

SAD

Steam Atomising Desuperheater

Installation and Maintenance Instructions



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1. Safety information

Safe operation of these products can only be guaranteed if they are properly installed, commissioned, used and maintained by qualified personnel (see Section 1.11) in compliance with the operating instructions. General installation and safety instructions for pipeline and plant construction, as well as the proper use of tools and safety equipment must also be complied with.

1.1 Intended use

Referring to the Installation and Maintenance Instructions, name-plate and Technical Information Sheet, check that the product is suitable for the intended use/application. The products listed below comply with the requirements of the European Pressure Equipment Directive and carry the  mark when so required. The products fall within the Pressure Equipment Directive categories as shown below:

Application	Group 1 Gases	Group 2 Gases	Group 1 Liquids	Group 2 Liquids
Steam	-	Will not exceed Cat. 3	-	-
Water	-	-	-	Will not exceed Cat. 2

- i) The products have been specifically designed for use on steam which is in Group 2 of the above mentioned Pressure Equipment Directive.
- ii) Check material suitability, pressure and temperature and the maximum and minimum design pressure and design temperature values on the product nameplate. If the maximum operating limits of the product are lower than those of the system in which it is being fitted, or if malfunction of the product could result in a dangerous overpressure or over-temperature occurrence, ensure a safety device is included in the system to prevent such over-limit situations.
- iii) Determine the correct installation situation and direction of fluid flow.
- iv) Spirax Sarco products are not intended to withstand external stresses that may be induced by any system to which they are fitted. It is the responsibility of the installer to consider these stresses and take adequate precautions to minimise them.
- v) Remove protective covers from all connections and protective film from all name-plates, where appropriate, before installation on steam and water lines.

1.2 Access

Ensure safe access and if necessary a safe working platform (suitably guarded) before attempting to work on the product. Arrange suitable lifting gear if required.

1.3 Lighting

Ensure adequate lighting, particularly where detailed or intricate work is required.

1.4 Hazardous liquids or gases in the pipeline

Consider what is in the pipeline or what may have been in the pipeline at some previous time. Consider: flammable materials, substances hazardous to health, extremes of temperature.

1.5 Hazardous environment around the product

Consider: explosion risk areas, lack of oxygen (e.g. tanks, pits), dangerous gases, extremes of temperature, hot surfaces, fire hazard (e.g. during welding), excessive noise, moving machinery.

1.6 The system

Consider the effect on the complete system of the work proposed. Will any proposed action (e.g. closing isolation valves, electrical isolation) put any other part of the system or any personnel at risk?

Dangers might include isolation of vents or protective devices or the rendering ineffective of controls or alarms. Ensure isolation valves are turned on and off in a gradual way to avoid system shocks.

1.7 Pressure systems

Ensure that any pressure is isolated and safely vented to atmospheric pressure. Consider double isolation (double block and bleed) and the locking or labelling of closed valves. Do not assume that the system has depressurised even when the pressure gauge indicates zero.

1.8 Temperature

Allow time for temperature to normalise after isolation to avoid danger of burns.

1.9 Tools and consumables

Before starting work ensure that you have suitable tools and/or consumables available. Use only genuine Spirax Sarco replacement parts.

1.10 Protective clothing

Consider whether you and/or others in the vicinity require any protective clothing to protect against the hazards of, for example, chemicals, high/low temperature, radiation, noise, falling objects, and dangers to eyes and face.

1.11 Permits to work

All work must be carried out or be supervised by a suitably competent person.

Installation and operating personnel should be trained in the correct use of the product according to the Installation and Maintenance Instructions.

Where a formal 'permit to work' system is in force it must be complied with. Where there is no such system, it is recommended that a responsible person should know what work is going on and, where necessary, arrange to have an assistant whose primary responsibility is safety.

Post warning notices if necessary.

1.12 Handling

Manual handling of large and/or heavy products may present a risk of injury. Lifting, pushing, pulling, carrying or supporting a load by bodily force can cause injury particularly to the back. You are advised to assess the risks taking into account the task, the individual, the load and the working environment and use the appropriate handling method depending on the circumstances of the work being done.

1.13 Residual hazards

In normal use the external surface of the product may be very hot. If used at the maximum permitted operating conditions the surface temperature of some products may reach temperatures of 570 °C (1058 °F).

Many products are not self-draining. Take due care when dismantling or removing the product from an installation (refer to 'Maintenance instructions').

1.14 Freezing

Provision must be made to protect products which are not self-draining against frost damage in environments where they may be exposed to temperatures below freezing point.

1.15 Disposal

Unless otherwise stated in the Installation and Maintenance Instructions, this product is recyclable and no ecological hazard is anticipated with its disposal providing due care is taken.

1.16 Returning products

Customers and stockists are reminded that under EC Health, Safety and Environment Law, when returning products to Spirax Sarco they must provide information on any hazards and the precautions to be taken due to contamination residues or mechanical damage which may present a health, safety or environmental risk. This information must be provided in writing including Health and Safety data sheets relating to any substances identified as hazardous or potentially hazardous.

2. General product information

2.1 General

This document presents the installation, operation and maintenance instructions for steam atomising desuperheaters - SAD.

This document should be read in conjunction with the general arrangement drawing of the desuperheater.



Fig. 1 SAD steam atomising desuperheater

3. General product information

Direct contact desuperheaters reduce the temperature of superheated steam to produce steam temperatures approaching saturation temperature (typically to within 3 °C of the saturation temperature). To cool the superheated steam water is entrained and flashed into vapour by absorbing heat from the steam. It contains no moving parts and is therefore very simple in operation.

3.1 Construction

An SAD steam atomising desuperheater comprises an external shell, and has end connections which make it suitable for connecting directly into the steam pipework.

Inside the SAD there are a number of internal components, which give the unit its operating characteristics.

These components are referred to as 1) the nozzle, 2) the diffuser, and 3) the internal housing. The nozzle and diffuser are removable items, generally screwed into the internal housing. On larger units the nozzle and diffuser are attached to the internal housing by an internal flange arrangement.

3.2 Materials of construction

Component	Mechanical design temperature up to and including 425 °C	Mechanical design temperature above 425 °C up to and including 570 °C
Shell	ASTM A106 GrB	ASTM A335 P11
Atomising steam branch	ASTM A106 GrB	ASTM A335 P11
Water branch	ASTM A106 GrB	ASTM A335 P11
Flanges	ASTM A105N	ASTM A182 F11
Nozzle	ASTM A182 F316L	ASTM A182 F11
Diffuser	ASTM A182 F316L	ASTM A182 F11
Internal housing	ASTM A350 LF2N	ASTM A182 F11
Internal seals	Soft copper	Soft copper

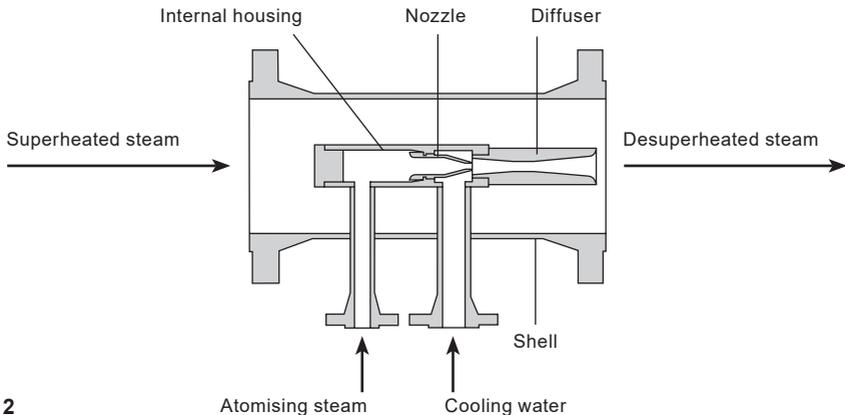


Fig. 2

It can also be supplied with butt-weld ends (not shown) for welding directly into the steam line by others.

Mechanical design temperature and flange rating

<374 °C	Class 150, Class 300 and Class 600 + PN16, PN25 and PN40 Slip-on (Weld neck optional)
374 - 525 °C	Class 150, Class 300 and Class 600 + PN16, PN25 and PN40 Weld neck (Slip-on N/A)
375 - 570 °C	Class 300, Class 600, Class 900 and Class 1500 + PN10, PN16, PN25, PN40, PN63 and PN100 Weld neck (Slip-on N/A)

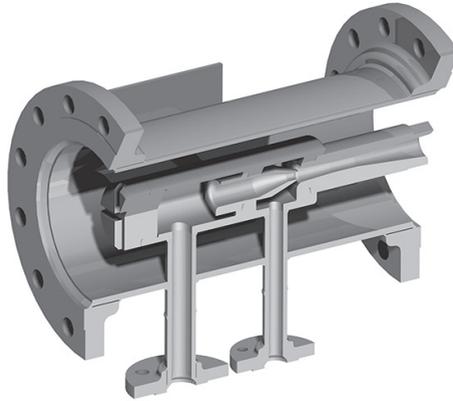


Fig. 3 Standard construction

4. Inspection and performance confirmation

4.1 Receiving inspection

Although Spirax Sarco carries out full inspection of all units before despatch, damage may have occurred during transit. On receipt of the unit, a visual inspection will highlight any external damage and hence indicate any internal damage that may have occurred. If this is the case please contact us immediately.

4.2 User's rating inspection

Before installing the SAD, the user must ensure the mechanical rating of the unit is suitable for the intended service.

Details of the mechanical rating can be found on the nameplate and associated documentation for the unit.

5. Installation

Note: Please read Section 1, 'Safety information' before proceeding with installation.

5.1 General

It is important that installation should only be carried out by qualified, experienced personnel, who are familiar with the fitting of steam atomising type desuperheaters, and who have read and understood the instructions in this IM.

5.2 Installation considerations

5.2.1 Steam piping upstream desuperheater

- a) The pipe size should be the same as the desuperheater steam inlet connection.
- b) The associated PRV is usually smaller than the desuperheater connection size. We recommend eccentric pipe reducers are used to achieve the change in size.
- c) Where noise from the PRV is expected to be a problem, consider making this pipe thicker than that required to just contain the pressure. This will help reduce noise levels emitted to atmosphere. Under extreme conditions this pipe may have to be acoustically insulated. This, however is very rare indeed.
- d) The distance between the PRV and inlet to the SAD should be as short as possible but long enough to have eliminated valve turbulence at the inlet to the desuperheater. The rule of thumb is that this distance should be five times the diameter of the desuperheater inlet or 1.5 metres, whichever is the longer. If the PRV and desuperheater are too close or if the PRV is too close to a pipe bend or other fitting, then turbulence may cause noise and vibration.

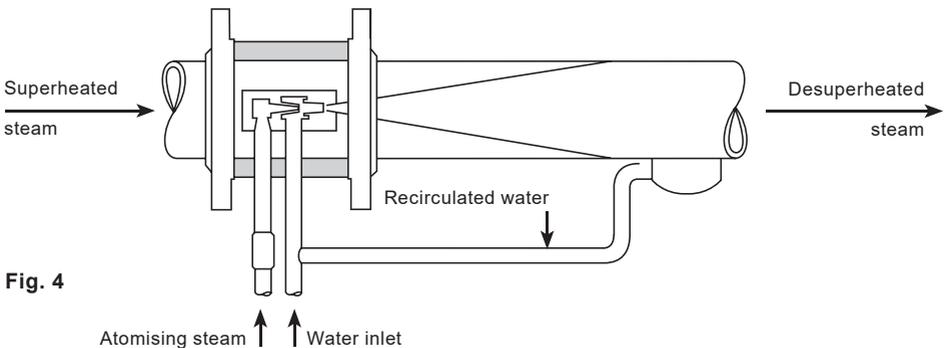


Fig. 4

5.2.2 Discharge steam piping

- a) The size should be the same as the desuperheater steam outlet connection.
- b) The distance between the desuperheater discharge connection and the location of the temperature sensor must be long enough to allow complete evaporation of the cooling water ahead of the sensor. If the sensor is too close to the desuperheater discharge, evaporation of the cooling water will not be complete and the sensor will give a false reading, with corresponding poor temperature control.
- c) This pipe should be straight, free of bends and contain no restrictions. We recommend a minimum straight length distance of 2.5 to 7.5 m depending on the amount of residual superheat required (specified in table below). The greater the amount of residual superheat required, the faster the water droplets are evaporated and the shorter the distance required.
- d) The table below specifies the minimum straight distance required between the desuperheater outlet and the temperature sensor versus residual superheat.

Amount of residual superheat	Minimum straight length distance to temperature sensor
3 - 5 °C	7.50 m
10 °C	6.80 m
15 °C	6.25 m
30 °C	5.00 m
50 °C	3.70 m
100 °C	2.50 m

- e) If bends or restrictions are placed in this pipework within the specified distance, before the droplets have had chance to evaporate, inertia causes the droplets to separate out from the main steam flow and run along the bottom or side wall of the pipe. Contact between the steam and cooling water is lost and desuperheating is halted.
- f) Use thermal insulation over this pipe section to help prevent false temperature readings (condensation can still occur on the walls of a 50 °C superheated steam line). Measurement error can be quite large, especially at low flow rates when heat lost through condensation is a high percentage of total heat energy in the line.
- g) The SAD has an inherent ability to 'suck-in' its own cooling water. When required to operate at high turndowns, this feature can be used to allow cooling water which has fallen out of suspension in the discharge line to be 'sucked' and recycled back to the cooling water inlet. The recycle arrangement is shown in the diagram below. It comprises a catch pot, which collects the 'fallen out' cooling water, and recycle line which re-cycles the fallen-out cooling water back to the incoming cooling water line, where it mixes with fresh, incoming cooling water.

5.2.3 Temperature sensor

- a) Speed of controlled response is important. For this reason, thermocouples or resistance thermometers are usually employed.
- b) The size of an associated thermowell is important. Ones with large mass slow down rate of heat transfer and can cause serious measurement time lags. At low flow rates the problem is worse. Sometimes it's sufficient to simply improve contact between the sensor and well. But in other cases a special well may be needed, such as an extended-surface type. Recommendations should be sought from the instrument supplier.
- c) The temperature sensor should be positioned on the uppermost surface of a horizontal installation.

5.2.4 Pressure sensor

This should be located at a minimum distance of 1.5 metres away from the desuperheater discharge flange. Ideally however, this should be located at the point of use so that the pressure control valve can compensate for any line loss between the desuperheater and the point of use.

5.2.5 Pressure relief valve (PSV)

In applications involving simultaneous pressure reduction and depending upon the pressure rating of the equipment, a safety relief valve to protect both the desuperheater and downstream equipment from the effects of excess pressure shall be considered. This could protect the desuperheater and downstream equipment if the PRV failed fully open for example.

5.2.6 Installation orientation

Desuperheaters may be installed either horizontally or vertically with the steam flowing upwards.

Spirax Sarco strongly advises against an installation in which the steam flow is vertically downwards.

In the case of a horizontal installation the cooling water connection should ideally point downwards, as this gives the best orientation for drainage of fluids in a shutdown situation. Other orientations are acceptable for satisfactory operation, but drainage is not as effective.

In a vertical installation we recommend that, the cooling water pipework should be brought to the desuperheater from below the corresponding connections on the desuperheater. This arrangement will provide the best layout for drainage of fluids on shutdown.

5.2.7 Other installation considerations

a) Isolation valves:

To provide a shut-off facility and to allow maintenance to be carried out, isolation valves are recommended upstream of:

- The superheated steam pressure control valve.
- The cooling water control valve.

b) **Strainers:** Depending on steam and cooling water quality, consider installing strainers in the lines in order to protect both the cooling water and steam valves as well as to prevent the small bores within the desuperheater from becoming blocked.

c) **Separator station:** In applications where there must be no moisture in the resulting steam (such as steam supply to a turbine or motive steam supply to a thermocompressor for example) it is recommended that a separator is installed downstream of the desuperheater system. This will protect downstream pipework and equipment from the effects of moisture in the event of a control system failure or from abnormal operating conditions, such as at start-up for example.

It is also considered prudent to install a separator station when desuperheating close to saturation temperature or for applications involving large steam turndowns. The separator must be located after the temperature sensor thereby giving the water droplets as much time as possible to evaporate.

The associated steam trap should be selected to prevent air binding and the discharge pipe from the steam trap should have ample capacity to deal with the drainage and be installed as near to the vertical as possible. There must be sufficient space in the drainpipe for the water to flow down and the air to pass up the pipe.

d) **Non Return Valve (NRV):** Consider the installation of an NRV in the cooling water line located immediately before the cooling water inlet connection to prevent back flow of steam into the cooling water inlet line in the event of either cooling water failure or excess pressure in the desuperheater caused by failure of the steam pressure reducing valve for example.

e) **Pressure tappings:** Include plugged pressure tappings within the connecting pipework which would allow gauges to be fitted to assist troubleshooting in the event of operational problems.

f) All connecting pipework must be sized in accordance with good working practice.

g) The termination points of the steam atomising desuperheater are not designed to be load bearing, therefore the client is responsible for ensuring that pipework loads are not transmitted to the connecting flanges of the desuperheater. We recommend that connecting pipework is supported from adjacent steelwork, to prevent loads being transmitted to the desuperheater.

h) Gaskets, valves, cocks and any in-line instruments should not reduce the cross sectional area of the connecting pipelines. This is of particular importance in smaller bore pipework.

i) Ensure that low points of all interconnecting pipework have suitable connections for drains.

j) Ensure the system can be safely vented back to atmospheric pressure following a shut down.

k) Consider the installation of air vents to remove air on start-up.

5.3 Unit installation

5.3.1 Pre-installation check

- a) The gasket materials used for the installation must be compatible with the fluids passing through the desuperheater and must be suitable for the design conditions of the installation.
- b) Ensure that the connecting pipelines are clean and that all weld spatter and foreign bodies have been removed.
- c) Ensure the desuperheater is free of foreign bodies such as packing materials etc.

5.3.2 Installation

Only four connections to the connecting pipework are required:-

- a) The steam inlet connection is to be connected to the superheated steam line.
- b) The steam outlet connection is to be connected to the discharge line.
- c) The atomising steam inlet is to be connected to the atomising steam supply.
- d) The cooling water inlet connection is to be connected to the cooling water inlet line.

6. Operation

6.1 Unit operation

It contains no moving parts and is therefore very simple in operation.

The SAD employs high pressure auxiliary steam (referred to as the atomising steam) to atomise the incoming cooling water. Thus, SADs are suitable for use in a combined pressure reducing/desuperheating stations where sufficient high pressure steam is available. In these cases, the atomising steam is taken from a location upstream of the PRV.

The atomising steam pressure needs to be at least 1.5 times the desuperheater operating pressure, with a minimum pressure of 3.0 bar g. The atomising steam flows are normally between 2 and 5% of main steam flow. The degree of superheat in the atomising steam is immaterial.

Other than an on/off isolation valve, the atomising steam flow does not require to be controlled. It is regulated by the size of the bore within the nozzle in conjunction with the atomising steam conditions. The flow of atomising steam into the SAD is therefore relatively constant.

The principle of operation is as follows:-

1. Atomising steam enters the SAD through the atomizing steam branch and passes towards the nozzle.
2. The steam enters the nozzle where it is accelerated to a high velocity, dropping in pressure as it does so. It emerges from the nozzle into the diffuser inlet as a high velocity jet of steam. The dimensions of the nozzle are determined by calculation.
3. Cooling water enters the desuperheater at line pressure and enters the internal housing, then the diffuser inlet.
4. At the diffuser inlet, the high velocity jet of steam leaving the nozzle serves to atomise the incoming cooling water.
5. The mixture of cooling water and steam is intimately mixed at high turbulence as it moves along the diffuser. The internal profile of the diffuser is determined by calculation and promotes turbulence, mixing and desuperheating in this region.
6. A saturated, highly atomised, mist (or fog) emerges from the diffuser at high velocity where it mixes with the incoming superheated steam which has passed around the outside of the nozzle, internal housing and diffuser.
7. The combined streams then pass out of the SAD into the discharge piping where the final desuperheating takes place.

6.2 Pre-operational check

- a) Check control system has been tested and is operational.
- b) Check relief valve (if fitted) has been tested and is fit for operation.
- c) Ensure all isolation valves (both steam and cooling water) are closed.
- d) Ensure that all line restrictions have been removed.
- e) Ensure that cooling water is available upstream of the cooling water isolation valve.
- f) Take all precautions necessary to handle the possibility of leakage, both in terms of protection of personnel and nearby equipment.

6.3 Start-up procedure

The following start-up procedure should be considered as our initial recommendation as to how to start-up the desuperheater. It must be reviewed by the end user, preferably within a HAZOP, to determine whether it is consistent with the operating philosophy of the rest of the plant. The sequence of steps can be revised if necessary. However, the approach of ensuring the cooling water is made available to the desuperheater before admitting steam must be followed.

1. Activate the control system. The temperature control valve in the cooling water inlet line should close.
2. Open the cooling water isolation valve.
3. Open the steam isolation valve downstream of the SAD. This may cause the desuperheater to pressurise, depending on the condition of the downstream system.
4. Open the atomising steam isolation valve. This will admit atomising steam into the SAD. The cooling water control valve may begin to open.
5. Very slowly open the upstream steam isolation valve to admit superheated steam to the desuperheater. Steam will begin to flow through the desuperheater. The PRV (if fitted) will begin to modulate to control the downstream pressure and the cooling water control valve will begin to open or (if already open) open further.
6. At this point the desuperheater is fully operational. Operational checks should be made to ensure:-
 - The cooling water valve is modulating correctly.
 - The PRV (if fitted) is modulating correctly.
 - The control valves are neither fully open nor nearly shut. (This would indicate incorrect sizing of these items).
 - The desired desuperheated temperature is being met.
 - The pressures of all streams around the desuperheater are correct.
 - All other ancillary items related to the desuperheater operation are functioning satisfactorily.

6.4 Shutdown procedure

This procedure must be reviewed and checked for consistency of operation with the rest of the plant. The sequence of steps may be revised if necessary, but the general principle of isolating the cooling water as the last step must be followed.

1. Slowly close the upstream steam isolation valve.
2. Close the atomising steam isolation valve.
3. Close the isolation valve downstream of the desuperheater.
4. Close the cooling water isolation valve.
5. De-activate the control system.

The desuperheater is now shut down.

7. Maintenance

Note: Please read Section 1, 'Safety information' before proceeding with any maintenance.

Maintenance should only be carried out by qualified, experienced personnel, who are familiar with desuperheaters and who have read and understood all the instructions in this document.

Caution

Do not proceed with any maintenance unless the SAD has:-

- i. Been relieved of all pressure and/or vacuum.
- ii. Been allowed to reach ambient temperatures.
- iii. Been drained and purged of all fluids.
- iv. Had all connecting lines fully isolated.

7.1 Preventative maintenance

Spirax Sarco suggests that the user creates maintenance schedules, safety manuals and inspection schedules for each specific desuperheater installation.

On all installations, the following items should be considered by the user :-

- a) Desuperheater for blockages, particularly the steam nozzle, internal diffuser and cooling water holes. Check cooling water holes for scale build up which could indicate poor cooling water quality.
- b) Desuperheater for internal wear, particularly the steam nozzle, internal diffuser, main diffuser and cooling water holes.
- c) Discharge piping and fittings to be checked for signs of erosion, corrosion, debris build up and blockages.
- d) Sufficient tightness of flange connecting bolts.
- e) Strainers for debris build up.
- f) All other associated ancillary equipment and valves, in particular:-
 - The correct operation of all control equipment.
 - The correct operation of instrumentation.

7.2 Maintenance of steam atomising desuperheaters

Steam atomising desuperheater disassembly

We recommend that any personnel carrying out maintenance work are in possession of the General Arrangement Drawing of the desuperheater.

For the purposes of:-

- a) Internal Inspection
- b) The fitting of new gaskets.
- c) Removing or fitting a new steam nozzle.
- d) Removing or fitting a new diffuser,

the steam atomising desuperheater must be dis-assembled to some degree.

1. Disconnect the connecting flanges to the desuperheater.
2. Remove the desuperheater from the line. This immediately permits an internal inspection of the desuperheater but it does not permit a full detailed inspection of the internals.
3. With the internals removal tool, enter the steam inlet of the desuperheater and engage the slots in the nozzle. Rotate anti-clockwise to unscrew and remove the nozzle. This will permit full inspection of the nozzle and its associated sealing gaskets.
4. With the internals removal tool, enter the discharge connection of the desuperheater and engage the slots in the diffuser. Rotate anti-clockwise to unscrew and remove the diffuser. This will permit full inspection of the diffuser, including the associated sealing gaskets.

At this point the desuperheater is completely disassembled.

Steam atomising desuperheater reassembly

Reassembly of the desuperheater is achieved by following the reverse procedure. However, when re-assembling:-

- a) Check all sealing faces are clean, flat and undamaged in anyway. Any damaged sealing faces, whether on the internal housing or internals, must be repaired.
- b) Renew all gaskets within the unit. It is essential for satisfactory operation that the thickness of these gaskets is the same as the ones originally present.
- c) Ensure against over tightening of any component.

8. Troubleshooting

Note: Please read Section 1, 'Safety information' before troubleshooting.

8.1 Introduction

Once successfully commissioned, desuperheaters provide trouble free service. However, as with any equipment in erosive or corrosive service, break down beyond control may occur.

A knowledge of the correct procedures for locating and correcting faults can lead to considerable time saving.

Poor performance of a desuperheater can be caused by either external or internal factors. Secondly, all performance can also be classified as either being gradual or sudden.

In general, a gradual loss of performance will normally suggest internal corrosion or erosion, whereas a sudden loss in performance will normally suggest an external factor is to blame.

Before setting out to examine why the desuperheater is not performing correctly, we strongly recommend that all instruments and any control systems are first checked that they are not giving false readings.

8.2 External causes of poor performance

At this stage, if an actual control system is fitted, ensure that all pressure and temperature indicating controllers are functioning and set correctly. Also check supply and signal pneumatic or electrical lines to the respective actuated control valve. Then check the operation of both the pressure and temperature control valves.

i.) Outlet pressure not in accordance with the specification.

Check the operation of the actuated or manually operated pressure control valve prior to the desuperheater.

- a) Check the steam pressure upstream and downstream of the pressure control valve.

The superheated steam at the inlet to the desuperheater must be in accordance with the design specification or the design of the unit must be modified.

- b) A varying steam pressure will cause a fluctuating outlet steam pressure unless an actuated pressure control system is fitted.

ii.) Steam outlet temperature not in accordance with the specification.

- a) Check temperature and pressure of cooling water prior to unit is in accordance with the design specification. If the pressure and temperature cannot be changed in accordance with the design specification, the desuperheater must be modified.

- b) Check all ancillary equipment associated with the cooling water supply line, including possible booster pumps, strainers, non - return valves and manually operated and actuated temperature control valves and associated control system.

- c) Check the atomising steam pressure and temperature is within specification.

8.3 Internal causes of poor performance

This involves an investigation into the individual desuperheater.

To perform a full investigation on an individual desuperheater, we recommend that it is removed from its location in the pipeline and then disassembled as described in Section 7.2 of this Manual.

Things to be checked during dis-assembly are as follows:-

1. Eroded and corroded parts, particularly the steam nozzle and the diffuser.

If the internal components are worn or corroded, spares should be fitted.

2. Gaskets and gasket seating surfaces.

Check that gaskets are sitting correctly and do not permit by-passing of steam or cooling water. New gaskets should always be fitted when re-assembling a desuperheater (See Section 5.3).

3. Blockages or partial blockages, particularly the small water holes in the internal diffuser.
4. Concentricity between steam nozzle and diffuser.
5. Cracked components.

