Pumps and valves for CO$_2$ applications.
KSB – your partner for CO₂ applications.

Providing increasingly crucial technologies
If industrial enterprises and energy providers are to achieve their ambitious climate protection goals, they will need to find a way to isolate, transport and safely store or process the CO₂ they produce. The separation and sequestration of CO₂ is known internationally as carbon capture and storage (CCS), and its subsequent use instead of storage is referred to as carbon capture and utilisation (CCU).

The full course of action is a process chain, the links of which consist of carbon capture, compression, transport and injection for subsequent storage or utilisation.

Perfect products, special consultancy
Our long-standing experience makes us your ideal partner for reliably and efficiently finding and implementing individual solutions for all points of the process, for all methods of capture and for all types of plant. As a global market leader for pumps, valves and systems, we also make a perfect partner for all operators, consultants and engineering contractors. With more than 15,000 employees and 160 service centres, we guarantee our customers’ success by providing:

- State-of-the-art products characterised by minimal life cycle costs and an excellent eco-balance
- The kind of power plant engineering experience it takes to implement your particular set of requirements

Give us a call – have a talk with the specialists.
KSB solutions for CO₂ processes

A. CO₂ capturing process
   - Pre-combustion
   - Post-combustion
   - Oxyfuel combustion

B. CO₂ compression
   1. Power plants
   2. Refineries
   3. Cement/Steelworks

C. CO₂ transport and injection

Capture >> Compression >> Transport >> Injection
The **pre-combustion** method.

In the pre-combustion method, the CO₂ is captured prior to combustion. This involves subjecting coal to high temperatures and high pressure in a gasifier, hence converting it to syngas consisting primarily of hydrogen (H₂) and carbon monoxide (CO).

**Energy recovery included**

In a downstream shift reaction, the syngas is converted to hydrogen and CO₂ that can be captured. The hydrogen serves as fuel for generating energy in a gas turbine. Referred to as the integrated gasification combined cycle (IGCC), this process is best suited for new plants.
KSB pumps and valves:

A Pump for cooling-water circuits (burners)
B Pump for cooling-water circuits (syngas)
C Pump for flue gas scrubbing
D Pump for feed-water and fresh-water applications
E Pump for black-water treatment

1 Shut-off valve
2 Check valve
The post-combustion method.

The post-combustion process is a method of separating CO$_2$ out of flue gas from a combustion process. Several different variants are available, and there are physical as well as chemical methods for scrubbing the flue gas.

**Readily retrofitted**

First, the flue gas is relieved of its ash, sulphur and nitrogen oxides and cooled. Then, it is put through a scrubber (absorber), where a solvent captures the CO$_2$. The CO$_2$-laden solvent is then pumped through a desorber, where heat is added to separate the CO$_2$ from the solvent and make it ready for further treatment. The solvent can be returned to the process.
KSB pumps and valves:
A Pump for flue gas scrubbing
B Pump for cooling-water circuits
C Pump for solvent handling
D Pump for solution transport
1 Shut-off valve
2 Check valve

Post-combustion method
Pre-scrubbing

Absorption

Desorption

Flue gas
Pre-scrubber
Blower
NaOH solution tank
Black water
NaOH
Lean solution
Rich solution
Absorber

Desorber

CO2
Condenser
Steam generator
Make-up water
Heater

Absorption Desorption

Water Solution tank
Solvent
The oxyfuel combustion method.

The term oxyfuel derives, of course, from ‘oxygen’ and ‘fuel’. As the name implies, this method of capture relies on the coal being combusted with oxygen instead of the usual air. The first step, then, is to break down the combustion air into oxygen and nitrogen. Fuel burned with oxygen yields a higher concentration of CO₂ in the fuel gas. Downstream, the ash, SO₂, SO₃ and other impurities are removed from the flue gas, and the gas is cooled to such a low temperature, that its water content condenses, leaving behind very pure CO₂ that can be captured, compressed, transported and either stored or further processed.
Steam turbine
ASU (air separation unit)
Oxyfuel-Verfahren
Transformer Generator
Condenser
Flue gas scrubbing
Air
Nitrogen
Recirculation
Flue gas
Oxygen
Fuel
Feed water
Distillation
Feed-water tank
Water
Flue gas

KSB pumps and valves:
A Pump for cooling-water circuits
B Pump for district heating
1 Shut-off valve
2 Check valve
Lower energy costs via pumped compression.

Using a centrifugal pump to compress and convey supercritical fluid CO₂ offers numerous advantages. It enables circumvention of the last compression stages, so that there is less specific compression work and, hence, less energy is required. Since the process takes place at low temperatures, the heat losses are accordingly lower, and the material is not exposed to thermal stress.

The amount of energy needed for compressing CO₂ can be significantly reduced with the aid of a centrifugal pump. The potential savings on energy run as high as 23%.
CO₂ can only be moved over long distances by pipeline or ship. In either case, high-pressure pumps designed especially for such applications are needed.

Specially engineered high-pressure pumps are also needed for the underground injection of CO₂. In this process, CO₂ is injected into subterranean rock strata, the idea being to keep the greenhouse gas from escaping to the atmosphere.

CO₂ can also be injected underground to enable tertiary recovery of crude oil or natural gas, as it increases the pressure prevailing in the oil reservoir and reduces the viscosity of the oil.
KSB’s CO$_2$ test facility has produced solutions for a broad array of CO$_2$ pumping requirements. The facility’s closed stainless-steel test loop can simulate any number of different situations with a single-stage centrifugal pump and collect valuable test results in the process.

As a compressible fluid, CO$_2$ imposes strict criteria on pump systems. The optimal design of such a system requires attention to the course of fluid density between the inlet and outlet of the pump. Such systems also have to be optimally sealed to prevent leakage and resultant ice formation. Double mechanical seals with barrier-fluid pressure control have already been put into successful shakedown operation in the test facility. Other barrier fluids and sealing systems are being tested right now. Also, the test facility’s safety concept applies not only to proper sealing but also includes CO$_2$ detection.

The test facility can be heated and cooled as necessary for measuring and comparing CO$_2$ in different states and mixtures. Admixtures can be injected, and the system pressure can be increased to 100 bar maximum. Temperatures, pressures, volume flow rates, shaft torques and densities are monitored with sensors and compared with existing data. This approach has given rise to a new technique for the appropriate hydraulic design of pumps.
Test results

- In the supercritical range up to 100 bar and for densities beyond 600 kg/m³, the pump maintains a constant output.

- The measured rise in temperature due to compression is in full agreement with the thermodynamic calculations.
With pumps and valves by KSB, you are ideally equipped for any and all CO₂ applications. Technically mature, high-quality products and, not least, our experts’ vast experience guarantee your equipment’s smooth operation.

Every single product means safety and reliability.
<table>
<thead>
<tr>
<th>RPH</th>
<th>Mega CPK</th>
<th>SEZ/SNW/PNW/PHZ/PNZ</th>
<th>ITUR CTN</th>
<th>ISORIA/MAMMOUTH</th>
<th>DANAIS 150</th>
<th>PSA KHG</th>
<th>ECOLINE BLT 150-300</th>
<th>SISTO 20 / SISTO KB</th>
</tr>
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</table>
Pumps for CO₂ applications.

### HGB / HGC® / HGD

Boiler feed pump

- **Design:** Horizontal, radially split, multistage ring-section pump with radial impellers; single or double entry.

- **Applications:** Handling of feed water and condensate in power stations and industrial facilities, generation of pressurised water for bark-peeling machines, descaling equipment, snow guns, etc.

<table>
<thead>
<tr>
<th>DN</th>
<th>40–400</th>
<th>Q [m³/h]</th>
<th>max. 2,300</th>
<th>H [m]</th>
<th>max. 5,300</th>
<th>p [bar]</th>
<th>max. 560</th>
<th>T [°C]</th>
<th>max. 210</th>
<th>n [min⁻¹]</th>
<th>max. 7,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data for 50 Hz operation.</td>
<td></td>
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</table>

### HGM®

Boiler feed pump

- **Design:** Horizontal, radially split, product-lubricated, multistage ring-section pump with radial impellers; axial and radial single-entry inlet.

- **Applications:** Handling of feed water in power stations, boiler feed water and condensate in industrial facilities.

<table>
<thead>
<tr>
<th>DN</th>
<th>25–100</th>
<th>Q [m³/h]</th>
<th>max. 274</th>
<th>H [m]</th>
<th>max. 1,400</th>
<th>p [bar]</th>
<th>max. 140</th>
<th>T [°C]</th>
<th>max. 160</th>
<th>n [min⁻¹]</th>
<th>max. 3,600</th>
</tr>
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<tbody>
<tr>
<td>Data for 50 Hz operation.</td>
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</table>

### CHTR

High pressure pump BBS

High pressure pump API 610

- **Design:** Horizontal, high-pressure barrel-type pump with radial impellers; single and double entry; multistage; with flanges / weld-end nozzles to DIN; API 610 and ANSI.

- **Applications:** In refineries, in the petrochemical industry and in steam generation plants.

<table>
<thead>
<tr>
<th>DN</th>
<th>50–150</th>
<th>Q [m³/h]</th>
<th>max. 900</th>
<th>H [m]</th>
<th>max. 2,500</th>
<th>p [bar]</th>
<th>max. 250</th>
<th>T [°C]</th>
<th>max. 400</th>
<th>n [min⁻¹]</th>
<th>max. 7,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data for 50 Hz operation.</td>
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</table>

### Multitec®

High-pressure pump in ring-section design

- **Design:** Multistage horizontal or vertical centrifugal pump in ring-section design; long-coupled and close-coupled variant; with axial or radial suction nozzle; cast radial impellers. ATEX-compliant version available.

- **Applications:** Water and drinking-water supply systems; general industry; pressure-boosting systems; irrigation systems; in power stations; heating, filter, firefighting, reverse osmosis and washing plants; snow guns; etc.

<table>
<thead>
<tr>
<th>DN</th>
<th>32–150</th>
<th>Q [m³/h]</th>
<th>max. 850</th>
<th>H [m]</th>
<th>max. 630 (1,000)</th>
<th>p [bar]</th>
<th>max. 63 (100)</th>
<th>T [°C]</th>
<th>-10 to 200</th>
<th>n [min⁻¹]</th>
<th>max. 4,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data for 50 Hz operation.</td>
<td></td>
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</table>

### Omega®

Axially split volute casing pump DN 80–350

- **Design:** Single-stage, axially split volute casing pump for horizontal or vertical installation; with double entry radial impeller; mating flanges to DIN EN or ASME.

- **Applications:** For handling water with a low solids content, e.g. in waterworks, irrigation and drainage pumping stations, desalination systems for water extraction, power plants, firefighting systems, shipbuilding and district heating/cooling.

<table>
<thead>
<tr>
<th>DN</th>
<th>80–350</th>
<th>Q [m³/h]</th>
<th>max. 2,880</th>
<th>H [m]</th>
<th>max. 210</th>
<th>p [bar]</th>
<th>max. 25</th>
<th>T [°C]</th>
<th>max. 80</th>
<th>n [min⁻¹]</th>
<th>max. 2,900</th>
</tr>
</thead>
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<tr>
<td>*Temperatures up to 140°C upon request.</td>
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</tbody>
</table>
RDLO® Axially split volute casing pump DN 350–700

- DN: 350–700
- Q [m³/h]: max. 10,000
- H [m]: max. 240
- p [bar]: max. 25
- T [°C]: max. 80
- n [min⁻¹]: max. 1,500

**Design:** Single-stage, axially split volute casing pump for horizontal or vertical installation; with double entry radial impeller; mating flanges to DIN EN or ASME.

**Applications:** For handling water with a low solids content, e.g. in waterworks, irrigation and drainage pumping stations, desalination systems for water extraction, power plants, firefighting systems, shipbuilding and district heating/cooling.

---

Hyamaster also available in 60 Hz

KWP® / KWP®-Bloc Non-clogging impeller centrifugal pump / close-coupled unit

- DN: 40–900 (1,000)
- Q [m³/h]: max. 15,000 (18,000)
- H [m]: max. 100
- p [bar]: max. 10
- T [°C]: -40 to 120 (max. 280)
- n [min⁻¹]: max. 2,900

**Design:** Horizontal, radially split volute casing pump in back pull-out or close-coupled design; single stage; single entry; available with various impeller types: non-clogging impeller, open multi-vane impeller or free-flow impeller. ATEX-compliant version available.

**Applications:** Handling of pretreated sewage, waste water and all types of slurries without stringy substances and pulps up to 5% completely dry.

---

Hyamaster also available in 60 Hz

HPK® / HPK-L® Hot water / thermal oil recirculation pump

- DN: 25–400
- Q [m³/h]: max. 4,150
- H [m]: max. 240
- p [bar]: max. 40
- T [°C]: hot water max. 240
- T [°C]: thermal oil max. 400

**Design:** Horizontal, radially split volute casing pump in back pull-out or close-coupled design; single stage; single entry; available with various impeller types: non-clogging impeller, open multi-vane impeller or free-flow impeller. ATEX-compliant version available.

**Applications:** Handling of hot water and thermal oil in piping or tank systems, particularly in medium-sized and large hot-water heating systems, forced circulation boilers, district heating systems, etc.

---

Hyamaster also available in 60 Hz

HPH® Hot-water recirculation pump

- DN: 40–350
- Q [m³/h]: max. 2,350
- H [m]: max. 225
- p [bar]: max. 110
- T [°C]: max. 320

**Design:** Horizontal, radially split volute casing pump in back pull-out design; single stage; single entry; with centreline pump feet and radial impeller. TÜV certification to TRD as an option. ATEX-compliant version available.

**Applications:** Handling of hot-water in high-pressure hot-water generation plants and for use as boiler feed and recirculation pump.

---

Hyamaster also available in 60 Hz

RPH® OH2 process pump to API 610

- DN: 25–400
- Q [m³/h]: max. 4,150
- H [m]: max. 270
- p [bar]: max. 51
- T [°C]: max. 450

**Design:** Horizontal, radially split volute casing pump in back pull-out design to API 610 (10th edition) or ISO 13709 (heavy duty); with radial impeller; single stage; single entry; centreline pump feet; with inducer, if required. ATEX-compliant version available.

**Applications:** refineries, petrochemical and chemical industry and power stations.

---

Hyamaster also available in 60 Hz
### MegaCPK

<table>
<thead>
<tr>
<th>DN</th>
<th>25–250</th>
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<tbody>
<tr>
<td>Q [m³/h]</td>
<td>max. 1,160</td>
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<tr>
<td>H [m]</td>
<td>max. 162</td>
</tr>
<tr>
<td>p [bar]</td>
<td>max. 25</td>
</tr>
<tr>
<td>T [°C]</td>
<td>max. 400</td>
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</tbody>
</table>

**Design:** Horizontal, radially split volute casing pump in back pull-out design to EN 22 858 / ISO 2858 / ISO 5199; single stage; single entry; with radial impeller. Also available as variant with ‘wet’ shaft. ATEX-compliant version available.

**Applications:** Handling of harsh liquids in the chemical and petrochemical industries as well as in refineries.

### SEZ® / SEZT / PHZ / PNZ

**Cooling-water pump**

<table>
<thead>
<tr>
<th>DN</th>
<th>350–800</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q [m³/h]</td>
<td>max. 9,000</td>
</tr>
<tr>
<td>H [m]</td>
<td>max. 50</td>
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<tr>
<td>p [bar]</td>
<td>max. 10</td>
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<tr>
<td>T [°C]</td>
<td>max. 60</td>
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<tr>
<td>n [min⁻¹]</td>
<td>max. 1,500</td>
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</tbody>
</table>

**Design:** Vertical tubular casing pump with open mixed-flow impeller (SEZ), mixed-flow propeller (PHZ) or axial propeller (PNZ). Pump inlet with bell mouth or suction elbow; pull-out design available; discharge nozzle arranged above or below floor; flanges to DIN or ANSI standards available.

**Applications:** Handling of raw, pure, service and cooling water in industry, water supply systems, power stations and seawater desalination plants.

### SNW / PNW

**Cooling-water pump**

<table>
<thead>
<tr>
<th>DN</th>
<th>40–1,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q [m³/h]</td>
<td>max. 800</td>
</tr>
<tr>
<td>H [m]</td>
<td>max. 93</td>
</tr>
<tr>
<td>p [bar]</td>
<td>max. 16</td>
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<tr>
<td>T [°C]</td>
<td>max. 300</td>
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</tbody>
</table>

**Design:** Vertical tubular casing pump with mixed-flow impeller (SNW) or axial propeller (PNW), single stage, with maintenance-free Residur shaft bearings; discharge nozzle arranged above or below floor.

**Applications:** Irrigation and drainage systems, storm-water pumping stations, handling of raw and pure water, water supply systems and handling of cooling water.

### ITUR CTN

**Chemical vertical shaft submersible pump**

<table>
<thead>
<tr>
<th>DN</th>
<th>25–250</th>
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<tbody>
<tr>
<td>Q [m³/h]</td>
<td>max. 800</td>
</tr>
<tr>
<td>H [m]</td>
<td>max. 93</td>
</tr>
<tr>
<td>p [bar]</td>
<td>max. 16</td>
</tr>
<tr>
<td>T [°C]</td>
<td>max. 300</td>
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</tbody>
</table>

**Design:** Radially split, vertical-shaft submersible pump with double volute for wet and dry installation, single or double stage, single entry, with radial impeller; model that can be heated available. ATEX-compliant version available.

**Applications:** Handling of chemically harsh liquids, also those that are slightly contaminated or with a low solids content; in the chemical and petrochemical industry.

### Valves for CO₂ applications.

### ISORIA® 10–25

<table>
<thead>
<tr>
<th>PN [bar]</th>
<th>10–25</th>
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<tbody>
<tr>
<td>DN</td>
<td>40–1,000</td>
</tr>
<tr>
<td>T [°C]</td>
<td>-10 to 200</td>
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</table>

**Description:** Centred-disc butterfly valve with elastomer liner. With lever, manual gearbox and a pneumatic, electric or hydraulic actuator. Wafer type body (T1), semi-lug type body (T2), full-lug type body (T4) or U-section body with flat faces (T5). Body types T2, T4 and T5 are suitable for downstream dismantling and dead-end service with counter-flange. EN, ASME and JIS connections possible.

**Application:** Shut-off and control duties in all industrial and energy applications.
### Mammouth

<table>
<thead>
<tr>
<th>PN [bar]</th>
<th>6/10/16/20/25</th>
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<tbody>
<tr>
<td>DN</td>
<td>1,000–4,000</td>
</tr>
<tr>
<td>T [°C]</td>
<td>0 to 65</td>
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</tbody>
</table>

**Design:** Centred-disc butterfly valve with elastomer liner. With manual gearbox, electric, hydraulic actuator or counter weight. U-section / double flanged body with flat faces (T5). EN, ASME and JIS connections possible.

**Applications:** Water supply, water treatment, irrigation, disposal, desalination (reverse osmosis, MSF), industry. Cooling circuits, firefighting systems, shipbuilding, steel industry and power stations (water, thermal and nuclear). Shut-off and control duties in all industrial applications.

### DANAïs® 150

<table>
<thead>
<tr>
<th>PN [bar]</th>
<th>max. 25 or 150 or Class 150</th>
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<tbody>
<tr>
<td>DN</td>
<td>50–1,200</td>
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<tr>
<td>T [°C]</td>
<td>-50 to 260</td>
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</tbody>
</table>

**Design:** Double-offset butterfly valve with plastomer seat ring (also in fire-safe design) or metal seat ring. With lever or gearbox, pneumatic or electric or hydraulic actuator. Body made of cast steel or stainless steel. Wafer type body (T1) or full-lug type body (T4). Body type T4 is suitable for dead-end service and downstream dismantling. EN, ASME and JIS connections.

**Applications:** Petroleum, gas, chemical and petrochemical industry, nuclear power stations, sugar industry, paper industry, geothermal energy, shipbuilding, low-pressure steam and vacuum service. All applications requiring offset-disc butterfly valves.

### PSA-KHG

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<tr>
<th>PN</th>
<th>16/25/40/63/100/160/250</th>
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<tbody>
<tr>
<td>DN</td>
<td>15–1,200</td>
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<tr>
<td>T [°C]</td>
<td>-60 to 250</td>
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</table>

**Design:** Flanges (DIN/ASME), butt weld ends, socket weld or threaded ends, metal-seated primary seal, soft secondary seal, double block and bleed, fully welded design and with lever or gearbox.

**Optional:** Polyurethane coating, emergency seal, pneumatic or electric actuators and split body (bolted).

**Applications:** Gases to DVGW Worksheet G260/I and II and combustible liquids, general industry, petrochemical industry and all related industries, power stations, gas lines, gas plants, refineries, pipelines, gas storage facilities and tank farms.

### ECOLINE BLT 150–300

<table>
<thead>
<tr>
<th>Class</th>
<th>150–300</th>
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<tbody>
<tr>
<td>DN</td>
<td>½–8”</td>
</tr>
<tr>
<td>H [m]</td>
<td>max. 225</td>
</tr>
<tr>
<td>T [°C]</td>
<td>-10 to 200</td>
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</tbody>
</table>

**Design:** Two-piece body, full bore, floating ball concept, flanged (RF) and plastomer sealing (also in fire-safe variant). With lever or gearbox, pneumatic or electric actuator. Design as per ASME B 16.34.

**Applications:** General industry, power stations, chemical and petrochemical industry and all associated branches of industry. Paper industry, food industry and pharmaceutical industry.

### SISTO-KB / SISTO-20

<table>
<thead>
<tr>
<th>DN</th>
<th>15–200</th>
</tr>
</thead>
<tbody>
<tr>
<td>T [°C]</td>
<td>-20 to 160</td>
</tr>
<tr>
<td>DIN PIN</td>
<td>10, 16</td>
</tr>
</tbody>
</table>

**Design:** Diaphragm valve with flanges. Top-quality materials and innovative production processes ensure these valves’ high operating reliability and availability. The diaphragm is the only seal element and provides reliable shut-off and sealing to atmosphere while also hermetically sealing all functional parts against the fluid handled.

**Applications:** General industry and power plants. Suitable for service water, air, oil, technical gases, harsh and abrasive products.
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