ASVIN Pressure Reducing and De-superheating Stations
ASVIN Pressure Reducing Stations
ASVIN-De-superheating Stations

Desuperheaters to control the temperature of superheated steam (or gas)

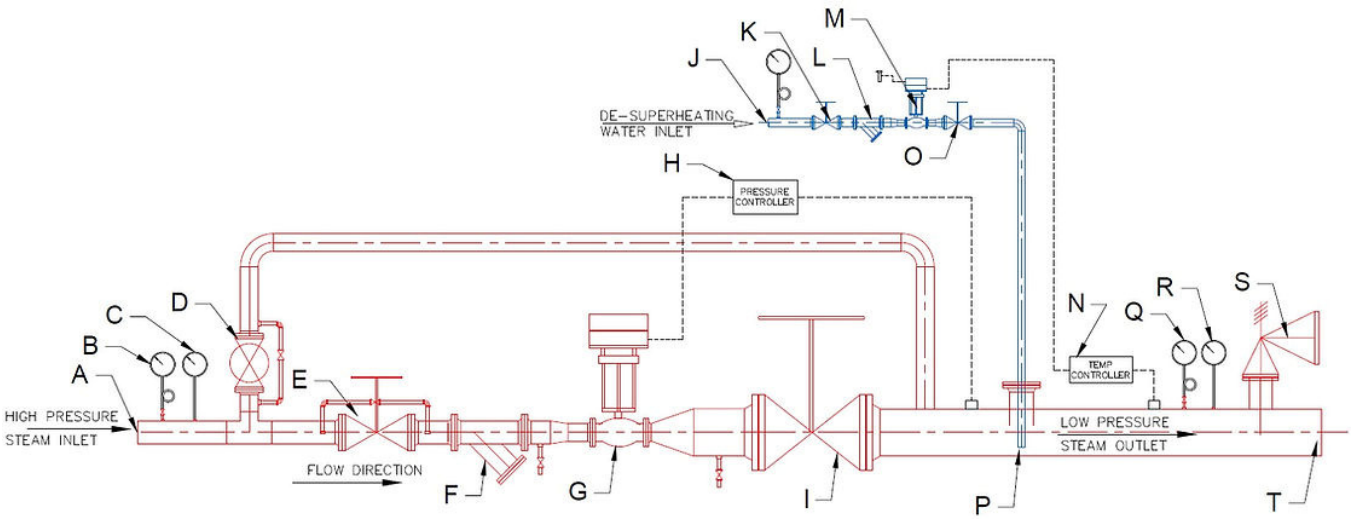
ASIAN INDUSTRIAL VALVES AND INSTRUMENTS (ASVIN) are single source for Pressure Reducing Stations complete with piping and instrumentation. **ASVIN** PRDS (Pressure reducing de-superheater) is used to reduce temperature as well as pressure of steam extracted from the main steam line for various purpose. Pressure of main Steam line is reduced with the help of control valve while temperature is lowered by adding feed water in to steam.

Split PRDS: separate PRV (Pressure Reducing Valve) and De-Superheater

Combined PRDS: Both PRV and De-Superheater in a compact single unit

PRDS for process heating applications in sugar, food, textile, paper, etc.., Deaerator, Ejector PRDS for the boiler. Turbine By-pass PRDS. **ASVIN** PRDS stations are supplied complete and ready to fit on piping. The pre-assembled stations are individually sized to meet the end-user's specific needs. The Inlet and Outlet piping, as well as valves are sized as per best engineering practices and International Standard. Each unit is custom engineered and designed to meet specific system requirements. **ASVIN** PRDS stations are also easy to maintain. Pressure Reduction & Temperature Reduction is done in two different units.

COMPONENTS OF PRDS:



A) Steam inlet, **B)** Pressure Gauge, **C)** temperature gauge, **D)** by pass isolation valve, **E)** inlet isolation valve, **F)** strainer, **G)** pressure reducing valve **H)** PID controller (pressure),**I)** outlet isolation valve, **J)** water inlet, **K)** water inlet valve, **L)** strainer, **M)** temperature control valve, **N)** PID controller (temperature), **O)** water outlet valve, **P)** water injector, **Q)** pressure gauge, **R)** temperature gauge, **S)** safety valve **T)** de- super-heated steam outlet

OPERATION of ASVIN PRDS-Super-heated Steam enters from steam inlet **A** and travel through the pipe which passes by the Temperature gauge **B** and Pressure gauge **C** which indicates the pressure and temperature at the inlet point. Further the super-heated steam travels towards outlet valve **I** through Inlet let valve **E**, Strainer **F** and Pressure regulating Valve **G** which is connected with PID pressure controller **H**, which receives pressure from outlet pipe and send signal to Pressure regulating valve **G** to adjust to desired required pressure. Parallelly from water inlet **J,** the de- superheated water travels to injector **P** through water inlet valve **K**, Strainer **L**, Temperature control Valve **M** which is connected with PID controller **N**. PID controller (temperature) **N**, senses the signal from sensor inserted in Steam outlet pipe and transmit the signal to temperature control valve **M** to maintain the desired required temperature through water outlet valve **O**. Now the controlled (Both Pressure and Temperature) de-superheated steam comes out through outlet **T**. The outlet Pressure gauge **Q**, temperature gauge **R** are fixed to validate the controlled steam pressure and Temperature. Safety valve **S** safeguard the system from any malfunction of the station. The out let of the Safety valve **S** has to be taken out as per API standard to a safe place.

ASVIN PRDS Technical Specifications:

Size: 15 NB x 15 NB to 300 NB x 500 NB and Higher size as per Requirement.

Inlet pipe Size- 25 Nb to 300 NB (PRS) & 25 NB to 80 NB (DSH)

Outlet pipe Size- 25 Nb to 600 NB (PRS) & 25 NB to 80 NB (DSH)

Rangeability: 40:1 (PRS & DSH)

Flow Characteristics: Equal % / Linear (PRS & DSH)

Rating: ANSI Class 150, 300, 600, 900, 1500 LBS & higher ratings on request.

Material: Carbon Steel (A216 Gr. WCB) / Alloy Steel (A217 Gr. WC6/WC9) / A182 (F11/F22)

End connections: Flanged / Butt Weld / Socket Weld

Inspection Options: IBR / Non-IBR/ TPI

Compliance to: ASME Section VIII, Div. I,

Certification: International Stampings, PED, CE on request, for export jobs.

TYPES OF REDUCTION UNITS.

I) **PRDS STATION**- Both units combined, termed PRESSURE REDUCTION & DE-SUPERHEATING STATION.
II) **PRS STATION**- in which pressure reduction is done, is termed PRESSURE REDUCTION STATION
III) **DSH STATION**- in which temperature reduction is done, is termed DE-SUPERHEATING STATION

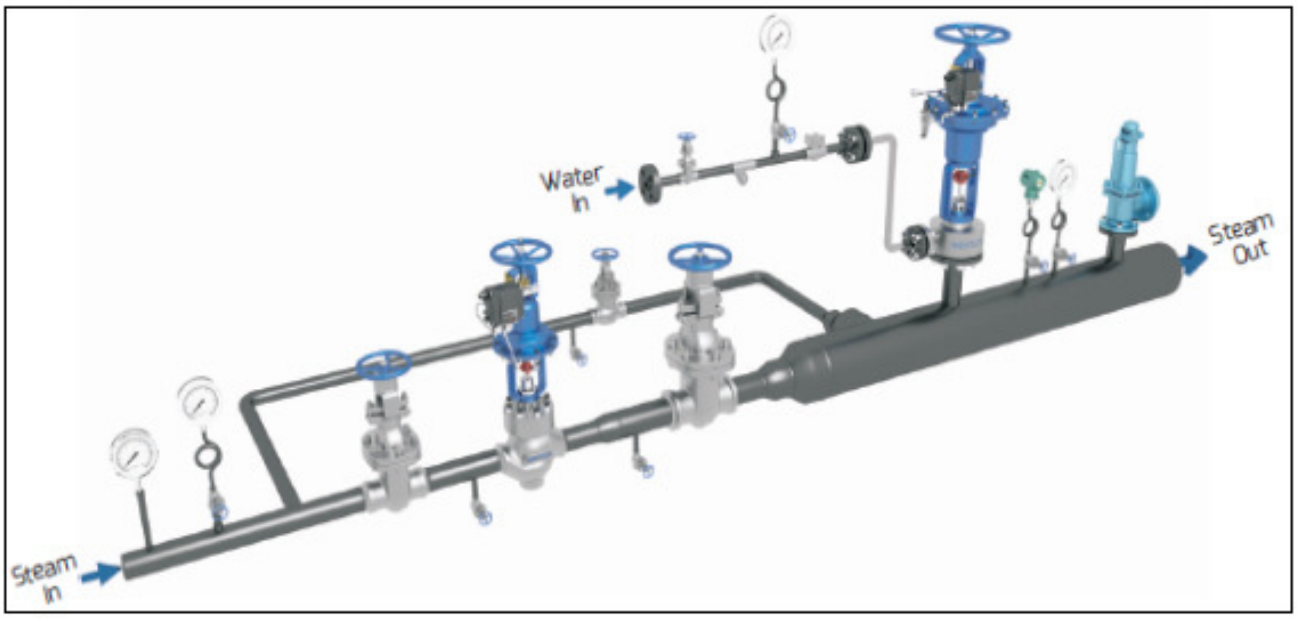
I) **PRESSURE REDUCTION & DE-SUPERHEATING STATION (PRDS)**

ASVIN can supply Pressure Reducing and de-superheating stations for whichever application regardless its criticality and dimension.

-Minimum sizes available: 15 NB to higher size as per design requirement
-Available pressure rating:

a) Class 150-600 Lbs. (normally flanged ends)
b) Class 900-2500 Lbs. (normally BW ends)
c) All stations are engineered and factory assembled

-Stations are mostly supplied with 'Combined PRDS' Valves which provide the advantage of pressure reduction and temperature control in a single unit



Arrangement for PRDS station DSH + Integral spray water Control valve

-The water flow Control Valve and waterline are offered with the steam line, which ensures correct design and matching of pressure and temperature control stations

-The entire assembly is hydro tested

-Stations are available in various sizes from 25 NB up to 1500 NB or larger

-Pipe materials:

a) A106 Gr.B with flanges A105/A515 for temp. Up to 427°C
b) A335 P11 with flanges A182 F11 for temp. above 427°C and below 493°C
c) A335 P22 with flanges A182 F22 for temp. above 493°C

II) **PRESSURE REDUCTION STATION (PRS)**

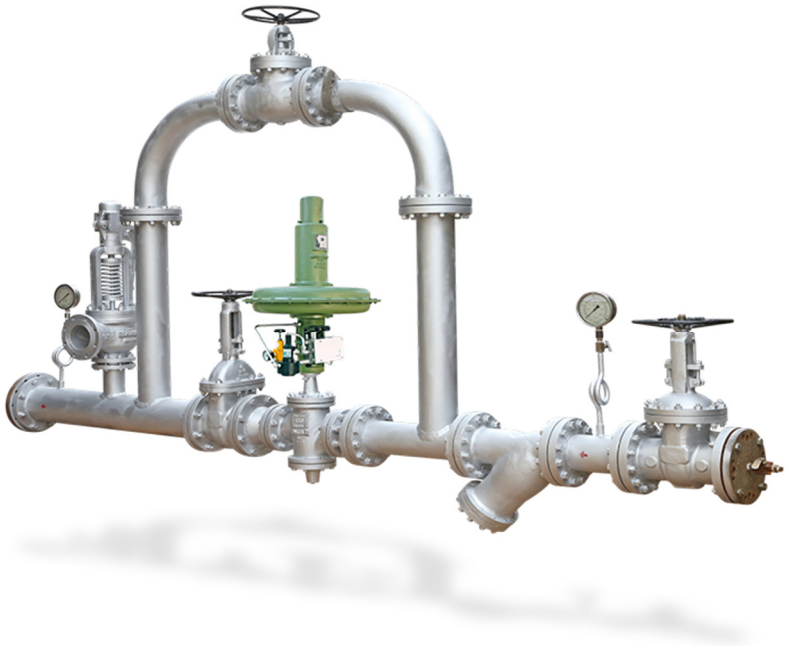
The steam inlet pressure gauge and dial thermometer indicate the pressure and temperature respectively of the inlet steam. The Pressure Reducing Valve (PRV) reduces the pressure of the steam. The steam inlet isolation valve along with the outlet isolation valve is used to isolate the Pressure Reducing Valve, whenever maintenance of the PRV is to be carried out.

The pressure transmitter senses the outlet steam pressure and gives a proportional current signal as output to the PID controller. The PID controller then compares the measured value with a set point, The safety valve opens and relieves excess pressure when steam pressure goes above set value.

-All Piping / SRV / PRV are precisely Sized with Sizing Selection Programme for Accurate Controlled Performance.

-Complete PRS is in house Fabricated with high skill IBR approved welder with seamless pipes, fittings and flanges with bypass line dully assembled and finally tested and certified by TPI, if required.

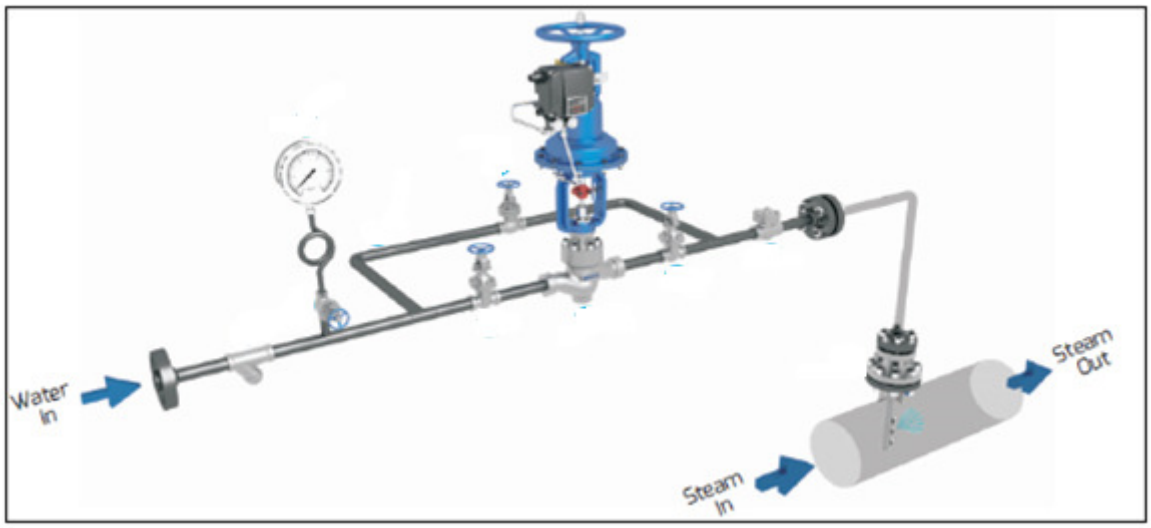
-Hydro Testing of PRS and Final Pressure setting is done with air before dispatch.It is Recommend to Provide External Balance Pipe when the Reduced Pressure is Below 55% of the Inlet Pressure



PRESSURE REDUCTION STATION (PRS)

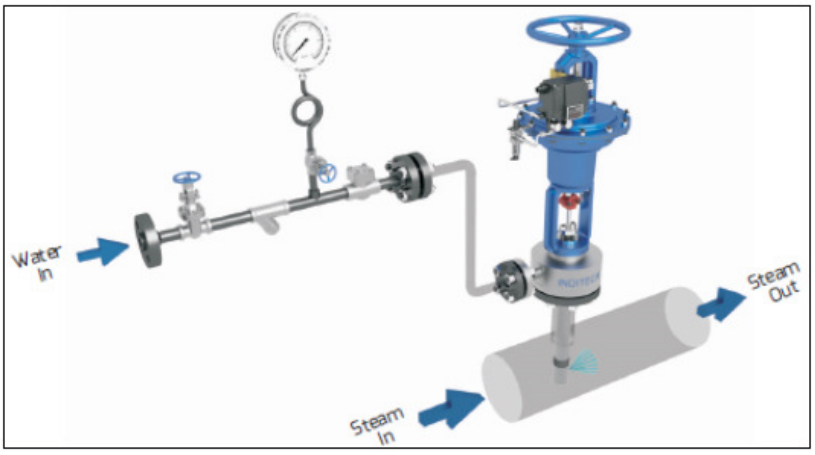
III) **DE-SUPERHEATING STATION (DSH)**

De-superheating systems are designed to reduce the temperature of superheated steam close to that of saturation. The steam temperature is reduced close to saturation by injecting water into high velocity steam by controlled water flow through water control valve



Arrangement for DSH station DSH + separate spray water Control valve

The spray water enters the DSH station. The water strainer at the inlet prevents entry of foreign particles into the water control valve & de-superheater spray nozzles. The water inlet pressure gauge indicates the pressure of the spray water. The water flow control valve regulates the quantity of the spray water going into the spray nozzles, depending on the steam load. The temperature transmitter senses the outlet steam temperature and gives a proportional current signal as output to the PID controller. The PID controller then compares the measured value with a set point.



Arrangement for DSH station DSH with integral spray water Control valve

TYPES OF DESUPERHEATER (DSH)

INDIRECT CONTACT TYPE:

The water and the superheated steam are not contacted directly. A layer of solid, separates the two fluids. Usually, Shell and Tube Heat Exchangers are used for the process. **ASVIN** are not manufacturing Indirect Contact Type Desuperheaters.

DIRECT CONTACT TYPE- ATTEMPERATORS

The superheated steam and the water are contacted directly. Direct contact steam Desuperheaters are used as a method of steam temperature control, reducing the temperature of superheated steam. The Integral a Non- Integral Types are Direct Contact Desuperheaters.

INTEGRAL TYPE DESUPERHEATER:

De-Superheater is in-built with actuator. Hence there is no need of separate spray water valve.

NON-INTEGRAL TYPE DESUPERHEATER:

De-Superheater nozzle and water valve are separate units.

DESUPERHEATERS ARE ALSO CLASSIFIED AS:

A. **Venturi Steam Desuperheaters**: A venturi nozzle is used to create extra turbulence resulting in effective steam cooling within the double diffusers. This desuperheater suits most general applications.

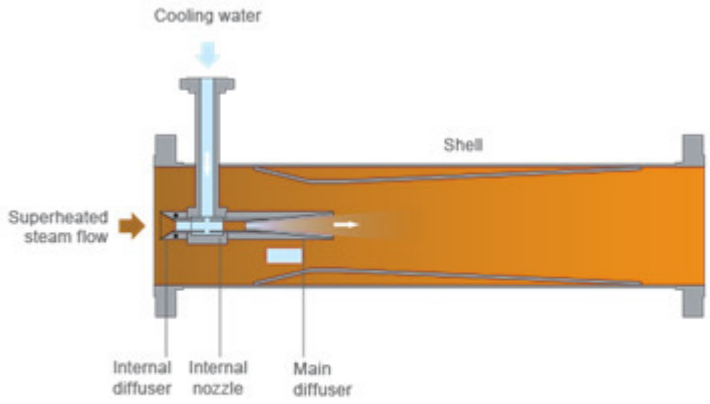
B- **Steam Atomising Desuperheaters:** For applications where the load varies considerably, these desuperheaters use a secondary, high-pressure steam supply to atomise the cooling water entering the superheated steam.

C. **Variable Orifice Desuperheater**: orifice area opening will vary according to the flow and pressure variations.

D. **Spray Nozzle Desuperheaters**: Inserted into the steam line to release a fine spray of water into the flow, these desuperheaters suit retrofitting in existing pipes and are highly cost-effective for large diameter pipes.

E- **Spray Type Desuperheaters**: A complete pipeline unit incorporates spray nozzle technology with thermal pipeline sleeves reducing water droplet fall out.

ASVIN VENTURI STEAM DESUPERHEATER (DSH)



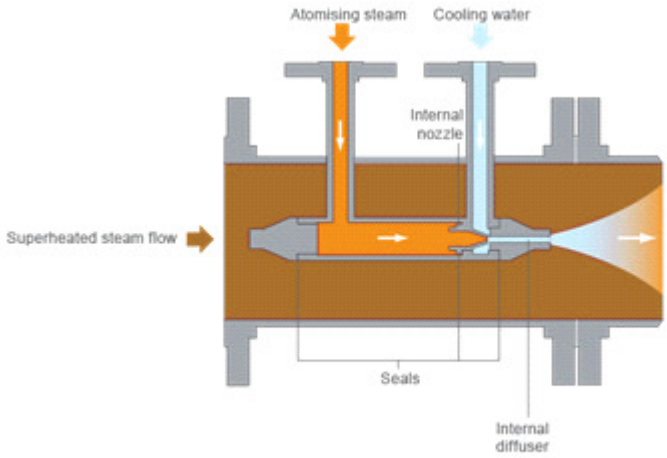
Venturi type desuperheater

A venturi nozzle is used to create extra turbulence resulting in effective steam cooling within the double diffusers. This desuperheater suits most general applications. Double-Venturi desuperheaters are our most commonly used and can accommodate most de-superheating applications. The Double Venturi Desuperheater sprays steam and water through a venturi shaped body and another venturi nozzle installed in the centre, creating a powerful turbulent. This results in fast mixing and uniform temperature.

Single Venturi desuperheaters have limited capability and a very low cost**.** The single Venturi Type Desuperheater creates mixing capacity through high vapor velocity made by combing finely designed spray nozzles. Single Venturi Desuperheater dispenses steam and water with Venturi nozzles installed in the centre of body, which momentarily mixes the water and the steam to become fully saturated.

STEAM ATOMISING DESUPERHEATERS

Steam Atomizing Desuperheaters maximizes mixing efficiency by spraying water and steam more strongly to venturi nozzles in the centre of the body with a high-pressure auxiliary steam supply. For applications where the load varies considerably, these desuperheaters use a secondary, high-pressure steam supply to atomise the cooling water entering the superheated steam.



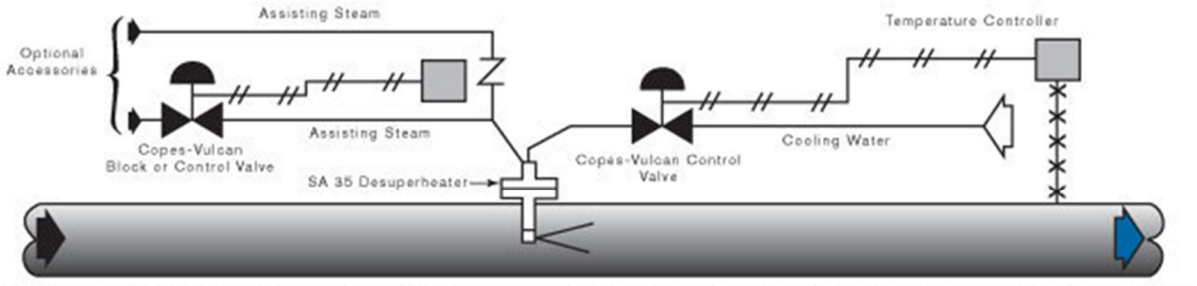
Steam atomising desuperheater

It was developed to obtain a more uniform spray under varying load conditions where no pressure drop in the steam header can be tolerated.

-High rangeability 25:1, Shorter mixing distances than mechanical atomizing desuperheaters,

-Horizontal or Vertical piping Installation.

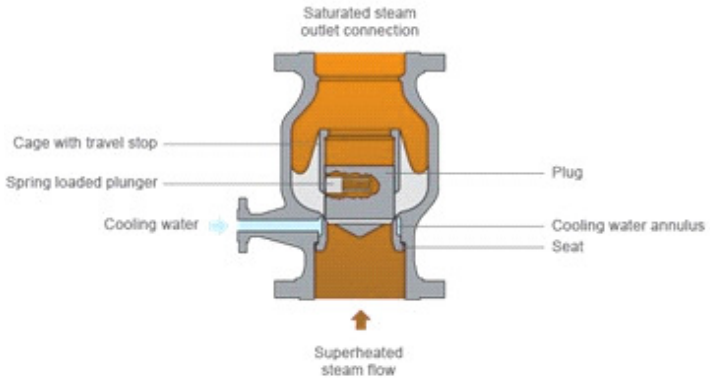
-Temperature control to within 15º F (8.3º C) of saturation with the ability to hold set point within tolerance of 10º F (5.6º C)



Temperature impulse signal from controller actuates cooling water valve flow to desuperheater. Atomizing steam may require a pressure reducing valve and pressure controller or check valve only, depending upon atomizing steam source conditions.

VARIABLE ORIFICE DE-SUPERHEATERS

This is a variable cut-off area desuperheater that are installed vertically on the ground with steam flowing upwards. The built-in valve core that moves up and down can automatically open the flow channel section according to the steam flow. It has a large adjustable ratio, constant flow rate, constant pressure loss, no need to add a straight pipe section at the outlet of the desuperheater.



Variable orifice desuperheater

This desuperheater is a robust compact design able to achieve complete evaporation with the shortest straight-pipe distance of just 1 meter and less than 5.5 meters of distance required to the temperature sensor**.**

SPRING LOADED - VARIABLE SECTION SPRAY NOZZLE DE-SUPERHEATER

The injection nozzle is screwed onto the body and secured by a lock washer. The nozzle itself has a spring-loaded plug which extends as the pressure in the nozzle holder increases. The amount of water being injected by each nozzle is determined by a number of factors, including the diameter of the nozzle body opening, adjustment of the spring, and the pressure differential between the steam inside the desuperheater and the water pipeline.

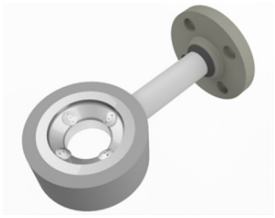
The plug and the seat are designed to create maximum water velocity at the nozzle edge point. The high velocity of the water when it leaves the nozzle guarantees fine atomisation, quickly evaporating the spray water. In order to maintain a constant pressure inside the injection nozzle, the latter is preloaded by a spring calibrated in function of the water/steam differential pressure.

MULTI NOZZLE SPRAY DESUPERHEATERS

ASVIN variable nozzle desuperheaters are best suited for applications involving high load fluctuations. They are designed to control the quantity of spray water at the point of water injection, thereby eliminating the need of a separate water control valve. This is achieved by coupling the desuperheater with an actuator and subsequently varying the number of injection nozzles in operation

WAFER-TYPE SPRAY NOZZLE DESUPERHEATER (DSH)

The Desuperheater (DSH) model is a non-integral type, which requires a separate spray water control valve. This is a venturi design with sharp edge against the flow- guarantees a high steam velocity and well atomized cooling water in the point of injection. The spray water quantity is controlled by an external control valve which responds to feedback from a controller and downstream temperature sensor.



This desuperheater (DSH) model is made for installation in steam pipes 25 NB to 100 NB. This type of DSH is, as standard, mounted between flanges.

SPRAY TYPE DESUPERHEATER

The water spray design of the Desuperheater offers a simple, cost-effective method of cooling steam to within 10°F of saturation. The desuperheater is a water spray type with single nozzle. This design has limited turndown and is intended for applications having relatively constant steam flow and cooling water demand.

The spray nozzle is located in the centre of the housing, providing axial injection in the direction of steam flow. A thermal sleeve isolates the main housing from contact with cooling water to prevent thermal stress and conical insert accelerates steam to promote turbulence and rapid absorption of cooling water.

TECHNICAL DATA REQUIRED from CUSTOMER

Steam data

Inlet pressure, Bar (g),

Inlet temperature °C

Outlet temperature °C set point

Steam flow, Inlet, T / Hr (Max, Nor, Min)

Water data

Water inlet pressure bar(g),

Water inlet temperature °C

Pipe size, mm / Pipe schedule

RECOMMENDATIONS- PIPING

ASVIN recommends a strainer with a mesh size of approx. 100 Microns, in the water supply line to protect the SPID Desuperheater from clogging. Desuperheater piping arrangement, straight length requirements, upstream and downstream, and temperature element placement have become very important parameters in de-superheating stations. ASVIN normally recommends that this distance be straight. However, as long as precaution is exercised, bend and curves can be made within 10' to 15' from unit discharge connection. **ASVIN** recommends five pipe diameters upstream of straight run if desuperheater is used in conjunction with pressure reducing valve.

ATOMIZATION

Atomization of the injected spray water into droplets increases surface area for heat transfer with the surrounding steam. Smaller droplet size is desirable because it means higher surface area of the spray water and evaporate more easily.

The most significant parameter governing atomization is Weber number, defined as:

$We = \rho U^2 d / \sigma$, Where,

ρ = Density of steam in kg/m3
U= Relative velocity of Steam in m/s
d= Droplet diameter in m
σ = Surface tension of water in N/m

Droplets are stable when the Weber number is below the critical value which is generally in the range of 12 - 16. Droplets with higher Weber number continue to break up until they reach a stable size. Primary atomization depends on the spray nozzle design.

QUANTITY OF ATTEMPERATOR WATER CALCULATION- with EXAMPLE

Injection of the correct amount of spray water flow is the first and most fundamental requirement to correct operation of any de-superheating system. The quantity of cooling water required is determined from heat balance and mass balance principles, which leads to:

An attemperator is used to control the 95 TPH super-heated steam from 425 deg C to 395 deg C by using 110 deg C feed water. Consider the main steam and feed water pressure 87 Kg/cm2 & 100 kg/cm2 respectively. Calculate the quantity of attemperator water. If, Boiler feed pump having head of 1000 meters and efficiency 62% supplies attemperator water, calculate the extra power consumption for attemperation. Consider motor efficiency 95%.

Given data,
Mass of steam Flow, Ms = 95 TPH

Enthalpy of Steam before attemperation at pressure of 87 Kg/cm2 & at temperature 425 deg C,

H1 = 762.41 Kcal/Kg

Enthalpy of Steam after attemperation at pressure of 87 Kg/cm2 & at temperature 395 deg C,

H2 = 741.81 Kcal/Kg

Feed water enthalpy at temperature 110 deg C, Hf = 111.65 Kcal/kg

For calculation of attemperator water, Mw., We have the relation,

Heat lost by the super-heated steam = heat gained by the feed water

Ms X (H1-H2) = Mw X (H2-Hf)

95 X (762.41 – 741.81) = Mw X (741.8 – 111.65)

Required Attemperator water, Mw = 3.1 TPH

Density of water at temperature 110 deg C = 960 Kg/M^3

Water Flow , M^3/sec = (3.1 X 1000) / (960 x 60 x 60) = 0.000897 M^3/Sec

For calculation of power required, For pumping 3,1 TPH of feed water, we have

Motor Power = Flow, M^3/sec X Head X Density of water X 9.81/(1000 X pump efficiency X Motor Efficiency)

Head = 1000 Meters (given)

Motor Power = (0.000897 X 1000 X 960 X 9.81) / (1000 X 0.62 X 0.95) = 8448 / 589 =14.34 KW

Design Equations for Steam Desuperheaters

The cooling water volumetric flow rate, Q is given by:

$Q = C\ A\ \sqrt{2gh}$

Here, C is coefficient of discharge, A is area of orifice and g is the acceleration due to gravity and h is the head due to differential pressure.

Calculation of Desuperheater Turndown Capacity

The turndown ratio describes the range of flow rates over which the desuperheater equipment operates. It is the ratio of maximum flow rate to minimum flow rate. Variation in flow rates causes variation in the requirement of amounts of cooling liquid. Two types of turn down ratios are to be specified in steam desuperheater equipment, they are; steam turndown ratio and cooling water turndown ratio.

The ratio of the maximum flow required to the minimum flow that accurate temperature control can be maintained is known as the capacity turndown. As an example, if a desuperheater is designed to operate at a maximum flow of 50,000 lbs/hr., and a minimum flow of 5,000 lbs/hr., then turndown is 10:1.The ratio of maximum to minimum flow of the desuperheater is no greater than that of the system control components.

If mounted horizontally, TD = (operating velocity) / (min. de-superheating velocity)

If mounted vertically, TD = (operating velocity) / (15 fps)

Operating velocity = {(max. steam flow) (specific volume)} / {25 (cross-sectional area of pipe)}

TD= (steam flow + atomizing steam flow) / (atomizing steam flow)

When TD is not a function of Velocity.

(TD is limited to a maximum of 50 to 1.)

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