Desuperheaters for High Temperatures and Pressures
Why desuperheating, and why do today’s Desuperheaters and Turbine-Bypass valves need to be much better than what the World has seen in the past?

High costs of primary energy sources and environmental protection regulations require to operate power and process plants in the most economical way. Operation - flexibility and - availability are critical and mandatory requirements.

Today’s prevalent use of combined cycle plants (CCPP) with very high heat supply temperatures and lower temperatures of heat rejection represents a proven approach in the search of higher thermal efficiencies.

The use of higher steam pressures and temperatures remains a major approach to improve power generation and process plant efficiencies. Newer developments in once-through super- and ultra-supercritical boilers require 100% external HP bypass systems and desuperheaters to perform reliably at operating conditions typically between 600-720°C and 270-350 bar. These plants promise an improved operating flexibility with up to 50+% efficiency and also provide the capability for load cycling over a wide range with variable throttle pressure and reduced start-up flow.

With increased dimensions of major heavy metal components and the pronounced sensitivity of certain advanced HT-materials to high thermal gradients, a better control of non-steady-state temperature conditions (which occur during cycling operation) is required to avoid excessive thermal stresses.

Most of the newer power unit designs operate in a modified variable pressure mode, where the unit is running at constant pressure between 75 and 100% load and variable throttle pressure at lower loads.

The desuperheating of the hot reheat steam to LP exhaust conditions requires frequently water amounts in the order of 25 to 35...% of the inlet steam flow. Only the very best desuperheaters and spray nozzle designs are capable of producing a consistent micro-fine droplet spectrum which guarantees instantaneous evaporation of the water over the entire load range.

It is important to know the possible lifetime of spray water drops, especially if they could potentially hit sensitive parts of the turbine, pipe elbows, diffuser plates, condenser intake tubes or the very impingement-sensitive hot parts in the HRSGs.

TECartec has developed a range of desuperheaters and steam conditioning valves which precisely address today’s very challenging operating conditions and have proven to work in supercritical units and very demanding process environments all over the World.

Probe DSH with 15 individually controlled nozzles.

No moving parts and soft seals in the heat-affected zone.

DSH probe cross section with no moving parts

Control unit based on 25 years of experience
Overview of the TECtemp and TECsteam Range of High Performance Desuperheaters

Tecartec’s range of high performance DSHs was designed for the most demanding applications in today’s Process and Power Plants.

TECtemp Standard and Heavy-Duty Quarter-turn Desuperheater

TECtemp High Temperature Family-Tree

Desuperheater Selection based on the Severity of Service and the Technology-Level of the DSH

Based on the customer’s specific application data TECartec will suggest the optimal solution to handle the most challenging application.

TECsteam (steam-assisted)
## DSH/SCV/TBV Product Selection

<table>
<thead>
<tr>
<th>APPLICATION</th>
<th>Service</th>
<th>TECartec Product</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process Steam</td>
<td>Pressure &amp; Temp. Control</td>
<td>TECpress</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low-int.med. Temp. C.</td>
<td>TECtemp</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Elevated Temp. Controls</td>
<td>TECtemp</td>
<td>Boiler Environment</td>
</tr>
<tr>
<td></td>
<td>Super- and Ultra-supercritical Temp C.</td>
<td>TECtemp HT L, HT R</td>
<td>Boiler Interstage Attemperation</td>
</tr>
<tr>
<td></td>
<td>Steam-assisted DSH</td>
<td>TECsteam</td>
<td>Temp. contr. close to Saturation</td>
</tr>
<tr>
<td></td>
<td>IP/LP</td>
<td>TECpress, TECpress HT R/HT L</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hydr. Power Unit &amp; Controls</td>
<td>Depending on Application</td>
<td>Contact TECartec</td>
</tr>
<tr>
<td>Condenser Dump</td>
<td>Low to high Loads</td>
<td>TECpress (and Dumptube)</td>
<td></td>
</tr>
<tr>
<td>Spraywater Control</td>
<td></td>
<td></td>
<td>Contact TECartec</td>
</tr>
<tr>
<td>Spraywater Isolation</td>
<td></td>
<td></td>
<td>Contact TECartec</td>
</tr>
<tr>
<td>Filter</td>
<td></td>
<td></td>
<td>Contact TECartec</td>
</tr>
</tbody>
</table>

### Technology vs. Severity of Service

- **Steam-assisted Venturi DSH**
- **Steam-assisted DSH**
- **HT Family DSH**
- **Standard DSH**
- **Heavy Duty DSH**
- **Standard Venturi DSH**
- **FN DSH**
Our Desuperheaters ensure Maximum Performance and Reliability

The TECtemp range of valves is used in power plants in combination with the TECpress (SCV/TBV) for Steam Turbine Bypass applications and for the very demanding interstage-attemperation duty on HT/HP boilers, but it can also be utilized for similarly challenging desuperheating applications in process plants.

- As reliability and accurate performance are paramount to the operation and safety of the plant, the selection of the TECtemp product-line for challenging applications, requiring shortest possible evaporation lengths and preventing the temperature differential-sensitive HT-materials from excessive stress levels is crucial.
- For very large spray water amount requirements and extremely high steam temperatures the TECpress Turbine bypass valve is frequently equipped with the TECtemp HT R ring injection system. This system with no moving parts in the heat-affected zone is used in supercritical and ultra-supercritical power plants.

Characteristics and Advantages of TECartec Desuperheaters

- Rugged and reliable design for severe service in industrial and power plants
- Special designs for supercritical and ultra-supercritical power and process plants without soft seals
- Built-in ball valve water control mechanism (linear, equal percentage or customer-specified spray characteristics
- Easy maintenance if required
- No welded-on nozzle head or brazed-in nozzles which crack under high temp. differentials
- Extremely fine droplet generation and droplet size distribution result in short evaporation length
- No special tools required
- No piston rings which gall or wear out at high temperatures
- No threaded nozzle heads which breaks-off under steam flow induced vibrations
- Minimal pressure loss in the steam line (HT-R)
- HT Design without castings
- HT Designs with spray water control unit outside the heat-affected zone.
- High Control ratio up to 2500:1

Typical Applications for HRSG HT-Desuperheaters and TECpress Turbine Bypass Valves (with Desuperheater TECtemp R) in a Combined Cycle Power Plant
**Overview of TECtemp Desuperheaters:** TECartec has developed a number of very innovative desuperheaters for the most challenging applications in today’s process and power industry. Most of them have been patented globally.

The **TECtemp Heavy Duty** desuperheater enables a very precise control of the injection water amounts for the cooling of superheated steam. The special nozzle design and their individual control use a 90° rotary movement for proportioning the injection water, and ensures a constant, micro fine atomization of the spray water. Shut-off is performed by using an integral ball/seating design, outside the high temperature zone. The control-ball can be built to generate linear, equal percentage, or customized flow characteristics. High differential pressures between the injected water and the process steam (of for example) 100 bar are realized by using a multistage pressure reduction. The application of hard coating materials with a high resistance to wear results in a much longer service live. No castings are used in any of our desuperheaters.

**Used from DN150 and up** steam line diameter

Cooling water
- Nominal diameter: DN25
- Pressure level: PN25 to PN400
- Temperature: max. 580°C
- Control ratio: up to 250:1
- Lance diameter: 64, 71, 76 mm
- Quantity of nozzles: 6, 9, 12, 15 pcs.

**Spray nozzle components**

Special opening contours on the spindle ball permit to generate specific flow characteristics

The **TECtemp Standard** desuperheater is the device of choice for most common industrial applications with less severe operating conditions (lower p/T). It is typically equipped with a pneumatic or electrical actuator. Many of the internals are common with the Heavy Duty design. The special nozzle design and individual actuation uses a 90° rotary movement and ensures constant micro fine atomization of the injection water. The shut-off is performed about the nozzles inside the high thermally loaded zone. High differential pressures between injection water and process steam of e.g. 40 bar are realized using single-stage pressure reduction. The use of coating materials with high resistance to wear results in longer service lives.

**Used from DN150 and up** steam line diameter

Cooling water
- Nominal diameter: DN25
- Pressure level: PN25 to PN160
- Temperature: max. 530°C
- Control ratio: up to 250:1
- Lance diameter: 64, 71, 76 mm
- Quantity of nozzles: 6, 9, 12, 15 pcs.
TECtemp HT L - This patented probe-style desuperheater is suitable for applications at temperatures up to 750°C due to a design without moving parts in the heat-affected zone. The three-part design (control unit, individual spray nozzle feeding conduits, and the DSH-lance) makes it possible to install the control unit with the actuator outside of the heat affected zone. The reduced weight of the DSH lance has a positive effect on the support load on the steam line. The functional principle is based on the design of the proven TECtemp desuperheater. In case of maintenance, the compact control unit can easily be removed and the lance and control unit individually serviced.

Used from DN 150 steam line diameter

- Cooling water nominal diameter: from DN25
- Pressure level: PN25 to PN400

| Applic. Temperature: max. | 750°C |
| Control ratio: | up to 2500:1 |
| Lance diameter: | 85 mm |
| Quantity of nozzles: | 6, 9, 12, 15 pcs |

DSH-Lance: No moving parts, 100% pure metal sealing (no compress. soft gaskets)

Cross section of DSH lance

Example of high temperature TECtemp HT L in a large pipe protected inside with a thermal liner.

The control unit with the electrical actuator and the individual water pipes are all installed outside of the heat-affected zone.

TECtemp HT R - The ring cooler is designed based on a three-part structure without moving parts and without weld seams in the steam cooling components. It is designed for applications up to 750°C and has no moving parts in the heat-affected zone. The nozzle holders are arranged circumferentially around the main steam pipe. Up to 40 individually controlled spray-nozzles can be used in this way. Homogeneous distribution of the very fine injection water drops permits a quick start-up of the steam system. The geometry of the steam nozzle head acts like a Venturi nozzle in the steam pipe which results in a clearly reduced loss of pressure compared to conventional systems.
This patented design is by far the most efficient and most gentle way to overcome the high temperature differentials between the hardware, steam, and cooling water. This design is also typically used in combination with our Turbine-Bypass valve TECpress.

**Used from DN 150 steam line diameter**

- Cooling water nominal diameter: from DN25
- Pressure level: PN25 to PN400
- **Applic. Temperature:** max. 750°C
- **Approx. pressure loss in steam line:** < 0.1bar
- **Lance diameter:** 85 mm
- **Quantity of nozzles:** 5 per Lance, max. 40 pcs.

Installation of DSH lance on a pipe with a thermal liner.

**Installation Example of TECtemp HT R**

**TECsteam** - This steam-assisted spray nozzle is used for cooling steam close to saturation and for very hot gases. It is designed for applications up to 750°C. The line temperature is controlled by injecting water into the steam flow or hot gas stream, whereby the cooling water is thermally atomized by high pressure steam. The high pressure atomizing steam is returned again to the high pressure steam system. The cooling water is supplied by a control valve. Very short evaporation lengths of less than 3m can be realized with this valve.

**Used from DN 80 steam line diameter**

- Cooling water nominal diameter: from DN25
- **Pressure range:** PN25 to PN400
- **Applic. Temperature:** max. 750°C
**TECtemp HT V** - This is also steam-assisted ventury desuperheater design, accomplishing the same goal as the larger version TECsteam, but it is specifically designed for small pipe diameters and high temperatures. The three-part design makes it possible to install the control unit and drive outside of the high temperature area. The functional principle is based on the proven TECtemp injection cooler. The compact control unit can be removed easily and can be serviced individually for servicing work. This injection cooler is used as a compact solution for small pipelines with a high number of nozzles and small pressure loss requirements.

Used from DN 150 steam line diameter
Cooling water
Nominal diameter: from DN25
Pressure level: PN25 to PN400
**Appl. Temperature:** max. 750°C
Control ratio: up to 2500:1
Quantity of nozzles: max. 20 pcs

**Qualifications, Codes & Standards, Actuation**

- Design acc. to PED, DIN, EN 12952, ASME B16.34
- Forged, machined and welded body designs
- Connections
  - Flanges acc. DIN, ANSI, JIS, or
  - BWE
- Actuation
  - Pneumatic
  - Electric
  - Hydraulic (incl. hydraulic actuator, power supply unit, and electronic controls)
Combination of the TECtemp Ring-style Desuperheater with the TECpress Turbine Bypass

This HP/IP Turbine Bypass Valve comes with the patented TECtemp HT R Cooler Unit installed immediately after the steam pressure reduction. It is specifically designed for Supercritical and Ultra-supercritical installations with large spray water amounts, and medium to very large steam outlet pipelines, and where short evaporation lengths are required.

TECartec offers different desuperheating solutions (probe-style, ring-style, ring-style with ventury spray body), all with absolutely no moving parts in the heat-affected zone, and depending on the particular design with up to 40 individually controlled spray nozzles of different size and spraying pattern/capacity. The pressure loss in the steam line due to these nozzles is max. 0.1bar, way less than with conventional desuperheaters. In case of several units in a plant this has a sizable impact on the efficiency of the process.

This design allows to generate the finest cooling water droplet size spectrum and allows to evaporate the spray water over the shortest possible distance, without impinging on the very sensitive pipe wall.
Desuperheater Engineering, R&D

TECartec’s advanced and unique designs display a significant degree of innovation and originality, incorporating several decades of valve know-how and practical experience in the power and process industries. Our field service team shares their long experience (based on our own and other makers’ valves) with the R&D group and feeds important inputs from our customers to develop solutions which provide an optimum performance, reliability, and best possible return of investment to the users of our products. Many of our unique designs have been awarded patents.

Virtual engineering, including computational fluid dynamics (CFD) allows us to gain information about the potential performance of a valve early during the conceptual engineering phase. As an example we can predict the kinetic energy of turbulence in the outlet of an HP/LP station and find the optimal location and direction for the cooling water injection.

Special attention is given to the injection, fine atomization and quick evaporation of spray water for the cooling of superheated steam. Virtual engineering methods are employed for the analysis of two-phase flow fields, velocity and temperature distribution and droplet tracing in the outlet of desuperheating valves. The droplet diameter produced increases nearly linearly with the increasing of the nozzle outlet diameter. Higher steam velocities reduce the maximum possible drop size at the injection point due to oscillation and friction.

Both, the steam pressure and temperature have a significant effect on the spray water atomization and evaporation process. If the pressure increases, the drop size diminishes because the drag force acting on the droplet increases with higher density. The spray cone angle and droplet size thus vary as a function of the steam density. More superheat reduces the preheat and evaporation time.

These computer simulations take place early in the concurrent engineering process, oftentimes several weeks before the product gets actually built and tested in the lab. The prediction of the evaporation length for a certain spray includes the investigation of a possible liquid film along the pipe wall and resulting secondary atomization effects due to steam flow turbulence and velocity differences between the steam and water film.

Requirements for a reliable high performance Desuperheating System

- Resistance to thermal shock and fatigue
- Maximizing power output of plant and reduced valve maintenance
- Must handle severe temperature differentials and pressure drops
- Generates finest spray water droplet spectrum which results in shortest possible evaporation length
- Doesn’t spray to the pipe wall
- Desuperheaters cause minimal pressure drop which doesn’t negatively impact the plant efficiency

Example 1: The TECtemp HT multi nozzle turbine bypass DSH is used in combination with our TECpress control valve for temperatures above 520°C and has no moving parts at all in the hot area. The below shown design can be used up to 720°C. Special executions for higher temperatures are possible. The spray characteristics of the TECtemp HT design is substantially better than what for example commonly used spring-loaded nozzles are capable to achieve under best conditions.
Example 2: Water injection pipes with Thermal Liners for spray cooling in a supercritical Power Plant application. Replacement for a competitive desuperheater design. Our unique design is for long life time. Cracks in welding of the support pins are not possible. Thermal liners are fixed with pressure pipe by springs.

Example 3: Interstage Attemperation with TECtemp HT Desuperheaters in a Supercritical HRSG. This DSH with no moving parts in the heat-affected zone is good for up to 750°C, and can solve many of the current problems the industry experiences with conventional DSHs.
References

TECtemp Heavy Duty DSH

TECtemp Standard DSH

TECtemp HTV combined with Steam combustion station
TECtemp HT Desuperheater for superheated steam coal-fired power station

TECtemp HT Desuperheater for superheated steam with 20 single operating nozzles

Nozzle Heads for Turbine Bypass Valve - Minimal protrusion into pipe = min. pressure loss!

Multi Nozzle Venturi Desuperheater TECtemp HT V
Manufacturing / Stock

We are equipped with state-of-the-art CNC machines to manufacture, weld, assemble and test all of our products in-house.

We also keep a sizable inventory of all potential spare parts, and raw materials in various high temperature grades.

All welding work and PWHT is done internally

Machining of all components in our factory in Oranienburg near Berlin

In-house programming on CNC machines
AVK Valves Korea Co., Ltd. Korea
fon: +82 51 664 8808
e-mail: info@avkvalves.co.kr

AVK Flow Control Singapore Pte. Limited
fon: +65 6214 0248
e-mail: avkmalaysia@avkvalves.com.my

AVK Industrial Pty Ltd Australien
fon: +61 8 8262 8885
e-mail: sales@avkindustrial.com.au

AVK Flow Control Middle East
fon: +966 2637 1570
e-mail: sales@avksvmc.com

AVK Southern Africa
fon: +27 1265 38 313
e-mail: info@avkvalves.co.za

World Valve B.V.
fon: +31 5353 81 295
e-mail: info@worldvalve.com

Orbinox India Pvt Ltd Indien
fon: +91 422 669 1261
e-mail: india@orbinox.com

InterApp Italiana S.r.l. Italien
fon: +39 (0)2 33 93 71
e-mail: info@it.interapp.net

KITRO Pars Corporation Iran
fon: +98 21 220 53 563-4 Ext.: 105
e-mail: sales@kitropars.com

Bickel & Wolf GmbH Austria
fon: +43 2231 67390
e-mail: office@bickel-wolf.com