System solutions: Temperature control

The smart choice of Fluid Control Systems

bürkert
Fluid Control Systems

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The temperature control loop

Besides being used in industrial installations and machines, temperature control loops can be found in many types of equipment, devices and appliances that make our life more comfortable and convenient. For example, temperature control loops are used for setting the temperature and air conditioning levels in buildings, rooms and vehicles, utilized in coffee machines, irons, refrigerators and for adjusting the desired water temperature in the bath or shower.

Generally, these control systems are very simple control systems. If the actual temperature differs from the required temperature, either a heater or a cooler is switched on and is switched off again when the required temperature is reached (2-point or 3-point closed-loop control system). Such control loops can generally be implemented with very simple components. In contrast, the ever-more stringent demands made on product quality and environmental compatibility of processes in technical and industrial applications lead to stricter requirements on the accuracy and speed of temperature control loops.

The individual components must be intermatched as well as matched to the installation in order to obtain a control loop that operates optimally as regards accuracy, stability and speed. Like all control loops, a temperature control loop, in principle, consists of the following components:

- The controlled system, the respective installation or machine to be controlled. In virtually all cases, this is a given factor and cannot be changed. Generally, the art is to design a control system which meets the requirements of the situation.

- The temperature sensor or temperature measuring instrument for detecting the controlled variable or the auxiliary measured variables. Its measuring range, accuracy and reproducibility must be coordinated with the application. The pressures obtained in the installation or machine and the properties of the medium must also be taken into consideration. The output signal of the sensor must match the controller being used transducers may be required.

- The controller. Its principle of operation and structure (2-point, 3-point, P, PD, PI or PID) must match the application and the required quality of the closed-loop control system. The parameters have to be coordinated with the control loop.

- The final control element or actuator, which intervenes, via the controller, in the medium or energy streams of the installation. An extremely wide variety of control elements/actuators is used, depending on the controlled system. For example, electrical switches and power controllers in applications with electric heaters, pilot valves or control valves in water or steam-heated installations. (Process) valves in a broad variety of design (globe valves, angle-seat valves, diaphragm valves, ball valves or butterfly valves) are used to set fluidic process variables. These final control elements or actuators must be selected and rated in line with the controller used (continuous-action or switching), the required nominal diameter (kv value), the medium properties (materials coming into contact with the process) as well as the pressure and temperature ranges. They must be adjusted to the requirements of the relevant applications.

1. Temperature measuring instruments/ temperature sensors

The closed-loop control system, and thus the detection or measurement of temperatures, is of major significance in this very wide range of processes, for example, in installations in the chemical and pharmaceutical sectors, in medical devices or in vehicles and building air conditioning systems.

The styles and physical principles of action of the relevant sensors used are just as diverse as the fields of application of temperature measurement. There is no such thing as a general-purpose measuring instrument or sensor. The requirements differ depending on the application:

- measuring range
- accuracy
- dynamic behavior/response behavior
- overall size
- measurement with/without physical contact
- mechanical/chemical resistance
- the price.

Depending on the relevant, specific structure, temperature sensors have the task of converting a measurable temperature variable to an electrical signal (current, voltage or resistance). Most sensors used industrially can be equipped with an additional electronic module (transmitter) which converts the original output signal of the sensors to a standard electrical signal.

The table below shows an overview of the most popular sensors for temperature measurement and their basic characteristics and fields of application.

Sensor type	Characteristics	Fields of application
NTC	Output variable: electrical resistance NTC means **N**egative **T**emperature **C**oefficient, i.e. the electrical resistance of the NTC decreases with increasing temperature. NTCs are made of polycrystalline mixed oxide ceramics. Typical temperature range: -50 °C… +100 °C High offset coefficient, i.e. great change in resistance with temperature, good control response. Low accuracy; NTCs are not suitable for precision measurements. Poor reproducibility. This greatly impairs interchangeability of the sensors.	Plastics industry Automotive engineering Mobile measuring instruments Medical devices In addition to measurement tasks, NTCs are also used in the following applications: - Temperature compensation of coils - Working point stabilization of transistors - Overtemperature cut-outs
PTC KTY Silicon sensors	Output variable: electrical resistance The silicon sensors have a positive temperature coefficient. Their electrical resistance increases with temperature. They have an approximately linear characteristic. Typical temperature range: -50 °C… +200 °C High offset coefficient, i.e. large change in resistance with temperature, good control response. Higher accuracy and reproducibility than with NTCs. However, not suitable for precision measurements.	Industrial measurement and control systems Automotive engineering Medical technology Building/Facility services management and air conditioning Overtemperature cut-out for motors, generators and transformers

Sensor type	Characteristics	Fields of application
Resistance thermometer Nickel (Ni) and platinum (Pt) measuring resistors	Output variable: electrical resistance Nickel and platinum resistance thermometers have a positive temperature coefficient; their resistance increases with increasing temperature. Depending on the nominal value (resistance value at 0 °C), we talk of Pt/Ni100, Pt/Ni500 or Pt/Ni1000 sensors. The numerical value indicates the resistance value in Ω. While nickel sensors are less costly and have a higher measurable variable sensitivity than platinum sensors, they also have the following disadvantages: - lower temperature range - poorer corrosion resistance - poorer accuracy or linearity - more complex to produce. Typical measuring range, platinum thermometer: -200°C ... +850°C Typical measuring range, nickel thermometer: -60°C ... +240°C	Can be used universally and virtually in all fields of application, specifically in applications requiring high accuracy and reproducibility. Resistance thermometers are available in a wide variety of enclosure designs. Some of them are described or stipulated by standards.
Thermocouples	Thermocouples are based on the Seebeck effect. The Seebeck effect states that a voltage which depends on the temperature of the contact point is produced at the point of contact of two different metals. A thermocouple consists of two wires welded together at points. When this junction is heated, a voltage called the “thermal e.m.f.” is produced at the open ends. Thermocouples are connected to the evaluation unit or controller either directly or via equalizing conductors. This connecting point is referred to as reference junction. The temperature measured by the thermocouple or its output voltage is not directly proportional to the temperature of the measuring junction, but is proportional to the temperature differential between the measuring junction and reference junction. That means that the temperature of the reference junction must be constant or has to be measured and compensated for accordingly. The reference junction compensation circuit is generally incorporated in the evaluation and control unit. Thermocouples have the following characteristics: - good accuracy - good reproducibility - very high dynamics, depending on design. An extremely wide variety of thermocouples (metal combinations) is used depending on application. Type J, material: Fe – CuNi Temperature range: -40° ... +750 °C - high thermal e.m.f. coefficient, i.e. high resolution - iron (Fe) is at high risk of corrosion - very low-cost.	Can be used universally virtually in all fields of application. Specifically in applications requiring a good dynamic behavior of the sensor. Thermocouples are available in a wide variety of (enclosure) designs. Some of them are described or stipulated by standards.

Sensor type	Characteristics	Fields of application
Thermocouples	Type T, material: Cu – CuNi Temperature range: -40 °C ... +350 °C - high thermal e.m.f. coefficient, i.e. high resolution - copper (Cu) is at risk of corrosion at high temperatures - very low-cost. Type K, Material: NiCr – Ni Temperature range: -200 °C ... +1,200 °C - low thermal e.m.f. coefficient, i.e. low resolution, used preferably for high temperatures - scaling at high temperatures. Type E, material: NiCr – CuNi Temperature range: -200 °C ... +900 °C - low thermal e.m.f. coefficient, i.e. low resolution, used preferably at high temperatures - good chemical resistance. Type R, material: Pt10Rh – Pt Type S, material: Pt13Rh – Pt Temperature range: -40 °C ... +1,600 °C - highly accurate, very good reproducibility - low thermal e.m.f. coefficient, i.e. low resolution, used preferably at high temperatures - good chemical resistance - very expensive. If operating conditions allow, thermocouples can be used directly as unsheathed components. In the simplest case, the contact point is the measuring sensor directly. In aggressive environments, the elements are protected by sheathing.	
Pyrometers	Unlike the measuring methods or sensors discussed above, which must come into contact with the body to be measured, pyrometers operate without physical contact. The pyrometer measures the temperature via the heat dissipated by the bodies. Besides depending on its temperature, the thermal radiation of a body depends on its ability to radiate heat (emissivity), i.e. on its surface characteristics and color. Since the emissivity differs from measured object to measured object, a pyrometer must be calibrated for the relevant application. Ideal prerequisites for measurement with pyrometers include constant conditions concerning color, shape, surface, condition of the measured object and the measurement distance. In addition, it must be ensured that the pyrometer does not detect extraneous radiation, i.e. thermal radiation from other bodies or reflected radiation from the body to be measured. Typical measuring ranges: -50 °C ... +3,000 °C	Pyrometers are used whenever measuring objects or fluids with direct contact is difficult: - sticky, adhering media - very hot surfaces - moving objects - parts which are not easily accessible - aggressive media and environments - very small objects with low mass - sensitive surfaces.

2. Controllers

The aim of a closed-loop control system is to have the control loop operate stably and have the actual value – if malfunctions occur or the set-point value has changed – be corrected to the given set-point value as quickly and accurately as possible.

In order to obtain this behavior, the individual components of a control loop cannot be considered in isolation from each other. It is necessary to select a controller that matches the control system and with which a stable control response is achieved by appropriately setting its parameters.

The table below shows which controller types can be used for closed-loop temperature control systems. The information given is based on observations of the dynamic response and stability of the control loops and on empirical values.

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

Continuous-action controllers			
P	**PD**	**PI**	**PID**
permanent control deviation		no permanent control deviation	
conditionally suit.	conditionally suit.	suitable	suit. f. more stringent demands

Selection of the appropriate controller is only the prerequisite for correct operation of the control loop. It is only when the controller parameters are set appropriately that the required stability or control quality can be achieved. Please refer to our “Competences” brochure for information on how to choose the appropriate parameters.

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 switchover 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 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 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 m³/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 kv_s 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},
$\Delta p_{(max)} \rightarrow kv_{min}$

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.

The following applies to cold water:

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

Q: Volumetric flow rate in m³/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/m³

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

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

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-critcal, i.e. $p_2 < \frac{p_1}{2}$):

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

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

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

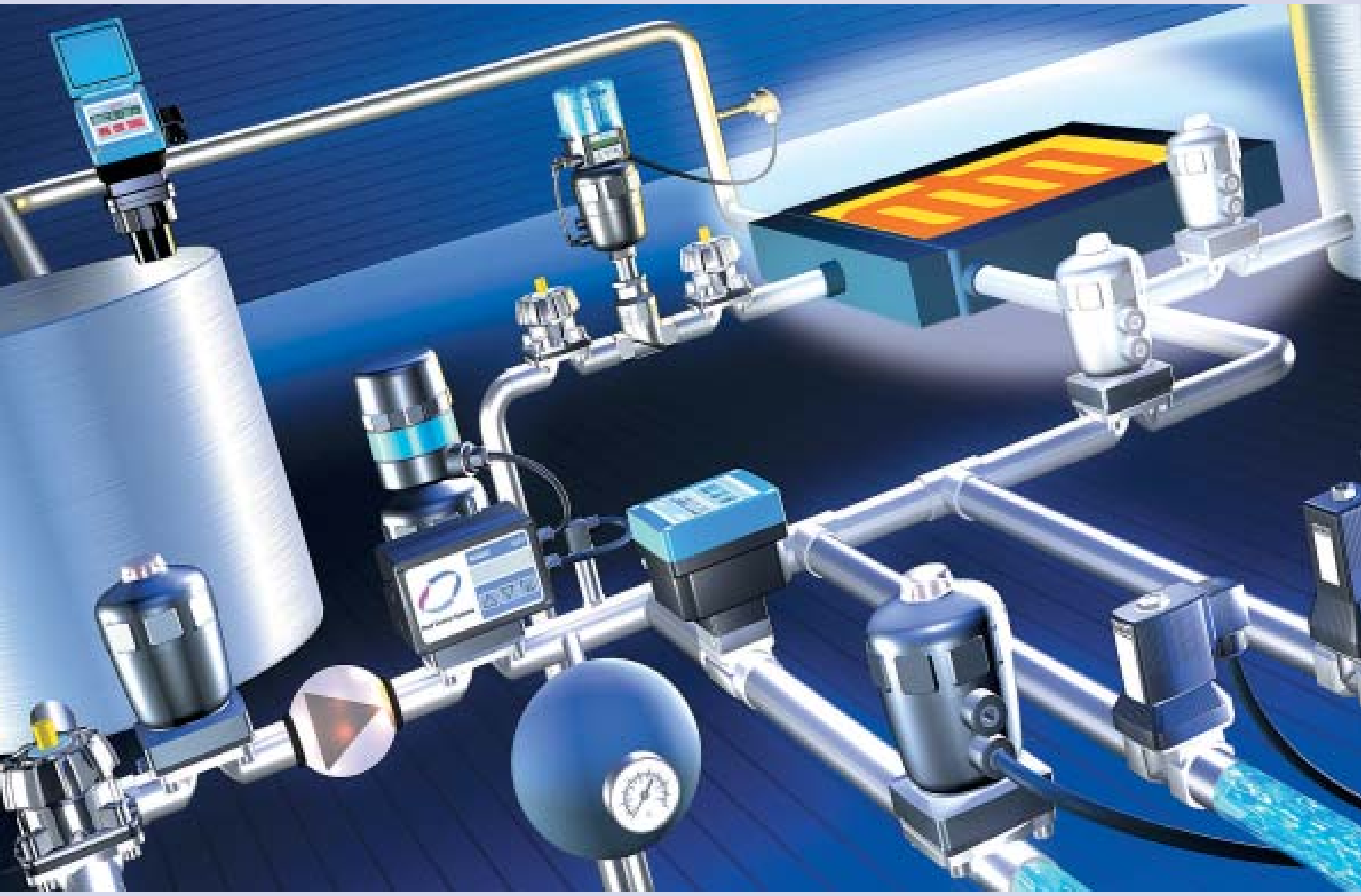
Q_N: Volumetric flow rate in Nm³/h
ρ_N: Standard density in kg/m³ (standard state: 0 °C and 1013 mbar)

The following applies to gases (super-critcal, 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: $T_1 = 273K + t_1$

Hot on meeting tomorrow's challenges.



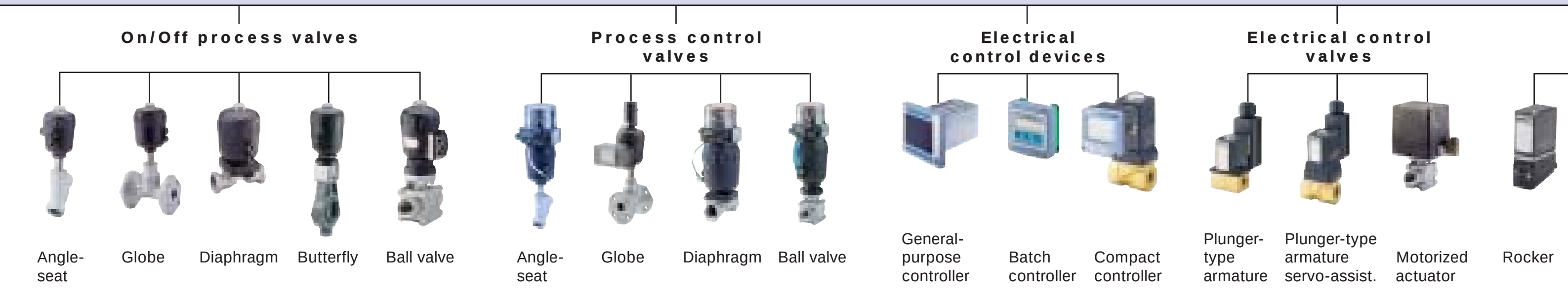
The impetus of technological revolution and change is at full throttle. What is considered "modern" engineering knowledge becomes practically outdated every seven years. The pace of innovation is breathtaking and specializations are branching off into finer and finer details. In these times, it is heartening to know you have a partner at your side who keeps a cool head.

A company whose integral and systematic approaches contrasts conventional, product-specific alignment.

We can competently cope with your problems concerning measuring or control systems, regardless of the type of problem or specific industry involved. With our technologically leading competence, we solve the problem completely, leaving no questions open. You can be sure with Bürkert systems engineering: you never stand alone! Our integral approach and all-in solutions from one source afford you clear advantages in temperature control.

We solve control problems systematically, where they occur. This facilitates commissioning and enhances

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



Systematically

availability and, ultimately, local control loops can be integrated via field bus into any automation concept.

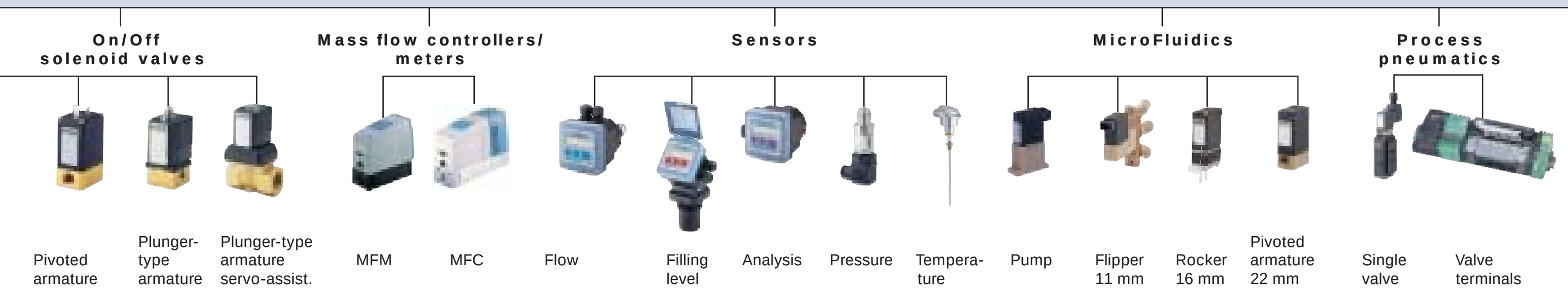
A hot tip: Benefit from the entire range of our supplementary services! From consultancy and planning through engineering and commissioning, up to training and servicing, our knowledge is at your disposal for optimum control of both temperatures and cost.

This brochure explains everything you need to know about temperature control with Bürkert. With this systematized information, we provide a practical roadmap for making it easier, for you and for us, to create and realize joint solutions.

Take our word on it. We are burning to program your success!

The smart choice of Fluid Control Systems

Future-orientated temperature control requires more than just technical implementation of measurement and control functions. The right components are just one part of the problem to be solved. Optimally intermatching of these components is another. By “all-in solution” we mean even more: a system package comprising innovative technology and individual services that safeguards your success. Systematic performance, from individual components to project planning of an installation up to the issue of how to practically integrate the ecological aspect.
What can we do for you?



Mold cooling

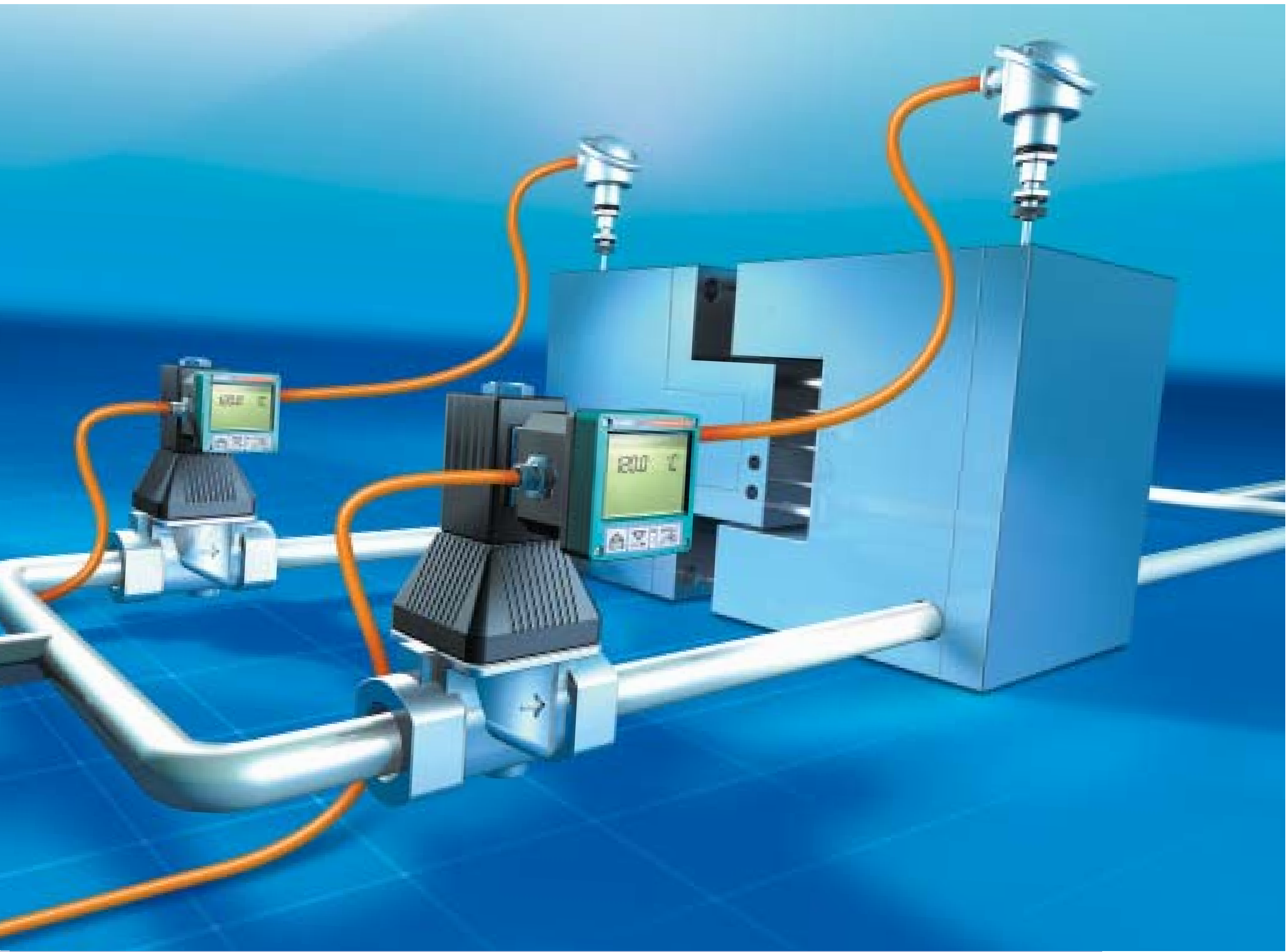
Task

Injection molds for plastics processing must be heated before injection molding. The molds must be cooled after molding to facilitate hardening and part ejection.

Solution

The temperatures of the each of the two halves of the injection mold are controlled independently. The molds are heated electrically by means of cartridge heaters incorporated in the mold. Cooling water is pumped through the two mold halves in order to cool the molds. The temperatures are measured with resistance thermometers. These actual temperature values are supplied to the temperature controllers, which, depending on the pre-settings, activate either the solenoid-operated control or proportional valves incorporated in the cooling water circuits.

The controllers are mounted directly on the proportional valves. The set-point presetting is performed locally using the buttons of the controllers, or the set-point value is preset externally via a standard signal.



L I N G

Type ST20, PT100

Temperature sensor

Series ST20 temperature sensors are designed as resistance thermometers. They consist of a process probe, connection head and protective tubes in various designs. An large variety of process connections is available.
If the measurement signal needs to be transmitted over long distances or if the control or evaluation unit being used does not have an input for direct connection of a resistance thermometer, a transmitter circuitry that generates a standard electrical signal can be incorporated directly in the connection head.

Type 8400, PT100

Temperature transmitter

Our microprocessor-controlled temperature switches are used for temperature indication and monitoring or in simple, 2-point temperature control circuits. They feature a local display and operating keys.

Incorporated relays signal the deviation from the set or externally preset setpoint value or, if the unit is used as a 2-point controller, they control a final control element or actuator. In addition, a 4 – 20 mA standard signal output is available. The transmitter can also be combined with customer-specific PT100 measuring sensors.

Temperature sensors

Style	Measuring range	Pressure range	Mounting length	Output signal Mechanical construction	1 x PT1000, 2-wire	1 x PT1000, 3-wire	2 x PT1000, 2-wire	4 ... 20mA	Switching output	Measured val. display	Without protect. tube	With protective tube
Screw-in resistance thermometer	-50 ... +500 C°	0 ... 100 bar	31 ... 510 mm		•	•	•	•	•	•	•	•
Plug-in resistance thermometer	-50 ... +500 C°	0 ... 50 bar	100 ... 500 mm		•	•	•	•			•	

Type 6223/8625
Servo-assisted proportional valve with attached compact temperature controller

Series 6223 servo-assisted, solenoid-operated proportional valves feature good control response and low hysteresis. The mechanical construction in the form of a servo-assisted valve makes it possible to implement large nominal diameters or high kv values with low electrical drive power values. In addition to the servo-assisted proportional valves, direct-acting proportional valves offer a broad application scope for dealing with low flow rates, high pressures, fast control response or low overall volume.

Use of the compact temperature controller integrated directly in the connector socket produces a high-performance control system. The controller is mounted directly on the proportional valve and temperature sensors are connected directly to the controller. Set-point presetting is performed using the keypad/display or externally by means of an electrical standard signal. Along with the temperature controller, this series of controllers comprises corresponding devices for control of pressure and flow rate.

Solenoid valves

	Circuit function			Function		Body material						
	2/2-way	3/2-way	2/2-way proportional	direct-acting	servo-assisted	Brass/ red bronze	Stainless steel	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	•	•

Tempering water

Task

A reaction or agitator vessel must be filled with a specific, adjustable quantity of water. The flowing water must be controlled at a preset temperature.

Solution

The flowing water is tempered by means of a steam-heated heat exchanger. The temperature of the water is measured with a resistance thermometer at the outlet of the heat exchanger. The quantity of steam for heating the heat exchanger is set via a globe control valve. A positioner with an integrated process controller, which assumes the task of closed-loop temperature control, is attached to the control valve.

The required water volume is dispensed by means of a flow sensor with an integrated dosing control system.

The temperature control system and the dosing control system are activated at the start of a filling operation. The dosing control opens a pneumatically operated diaphragm valve. When the required water quantity is reached, the valve is closed again and the temperature control system is deactivated.

TEMP

E R I N G

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	63	•	•	•	•		•	•	•	•		•	•

Type 2712/8630

Pneumatically operated globe control valve with attached TopControl continuous positioner

Temperature control systems are frequently subject to very stringent demands as regards the quality of a control valve since the valves in such applications are frequently used to control media containing a high quantity of energy, e.g. steam. With its broad adjustment range, globe control valve Type 2712 is optimally suited to such applications.

A full range of nominal diameters available as cone/seat combinations with metal-to-metal seals or plastic seals as well as the option for reducing the seat nominal diameter always allow optimum matching to the relevant application with liquid and gaseous media or steam.

Together with the Type 8630 TopControl continuous positioner, this produces a powerful closed-loop control system that offers far more than a control valve with “conventional” positioner:

- integrated set-up
- automatic adjustment of positioner and process controller parameters
- integrated process controller for setting up local control loops
- characteristic linearization/adaptation
- field bus interface.

TopControl continuous can also be used in conjunction with our angle-seat valves, diaphragm valves, ball valves and butterfly valves. TopControl ON/OFF, Type 8631, is used for ON/OFF process valves.

Type 2031/6519 NAMUR

Pneumatically operated diaphragm valve with attached pneumatic valve

This diaphragm valve is used in demanding applications in the hygiene and sterile sector, but also in applications subject to contaminated or aggressive, abrasive media. Type 2031 can be universal range of application due to its broad nominal diameter range, various surface qualities, a variety of diaphragm and seal materials and the appropriate process connection design. The valve is controlled in a many different ways, in this case, via a directly mounted pneumatic valve with NAMUR flange, Type 6519.

The mechanical construction as a diaphragm seat valve ensures extremely reliable switching behavior, even after long downtimes. The circuit function is set by means of adapter plates – 3/2 or 5/2-way – for control of single or double-acting actuators.

Positioner/control head

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

Process pneumatics

	Func-tion		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	•	•

Mixing water of differing temperature

Task

A specific volume of water at a pre-settable temperature is to be set or dosed by mixing up to three water quantities of known or measured temperature. Three water circuits (hot water, municipal water and chilled water) are available.

Solution

The temperatures of the three water circuits are measured directly at the tapping points by means of resistance thermometers. On the basis of the measured temperatures and the preset total water quantity, an open-loop control system calculates the volumes to be taken from the individual water circuits. The individual water volumes required are primarily calculated on the basis of economic aspects. The share of municipal water should be as high as possible, since provision of municipal water costs the least.

The calculated partial quantities are dosed via three dosing control systems which receive their set-point value from a control system. The quantities flowing during the dosing operation are detected by means of flow sensors which are connected to the actual value or dosing inputs of the dosing control systems. Dosing is performed by means of two, parallel-connected solenoid valves with differing nominal diameters. At the start of dosing, both valves are open. To avoid overdosing, the larger valve is closed just before the target quantity is reached.
A resistance thermometer in the water tank or mixing tank serves to indicate the mixing temperature.

I N G

Type 6213
2/2-way solenoid valve, servo-assisted for liquids

This servo-assisted solenoid valve features forced lifting so that, unlike conventional, servo-assisted valves, it also switches without differential pressure. With this characteristic, it is representative of numerous options offered by the comprehensive Bürkert range of solenoid valves.

- For neutral liquids and gases: switching and continuous-action, direct-acting and servo-assisted solenoid valves – can be used individually or as modular-structure blocks.
- For aggressive media: solenoid valves with plastic or stainless steel bodies, medium-separated, with mechanical construction appropriate to the application.
- For high-quality applications in medical engineering, biotechnology and analysis systems: special valves with medium separation, low thermal admission to the medium, minimum dead volume and a gap-free, easily flushable inside contour – for filling, dosing, mixing and distributing very small quantities of aggressive or ultra-pure media.

Rounding out this range are system solutions adapted individually to the relevant application.

Solenoid valves

	Circuit function			Function		Body material			Nominal diameters in mm	Port connections	Ex approval	Approvals e.g. UL/UR/CSA
	2/2-way	3/2-way	2/2-way proportional	direct-acting	servo-assisted	Brass/ red bronze	Stainless steel	Plastic				
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	•	•

Electronic open-loop and closed-loop controllers

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

Type 8025 D

Batch controller

In principle, filling containers with liquids or dosing liquids can be done in two ways. The liquid dispensed or the container being filled is weighed continuously. When the required weight is reached, the dosing operation is terminated. One other option is to detect the liquid quantity during dosing by means of a flow sensor and terminate the dosing operation when the required volume is reached.

In the second case, batch controller Type 8025D is used. It features an input for connection of a flow sensor. The input is designed so that all Bürkert flow sensors with pulse or frequency output can be connected directly.

The unit features two relay outputs via which dosing valves are controlled. Only one output and one dosing valve are used for simple dosing tasks. In the case of applications necessitating maximum accuracy, dosing is performed in two steps. In this case, both outputs are used to control both a coarse dosing valve and a fine dosing valve.

The dosing quantity can be preset and a dosing operation can be started directly via the keypad/display of the unit or via binary inputs externally as a preset or control signal.

In addition to the design shown here, which incorporates switch-panel mounting, the batch controller is also available as a compact version, i.e. it is integrated directly into the flow sensor. Flow sensors are available in various styles and with various basic modes of operation, matched to the relevant application.

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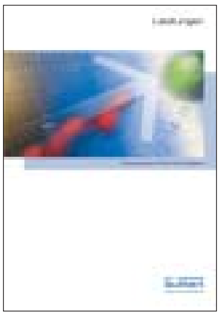
Service brochure

A systematic overview of the range of products and services offered by Bürkert. A network of comprehensive solutions integrating coordinated services.



Competence brochures

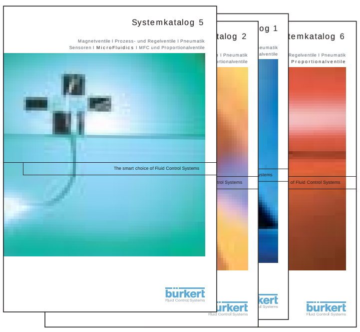
Essential information for the person planning control loops and field bus systems and who wants to ensure basic knowledge of the structure and selection of system components.

Application brochures

Example applications for deriving the appropriate system solution, supplemented by information on product advantages, user advantages and the range of products specifically available.

System catalogs

Background knowledge on product technology, including an up-to-date overview of the current offers. Rounded out with information to help you make your decision on the best application option.



Technical data sheets

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

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