal in the positioning valve allow a hermetically sealed function. Low hysteresis, high reproducibility and good response sensitivity are typical characteristics of the positioning valve, which is also used for industrial vacuum and which is normally closed (closed when deenergized).

Bürkert mass flow controllers MFC and mass flow meters MFM

	Measuring principle/ nominal flow rate Q_{nenn}	Operating pressure/ nominal pressure	Reproducibility	Accuracy	Body materials: Aluminium	Body materials: Stainless steel 1.4305	Port connection: Threaded port	Port connection: Compression fitting	Set-point input	Actual valve output	Binary inputs*	Relay outputs**
Type 8626 MFC Type 8006 MFM	Inline 25 - 1,500 l_N/min	up to 10 bar	±0.5 % of fsv	±1.5% of mv ±0.5% of fsv	•	•	•	•	Stand. sign. RS 232 RS 485 Field bus	Stand. sign. RS 232 RS 485 Field bus	3	2
Type 8716 MFC Type 8706 MFM	Inline 25 - 500 l_N/min	up to 10 bar	±0.5 % of fsv	±1.5% of mv ±0.5% of fsv	•	•	•	•	Stand. sign. RS 232 RS 485 Field bus	Stand. sign. RS 232 RS 485 Field bus	3	2
Type 8712 MFC Type 8702 MFM	CMOSens® Bypass 20 ml_N/min - 50 l_N/min	up to 10 bar	±0.5 % of fsv	±1.0% of mv ±0.5% of fsv		•	•	•	Stand. sign. RS 232 RS 485 Field bus	Stand. sign. RS 232 RS 485 Field bus	3	2
Type 8710 MFC Type 8700 MFM	Bypass (Stand.) 50 ml_N/min - 30 l_N/min	up to 10 bar	±0.5 % of fsv	±1.5% of mv ±0.5% of fsv		•	•	•	Stand. sign. RS 232 RS 485	Stand. sign. RS 232 RS 485	2	1

* Change of operating mode etc. **Limits and errors etc.

Bürkert solenoid valves

	Circuit function: 2/2-way	Circuit function: 3/2-way	Circuit function: 2/2-way proportional	Function: direct-acting	Function: servo-assisted	Body materials: Brass/ red bronze	Body materials: Stainless steel	Body materials: Plastic	Nominal diameters in mm	Port connections	Ex approval	Approvals e.g. UL/UR/CSA
Water and other neutral media	•	•	•	•	•	•	•	•	0.6–65	Sleeve M5 – G 2 1/2 Flange	•	•
Neutral gaseous media	•	•	•	•	•	•	•		0.4–65	Sleeve M5 – G 2 1/2 Flange	•	•
Aggressive media	•	•		•	•	•	•	•	0.6–50	Threaded couplings Fusion/solvent spigots Flange	•	•
High press. up to 250 bar	•			•	•	•	•		1–12	G 1/8–G 1/2	•	
Steam	•			•	•	•			2–50	G 1/4–G 2 Flange		•
MicroFluidics for biotechnology, medical technology a. analysis technology	•	•		•			•	•	0.4–4	G 1/8–G 1/4, hose Flange, UNF	•	•

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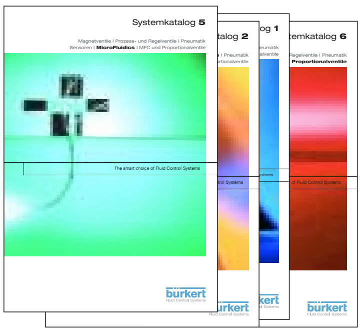

Technical data sheets

Detailed technical information for checking specific suitability. In addition, all the data needed for direct ordering.

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