BLAKEBOROUGH® DESUPERHEATERS

TRILLIUM FLOW TECHNOLOGIES™

TRILLIUMFLOW.COM

QUALITY ASSURANCE

We are qualified to industry standards and working practices including:

- ASME BPVC Section III (N and NPT Stamp)
- NQA-1 Quality system
- 10CFR50 App. B
- 10CFR21
- RCC-E
- RCC-M
- CSA Z299
- Performance testing and qualification to:
  ASME QME-1
  ASME B16.41
  IEEE 323
  IEEE 344
  IEEE 382
- ISO 9001
- ISO 14001
- PED 97/23/CE
- API Q1 TO API LICENCES:
  API 6D (6D-0182)
  API 6A (64-0445)
- TUV-AD MERKBLATT WRD HP0
- OHSAS 18001
- ATEX 94/9/CE
- Lean manufacturing practices

ATWOOD & MORRILL®
Engineered Isolation & Check Valves

BATLEY VALVE®
Butterfly Valves

RED POINT®
Tailor-Made Valves

BLAKEBOROUGH®
Control, Choke & Steam Conditioning Valves

HOPKINSONS®
Isolation Valves

SARASIN-RSBD®
Safety & Safety Relief Valves

SEBIM®
Nuclear Pilot Operated Safety Valves

TRICENTRIC®
Triple Offset Butterfly Valves

Portfolio of engineered service solutions and aftermarket support

A PROVEN TRACK RECORD

We have extensive references and a proven track record in the supply of valves across a number of key industries.

Our valves are industry renowned brands, each with an established reputation for quality engineering and reliability.

VALVE TESTING

All pressure containing items are hydrostatically tested, seat leakage tested and functionally tested.

We can also perform gas, packing emission, cryogenic and advanced functional testing, as well as seismic testing for nuclear applications.

MATERIAL TESTING

- Non-destructive examination by radiography, ultrasonics, magnetic particle and liquid penetrant.
- Chemical analysis by computer controlled direct reading emission spectrometer.
- Mechanical testing for tensile properties at ambient and elevated temperatures, bend and hardness testing. Charpy testing at ambient, elevated and sub-zero temperatures.

AFTERMARKET SOLUTIONS

Our valve aftermarket solutions are based on our engineering heritage, applying our OEM knowledge and expertise to maintenance strategies, life extension and upgrade projects.

Trillium Control & Choke Valves provides a wide range of control valves for the process industry. These include severe service, choke, desuperheating and turbine bypass applications.

Our world-wide reputation is based on engineering excellence applied to a comprehensive range of specialist products and effective customer support.

CONTENTS

WATER INJECTION OPTIONS

BV984 Spring Loaded Nozzle

The BV984 nozzle gives high capacity water injection while offering protection of the water system in case of loss of water supply. The superior pressure of the water system lifts the spring loaded nozzle away from its seat which results in a cone shape jet of water being injected into the steam. The system requires a separate spray water control valve to control the amount of water injection. This system ensures a high rangeability while ensuring the water droplet size is kept to a minimum. On loss of water pressure the water system is protected against high temperatures due to spring loading of the nozzle.

BV985 Variable Area Nozzle

The BV985 spray nozzle is used on applications where high rangeability is required with direct control across the spray nozzle. The BV985 is designed so that steam is injected into the centre of the pipe resulting in minimum droplet contact against the pipe walls. Water is injected across a series of 12 variable area nozzles which atomises the water into micro fine droplets resulting in faster absorption rates and shorter outlet steam pipe lengths. The amount of water injected into the pipe is directly controlled by the valve plug which is in turn controlled by the actuator. Where the pressure differential between the cooling medium and the vapour exceeds 60 bar, a two stage nozzle is available that extends the available pressure drop range to 100 bar. The two stage nozzle ensures erosion across the valve plug is maximised. The BV985 unit is fitted into steam pipes greater than 150mm (6”).

- Large range of design Cv options
- High rangeability
- Swirl chambers and conical nozzles for optimum atomisation
- Pipe sizes 150mm (6”) and above
- Interchangeable nozzles

BV986 Mini Desuperheater

The BV986 unit is a simplified spray nozzle where the spray water is circulated around an internal gallery and then injected into the steam through a series of radial holes. The BV986 unit fits between conventional flanges and is therefore easy to remove for service and maintenance purposes. The unit is connected to a stand alone spraywater valve which controls the amount of water being injected into the vapour. The BV986 can also be directly mounted onto the outlet of a pressure control valve so that water is injected into the turbulent vapor flow at the outlet of the valve. The BV986 is used on pipe sizes from 25mm (1”) and above

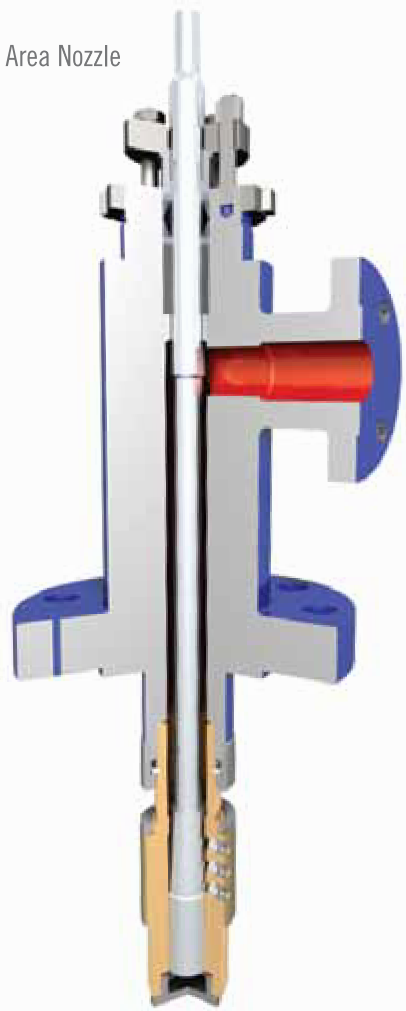
- Pipe sizes 25mm (1”) and above
- CV designed for each application
- Simple and inexpensive system

BV988 Fixed Area Spray Nozzle

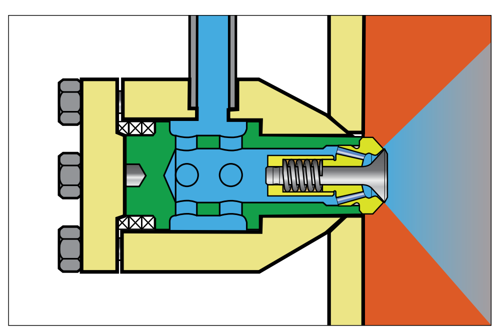
The BV988 unit offers good spraywater atomisation but with separate spray water control. The valve is similar to the BV985 unit but with all spraywater control removed from the unit. A flanged or butt weld connection is used to connect the spraywater which in turn is controlled via a separate control valve. This allows for high technology control valve trims to be used to eliminate the detrimental effects of erosion sometimes created by high pressure drops. The unit is also used in situations where space around the desuperheating system is limited.

- Multi nozzle for optimum dispersion in steam flow

BV985 Variable Area Nozzle



BV984 Nozzle



BV985 - VARIABLE SPRAY UNIT

General

The BV985 multi nozzle desuperheater is a proven design used in thousands of installations throughout the world. The latest version offers increased CV ratings and improved rangeability with the option of modified characteristics.

Design Details

- The standard model incorporates 12 carefully spaced spray nozzles for optimum dispersion in the steam flow, and to minimise coalescence of the droplets.
- Nozzles arranged so that at low steam flows water is injected into high turbulence zone of the vortices shed from the desuperheater probe.
- Nozzle design incorporates swirl chambers and conical nozzle for optimum atomisation even at low superior pressures.
- Nozzle assemblies can be characterised to suit process requirements and nozzle selection can be changed after installation.

Standard Design Options

- Water inlet connection size 25mm, 40mm and 50mm (1”, 1 1⁄2” and 2”)
- Connection - flanged, socket weld
- Ratings - ANSI 150 to ANSI 2500
- Nozzle sizes (see table 1)
- Superior Pressure 1 bar to 50 bar (15psi to 740psi)
- Nozzle Rangeability - up to 40:1

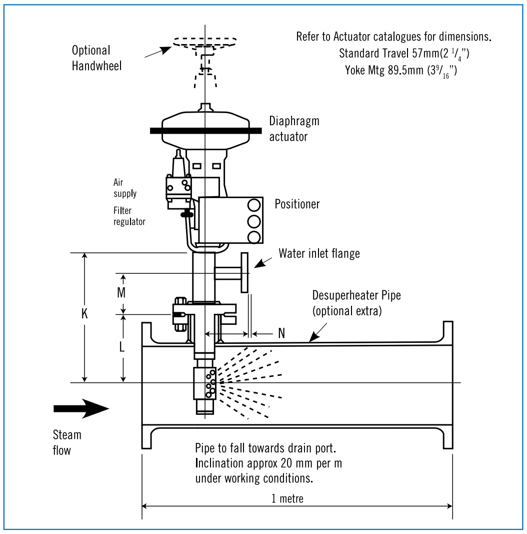


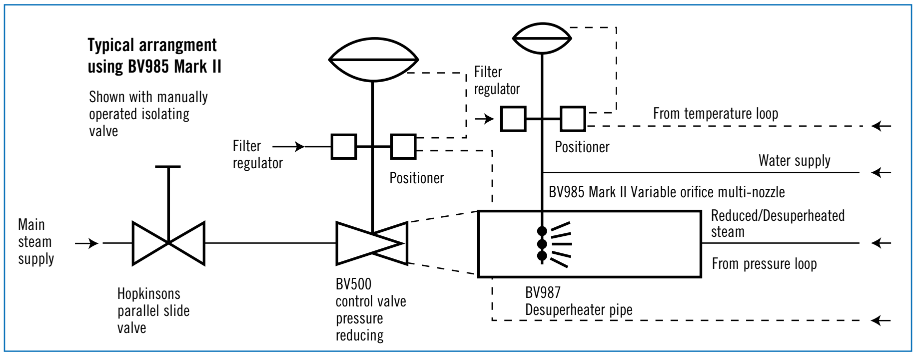
TABLE 1 – NOZZLE DESIGN CV

MN1	MN2	MN3	MN4	MN5	MN6
0.5	0.9	1.5	2.7	4.7	8.0

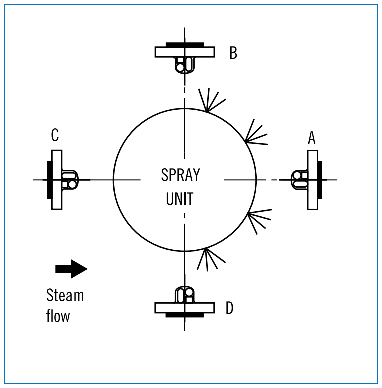
TABLE 2 – BRANCH HEIGHT & ACTUATOR MOUNT DIMENSIONS

BV987 Pipe Size mm	Branch Height	Act. Mount
150	177	382
200	200	405
250	226	431
300	251	456
350	277	482
400	302	507
450	327	532
500	350	555
600	372	577
650	416	621
700	454	659
750	480	685
800	501	706
850	517	722
900	547	752

Rating	M	N
≤ 600lb	135	133
900lb & 1500lb	184	167
2500lb	210	200



Water Flange Orientation
The pipework inlet flange can be arranged to suit customer’s pipework configurations.



BV986 - FIXED AREA SPRAY RING

General

This unit offers a relatively simple and inexpensive solution for applications which have low rangeability and stable steam demand. The system consists of a spray ring together with a separate spray water control valve. The spray water control valve regulates the flow into an annular feed within the spray ring body. This annular feed passes water into a number of holes to produce a series of radial jets into the steam flow, which assist in the mixing process.

Standard Design Options

- Body size - 25mm to 200mm (1" to 8")
- Ratings - ANSI 150 to ANSI 2500
- Nozzle size designed for specific application
- Superior Pressure 1 bar to 50 bar (15psi to 740psi)
- Rangeability - up to 8:1 on steam flow

BV986 Mini Desuperheater

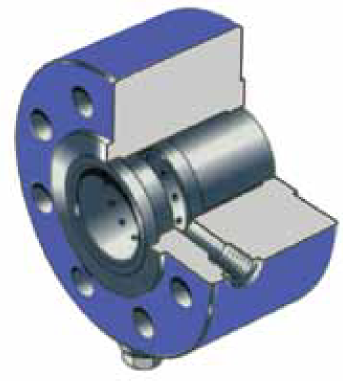


TABLE 3 - DIMENSIONS

FACE TO FACE DIMENSIONS							
Bore (mm)	25	40	50	80	100	150	200
Length (mm)	80	80	80	150	150	150	150

BV987 - PIPELINE DESUPERHEATER PIPE

The BV987 desuperheater pipe offers a convenient method to install either the BV985 or the BV988. It is available in sizes from 150mm to 900mm (6" to 36"). An 80mm (3") branch flange is provided for mounting the desuperheater. The desuperheater pipe can be supplied in carbon steel or chrome moly. Desuperheater pipes can be supplied with protective liners when the service conditions indicate the possibility of thermal shock or to increase the steam velocity.

TABLE 4 - DESIGN CV'S

DESIGN CV									
MD1	MD2	MD3	MD4	MD5	MD6	MD7	MD8	MD9	MD10
0.03	0.04	0.06	0.1	0.14	0.2	0.4	0.63	1.0	1.4

TABLE 5 - PIPELINE DESUPERHEATER STANDARD MATERIALS

Component	BV985/BV988	BV986
Body <=427 ˚C	Carbon Steel	Carbon Steel
Body >427 ˚C	Chrome Moly	Chrome Moly
Spray unit head	316 L st.st.	
Seat	316 L st.st.	
Plug/Stem	316 L st.st. + stellite face	
Nozzles	316 L st.st.	
Swirl Inserts	316 L st.st.	

BV988 - FIXED AREA PROBE

General

This multi-nozzle desuperheater can be fitted into line sizes >= 6". The nozzle head is the same as used in the BV985 incorporating up to 12 nozzles. The spray water is regulated by a separate spray water control valve.

Standard Design Options

- Refer to BV985 section
- Rangeability - up to 8:1 on steam flow

BV988 Fixed Area Spray Nozzle

INITIAL SIZING OF DESUPERHEATERS

Information required at enquiry stage

P_1	Inlet Pressure	Bara	(Psia)
T_1	Inlet temperature	°C	(°F)
P_2	Required outlet pressure	Bara	(Psia)
T_2	Required outlet temperature	°C	(°F)
P_W	Available spraywater pressure	Bara	(Psia)
T_W	Spraywater temperature	°C	(°F)
W_s	Maximum inlet steam flow	kg/hr	(lb/hr)

Controlled temp. should be higher than 5 °C (9 °F) above saturation point.

Initial calculations

Calculate the required flow of water WW, kg/hr (lb/hr), needed to control the steam temperature at the outlet, by the heat balance method.

$$WW = \frac{WS\,(h1 - h2)}{(h2 - hw)}$$

where h1 = enthalpy of superheated steam at inlet
where h2 = enthalpy of steam mixture at outlet
where hw = enthalpy of spraywater at inlet values in kJ/kg (Btu/lb)
Total outlet steam flowrate WM = WS + WW kg/hr (lb/hr)

Sizing of low pressure pipeline

This is the recommended pipe size for BV985, BV986 and BV988 pipeline types, or the outlet size for the BV995 design for efficient desuperheating.

The pipe is sized so that the steam velocity does not exceed 90m/s (300ft/s) or, for BV985, BV986, BV988 types, fall below 4.5m/s (14ft/s). The preferred velocity is 75m/s (250ft/s).

The minimum pipe diameter is calculated using the following formulae.

$$D = 18.8\sqrt{\frac{W_M \times V_S}{\text{Velocity}}}\ \text{mm or}\ D = 0.225\sqrt{\frac{W_M \times V_S}{\text{Velocity}}}\ \text{in.}$$

where WM = outlet steam flowrate kg/hr (lb/hr)
where VS = outlet specific volume m^3/kg (ft3/lb)
Velocity m/sec (ft/sec)

- For BV985, BV986 and BV988 desuperheaters there is a selection of standard trim sizes available
- BV995 units are often associated with outlet silencer sections depending upon the ratio of inlet and outlet pressures and the maximum permissible sound pressure. For these reasons each unit receives individual considerations based upon customer requirements.

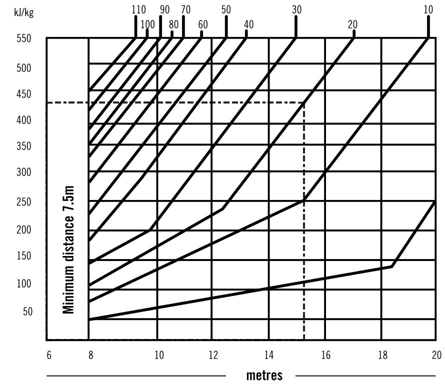
Distance to temperature sensing point

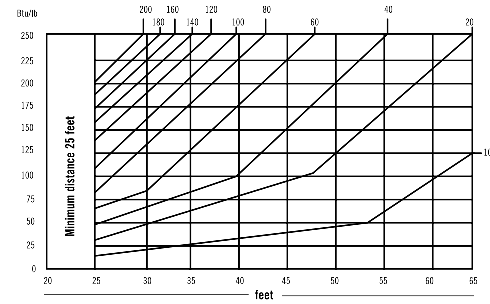
Depending upon the amount of superheat required in the steam after desuperheating, the minimum recommended distance to the temperature sensing point can be determined from the graphs shown. To ensure complete mixing and absorption of the injected water the recommended distance increases as the steam saturation temperature is approached.

Should the recommended location for the temperature sensing point coincide with a pipe bend, then the sensing point should be moved a further two metres downstream.

Final required degrees of superheat, degrees C.

Enthalpy Change Graphs





Graphs based upon 300mm pipe size. For other sizes multiply distance by

$$\sqrt{\frac{d}{300}}\quad (d = \text{pipe dia. mm})$$

Examples on use of the above graphs

Steam pressure 10 bars. Saturation temperature 180°C.
Required outlet temperature 200°C
Steam Inlet enthalpy 3253kJ/kg } Enthalpy change
Steam Outlet enthalpy 2829kJ/kg } 424 kJ/kg
Final required degrees of superheat = 200-180 = 20°C
Draw line from enthalpy change to intercept degrees of superheat line, read off minimum distance = 15.2 metres.

Spraywater Temperature

Effective desuperheater operation depends upon the correct amount of spraywater introduced into the steam flow. If the steam or water temperature conditions dictate a water addition of greater than 20% of the steam mass flow under normal conditions then a two stage nozzle system may be necessary. To limit the amount of water entering the steam to an acceptable level a maximum water temperature can be calculated using the following formulae.

$T_{max} = (P + 0.5DS - 1.427\Delta h + 630)$ °C Metric
$T_{max} = (0.125P + 0.5DS - 6.1\Delta h + 1190)$ °F Imperial

where P = absolute steam pressure bara (psia)

DS = final required degree of superheat °C (°F)
Δh = enthalpy change from inlet to outlet kJ/kg (Btu/lb)

Ideally the water temperature should be within the following range for satisfactory operation:-

$(T_{SAT} - 100)$ °C $< T_{WATER} < (T_{SAT} - 5)$ °C Metric
$(T_{SAT} - 210)$ °F $< T_{WATER} < (T_{SAT} - 10)$ °F Imperial
Also applying the maximum water temperature limitations when applicable (TSAT is the stream saturation temperature).

DESIGN & INSTALLATION OF PIPELINE DESUPERHEATER SYSTEMS

Location in pipework

The desuperheater should be installed so that the spray nozzle is located at the steam inlet of the tube (if supplied). A filter should be fitted in the spray water inlet line to prevent ingress of dirt.

Pipe Joints

Owing to the severe expansion strains which may be imposed on the joints when starting up it is essential that all flange joint bolts are manufactured from high tensile alloy steel irrespective of the steam pressure. These remarks also apply to the water joint flanges which are also subject to sudden temperature changes.

Drainage and drainage systems

Efficient drainage of the pipework following the desuperheater is essential. To ensure that water cannot accumulate at any point the pipe should be arranged to fall in the direction of flow approximately 20mm per metre (1⁄4" per foot) under actual working conditions and be provided with an efficient large capacity trap (10% of maximum flow to facilitate start-up and shut down of plant) at the lowest point. To prevent the trap becoming airbound the drain pipe should have ample capacity to deal with the drainage and be fixed as near to vertical as possible. There must be sufficient space in the drain pipe for water to flow down and air to pass up the pipe.

When starting up the plant it is advisable to open the trap by-pass valve to deal with any excess water. If a by-pass valve is not fitted the trap should be inspected to ensure that it is passing water and has not become airbound. When the pipework has warmed through to working temperature and a reasonable amount of steam is flowing the drainage of water should practically cease and the trap by-pass valve can then be closed.

Successful operation of a desuperheater depends to a large extent on the injection of water being hot, preferably near to the saturation temperature of the steam to be cooled so that it is mainly the latent heat which is extracted from the steam to evaporate the injected water. This minimises the time of the suspension of the water particles in the steam so that all the water is evaporated and none falls to the inside walls of the pipework. As mentioned below the pipes connecting the water supply to the injection nozzle should be efficiently lagged to minimise the loss of heat. The water pressure and temperature should be no less than the values originally specified at the enquiry/order stage since these figures are used for design purposes in sizing the injection nozzle. The pipes connecting the water supply to the injection nozzle should be no less in diameter than the water isolating valve flange connections indicate. Condensate supply should be free from debris and effectively filtered to less than 0.25mm.

Lagging of pipes

The fact that a desuperheater is a device for reducing the steam temperature sometimes leads to the mistaken impression that the lagging of steam and water pipes is not important. Unlike the absorption of heat by the spray water, any loss of heat should be avoided. Unless the pipework can be maintained at the proper temperature successful desuperheating may not be possible and a preliminary trial of a plant before it has been lagged may prove disappointing. Efficient drainage of the pipework following the desuperheater is essential. To ensure that water cannot accumulate at any point the pipe should be arranged to fall in the direction of flow approximately 20mm per metre (1⁄4" per foot) under actual working conditions and be provided with an efficient large capacity trap (10% of maximum flow to facilitate start-up and shut down of plant) at the lowest point. To prevent the trap becoming airbound the drain pipe should have ample capacity to deal with the drainage and be fixed as near to vertical as possible. There must be sufficient space in the drain pipe for water to flow down and air to pass up the pipe.

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