FLOWSERVE GESTRA

GESTRA

Condensate Manual

Experience In Motion

1st Edition 1980
2nd Revised Edition 1982
3rd Revised Edition 1986
4th Revised Edition 1987
5th Revised Edition 1991
6th Revised Edition 1995
7th Revised Edition 2003
8th Revised Edition 2004
9th Revised Edition 2005

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FLOWSERVE® GESTRA

Abbreviations

The following abbreviations are used in this booklet for the corresponding GESTRA equipment:

AK	GESTRA automatic drain valve for start-up drainage
BK	GESTRA Duo steam trap BK Thermostatic/thermodynamic steam trap with regulator of DUO stainless steel
MK	GESTRA steam trap Flexotherm MK. Thermostatic trap with membrane regulator
DK	Thermodynamic steam trap
UNA Duplex	GESTRA float trap UNA with thermostatic bellows or capsule for automatic air-venting
UNA Simplex	GESTRA float trap UNA without thermostatic element
GK	GESTRA Super steam trap GK. Thermodynamic steam trap with stage nozzle
RK	GESTRA DISCO non-return valve in wafer design
TK	GESTRA Duo Super steam trap TK. Thermostatic steam trap with thermostatic pilot control by membrane regulators
TD	GESTRA mechanical drier for steam
TP	GESTRA mechanical drier and purifier for compressed air and gases
UBK	GESTRA steam trap UBK. Thermostatic trap for condensate discharge without flashing
UNA 2	GESTRA float trap UNA 23/25/26/27

UNA 1	GESTRA float trap UNA 14/16
VK	GESTRA Vaposcope. Sightglass
VKP	GESTRA VAPOPHONE: Ultrasonic detector for monitoring steam traps for loss of live steam
VKP-Ex	GESTRA VAPOPHONE: Ultrasonic detector for monitoring steam traps for loss of live steam (Ex protected)
VKE	GESTRA test set VKE for monitoring steam traps
ZK	GESTRA drain and control valve with radial-stage nozzle
H capsule	GESTRA thermostatic capsule for opening temperatures ≈ 5 K below saturation temperature
N capsule	GESTRA thermostatic capsule for opening temperatures ≈ 10 K below saturation temperature
U capsule	GESTRA thermostatic capsule for opening temperatures ≈ 30 K below saturation temperature
DN	Dimension, nominal. The nominal size of a pipe or fitting in mm
PN	Pressure, nominal. The nominal pressure rating (maximum cold-water working pressure) in bar

Technical Advice and Training Seminars

The GESTRA Academy offers training programs and project management assistance for technical staff to help implement future-oriented and complex projects in all fields of steam, condensate and process fluid control.

The tremendously fast progress of technology combined with the recent economic developments are placing ever greater demands on the training and qualification of employees and managers alike.
A company's wealth of technical knowledge and the know-how of its personnel in particular constitute nowadays the most important non-material asset of an enterprise. In many seminars held over the last few years our customers have often expressed a keen interest in authoritative theoretical and practical support.

To assist with this objective, the GESTRA Academy was set up in order to provide comprehensive technical literature and conduct workshops, seminars and personalized consulting and training programs.

Our hands-on seminars place great emphasis on the exchange of experience and the active presence and collaboration of the participants. Various practical examples of projects already implemented in different industries will be considered in order to outline the problems involved and their solutions.

The focus of the training seminars is on the following subjects:

- Fundamental principles of steam and condensate systems
- Sizing and design of pipework
- Efficient utilization of energy in steam systems
- Boiler automation and operation (without constant supervision for 72 hrs)

and other related topics and practical examples.

GESTRA training seminars are geared to the needs of technical staff working for engineering companies, project-, design- and plant engineers, foremen, interested specialists and personnel responsible for commissioning, servicing and maintenance.
Our seminars on Steam and Condensate Systems provide an in-depth and up-to-date exposition of the topic, placing great emphasis on the latest developments and technological trends.

Objective

- Optimization of steam and condensate systems for cost-efficient and trouble-free operation
- Solving practical problems, exchanging experience and active presence of theparticipants
- Various installation examples based on actual projects will illustrate problemsand their respective solutions

Certificate

GESTRA Diploma

The seminars are rounded off with some practical demonstrations given at our in-house testing facilities:

- **Open steam system**
- **Closed steam system**
- **Transparent testing and demonstration facility**

What are Steam Traps?

To be able to operate a plant over a long period with an optimum efficiency the choice of the correct valves is of vital importance.
Amongst these valves are steam traps which have an important role to play. Steam must be trapped within heating equipment until it has surrendered all heat energy, at which point the condensate thereby formed must be immediately discharged.

The optimum efficiency of a steam-heated plant is dependent upon the performance of steam traps. One type of steam trap cannot be equally well suited for the various applications and requirements, therefore GESTRA offers a comprehensive steam trap range developed and refined on practical applications over the years. The choice of the steam trap typedepends, of course, on the plant condition. We are willingly prepared to assist you in selecting the most economic solution for your particular application.

The three different steam trap types

BK
The BK is a thermostatic steam trap with Duo stainless (bimetallic) regulator.
Advantage: particularly robust

MK
The MK is a thermostatic steam trap with membrane regulator.
Advantage: very sensitive response characteristic.

UNA
The UNA is a float trap.
Advantage: condensate discharge at extreme and sudden condensate flowrate and pressure fluctuations.

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1. Steam Traps

FLOWSERVE GESTRA

1. Steam Traps

1.1 Evaluation Criteria

There is no such thing as a universal steam trap. It is therefore important to study the requirements of a particular application to choose the trap which will give the best results. The following points, amongst others, should be considered when selecting a steam trap:

- its control characteristics and flowrate capacity, depending on the application either as a single unit (e.g. use for large pressure ranges, for large pressure fluctuations, for large flowrates, for large flowrate fluctuations) or jointly (e.g. for large fluctuations in flowrate and pressure);
- its ability to vent itself and the plant;
- the possibilities provided for installation and maintenance; and
- its service life; its suitability for back pressure etc. (see Fig. 1).

The most important technical criteria for evaluation, together with the corresponding assessment of the steam trap types manufactured by GESTRA, are summarized in Fig. 2.

Properties of the Steam Trap

Basic requirements

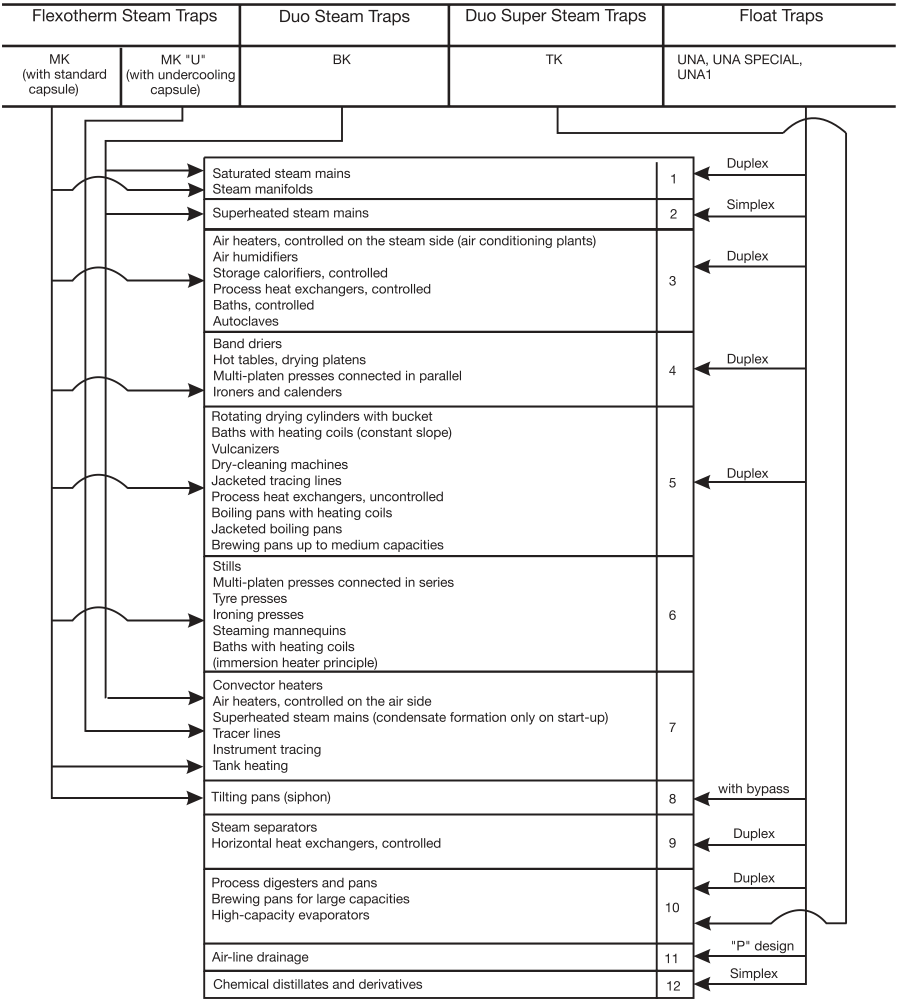
Discharging the required quantity of condensate without loss of live steam
Automatic air-venting

Additional requirements

No impairment of the heating process, no banking-up
Utilization of the sensible heat of the condensate by holding it back

Universal application	- Large pressure range - Works with high or low back-pressures - Wide range of flowrates - Accommodates large fluctuations in flowrate and pressure - For controlled installations
Low effort	- Easy installation - Minimum maintenance - Corrosion-resistant - Unaffected by dirt - Can withstand freezing - Resistant to waterhammer - Long service life - As few variants as possible

Fig. 1



1. Float trap - "Duplex" / MK / BK
2. Float trap - "Simplex" / BK
3. Float trap - "Duplex" / MK
4. Float trap - "Duplex" MK
5. MK / Float trap - "Duplex"
6. MK
7. MK "U" / BK
8. Float trap - "Duplex" with bypass/MK
9. Float trap - "Duplex"
10. Float trap - "Duplex" / TK
11. Float trap - "P" design
12. Float trap Simplex

Fig. 2 Steam trap selection
For a precise selection, please determine the application as per Chapter 4 and then choose the steam trap accordingly.
When assessing the operating economy of a good steam trap, the purchase price is usually of little importance in relation to the savings the trap provides later during operation of the plant.

Important Criteria for the Evaluation

1.1.1 Easy installation can significantly reduce costs. A lightweight trap which can be installed in any position might save its manufacturing cost compared to making pipework alterations or constructing support brackets for a large and heavy steam trap, which can also lose a considerable amount of heat by radiation.

1.1.2 A poorly vented and incompletely drained heat exchanger takes a long time to warm up – this can lead to higher manufacturing costs (owing to prolongation of the required heating times) or can even damage the product due to uneven temperatures in the heat exchanger (see Fig. 3).

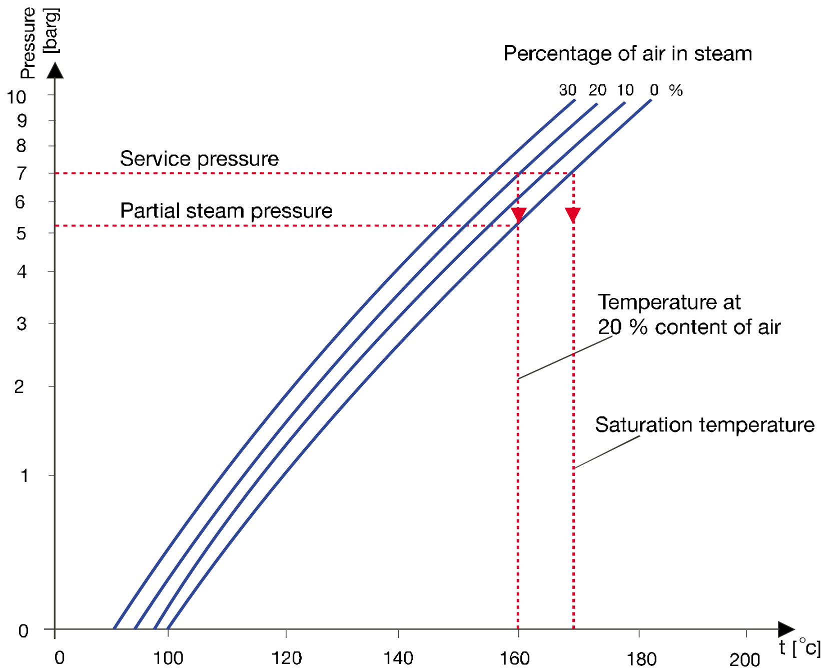


Fig. 3 Partial pressure of the steam and the corresponding saturated temperature as a function of the pressure for various percentages of air in steam.

1.1.3 Certain types of steam traps inherently blow off some steam, even when new. It is possible for the cost of the energy loss to exceed the purchase price of the trap within only a few months of operation. All steam traps operating according to the thermodynamic principle (e.g. the thermodynamic disc-type traps and inverted-bucket traps) suffer from this problem and will always waste a certain amount of steam.

1.1.4 Sometimes it is desirable to hold back the condensate in a heater to utilize the sensible heat. Use of an appropriate steam trap can yield considerable savings of energy (undercooling).

1.1.5 Freezing of the traps and the condensate piping in outside installations can cause serious production problems.

1.1.6 In the long run, using a cheap, non-repairable steam trap will require more effort in terms of time and money than a more expensive trap that can be removed and repaired.

1.1.7 The use of only a few trap types with wide applications throughout the plant will reduce costs, thanks to simplified stock-keeping as well as quick repair and maintenance by staff who are familiar with the traps.

1.2 The Various Steam-Trap Systems of GESTRA

have been developed to meet the special needs and expectations of the plant operators. Both technical requirements and economical considerations are always kept in mind.

1.2.1 Combined thermostatic/thermodynamic steam traps with bimetallic Duo stainless steel regulator, BK range (Fig. 4).

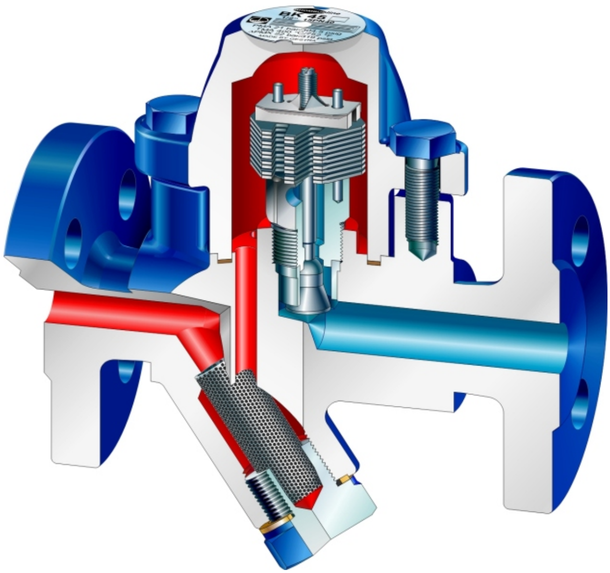


Fig. 4 GESTRA Duo steam trap BK

Condensate discharge is controlled by the regulating element of the trap as a function of pressure and temperature. The trap opens at a slight undercooling and closes immediately before saturation temperature is reached.

The high-lift effect (a thermodynamic process) produces the instantaneous opening of the trap and a consequently high hot-water capacity (see Fig. 5).
The discharge temperature of the condensate can be varied by using a regulator adjusted for undercooling. An increase in the condensate undercooling, provided the heating process permits, will lead to heat savings, whereas a reduced undercooling may lead to faster and more even heating.

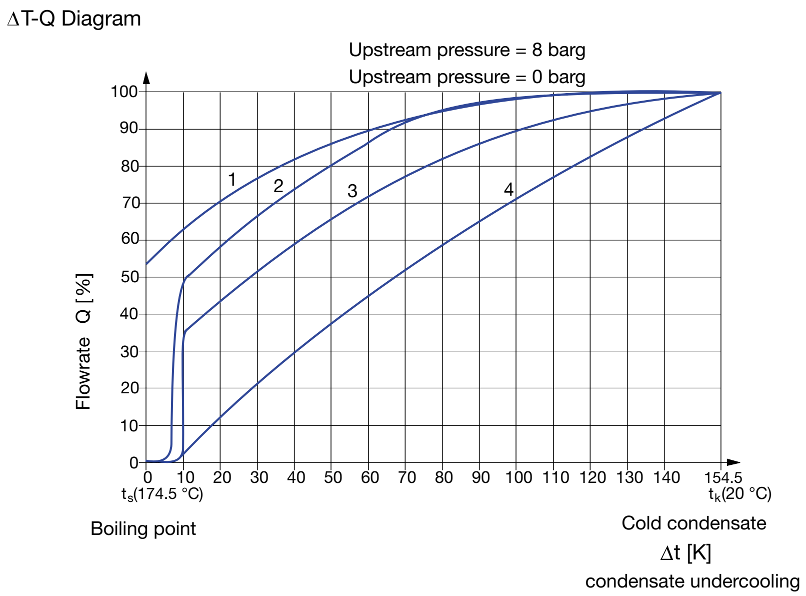


Fig. 5 Opening curves of various steam traps
Curve 1 – UNA Curve 3 – BK 45
Curve 2 – MK Curve 4 – standard bimetallic

Features of the BK range:

- Robust regulator unaffected by waterhammer, aggressive condensate and freezing; millions of installed units are giving excellent performance
- Stage nozzle with non-return valve action
- Automatic air-venting
- Available for all pressures and temperatures. Trap with long service life

A point to consider:
The condensate undercooling required for opening increases with rising back-pressure.

1.2.2 Thermostatic steam traps with membrane regulator, MK range (Fig. 6)

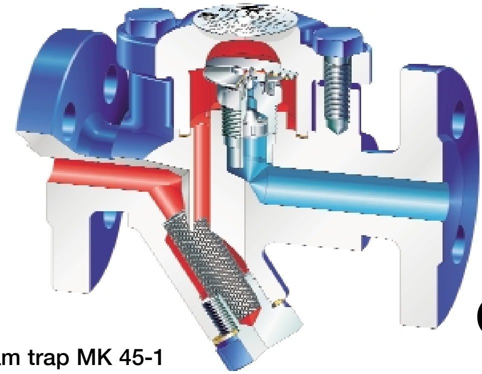


Fig. 6
GESTRA steam trap MK 45-1

RHOMBUS*line*®

Condensate discharge is controlled by the membrane regulator, a vapour-expansion thermostat, as a function of temperature. The control characteristic of the trap practically follows the saturated steam curve, and gives more accurate control than any other thermostatic trap (see Fig. 5). Owing to the sensitive response and the instant reaction to changes in temperature, the MK traps are particularly suited for heat exchangers where even the slightest banking-up of condensate would impair the heating process, such as vulcanizing presses, ironing presses and laboratory equipment.
The MK traps are available with three different capsules for different opening characteristics:

- **Condensate discharge without banking-up, for small to medium condensate flowrates**
  use the N capsule for condensate discharge practically without any banking-up (discharge temperature 10 K below saturation temperature).
  Two types of regulators are available for this purpose:
  With tandem shut-off (dual seat) for small condensate flowrates.
  With flat seat for medium to large amounts of condensate.
- **For large condensate flowrates**
  use the H capsule for condensate discharge practically without any banking-up (discharge temperature 5 K below saturation temperature).
  Various regulators with flat seat are available for this purpose:
  Depending on the condensate flowrate, with 1, 2, 3, 4 or 9 flat-seat membranes
- **For the utilization of a certain amount of sensible heat of the condensate**
  by banking-up, use the U (undercooling) capsule (discharge temperature 30 K below saturation temperature)
  For additional savings in energy (utilization of the sensible heat through banking-up in the heating surface, reduction of the amount of flash steam).

Two types of regulators are available for this purpose:
With tandem shut-off (dual seat) for small condensate flowrates.
With flat seat for medium to large amounts of condensate.

Features:

- Operation unaffected by back pressure. The capsule is corrosion-resistant and unaffected by waterhammer.
- Readjustment of regulator not possible (it is also unnecessary), which prevents steam losses as a result of tampering
- Automatic air-venting
- Thermostatic steam trap with perfect control

1.2.3 Rhombus*line* is more than just a new family of GESTRA steam traps

The objectives of harmonization, simplification of operating procedures and ease of installation always mobilizes the manufacturers to make continuous corrections and improvements, and to reduce the overall effort needed for manufacturing and operating a unit. One of GESTRA's chief aims is the advancement of all its products, wherever possible. Together with the introduction of the new casing form, called RHOMBUS*line*, a number of design changes were introduced with the aim of also improving the functional capabilities.

The designation RHOMBUS*line* covers the entire range of new traps of the type MK 45 and BK 45.

The fundamental change involved the shape of the casing cover of the steam trap. Until this point, the cover of the thermostatic traps of the type MK and BK had been fastened to the casing by means of four bolts. The cover of the new steam trap is affixed with only two. This increases the operating convenience and saves installation time.

Another important design modification for these steam traps involved modernizing the gasket between the cover and the casing. The gasket was embedded in the trap casing in the form of a ring in a groove. In contrast, the cover edge in contact with the casing was designed to have a projecting lip. Not only does this form a mechanical stop in conjunction with the casing surface, thus preventing uncontrolled squashing of the gasket, but it also creates a surface that presses the gasket against the curve of the groove. In this way, the gasket always remains in the tensioned state, guaranteeing the required tightness of fit. Moreover, it is not necessary to exchange the gasket every time the cover is fitted. Another advantage of this solution is that it is no longer necessary to retighten the fastening bolts of the trap cover after the first installation.

The wide-ranging experience gained with the BK 15 steam traps resulted in an optimization of the traps for the new RHOMBUS*line*. A patented Duo stainless steel plate arrangement in the regulator of the BK 45, consisting of a plate stack, reacts much faster than the previous version to parameter changes in the steam and in condensate lines.

Benefits of the RHOMBUS*line* traps:

1. The new regulator reacts more quickly to changes in the influencing factor steam/condensate (BK 45).
2. The shape of the RHOMBUS*line* casing permits the use of standard flange connecting bolts, both from the trap casing and from the counter-flanges.
3. It is no longer necessary to exchange the gasket between cover and casing every time the cover is removed from the trap.
4. The trap cover is mounted with only two bolts instead of four.
5. The Y-shaped strainer (with large filtering area for separating out impurities) simplifies the strainer cleaning process.
6. The sealing of the regulator (base bushing pressed into the casing) prevents internal leaks.
7. Retightening of the bolts after the initial commissioning is no longer required.
8. The overall length complies with the applicable codes.
9. Maintenance of the traps is simplified.

Fig. 7a RHOMBUS*line* steam traps

1.2.4 Thermostatic pilot-operated steam traps for very high flowrates, TK range (Fig. 7b)

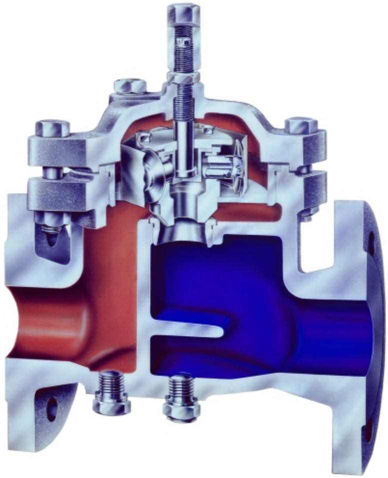


Fig. 7b GESTRA Duo Super steam trap TK 23/24 DN 50

The control element consists of a thermostatic pilot control with membrane regulators and a main valve. The regulating characteristic of the TK traps is similar to that of the MK traps, where the valve is directly operated by the membrane regulator.

Features:

- Easy to install in spite of large flowrate. Overall length corresponding to DIN standards for valves, low weight, installation in any position.
- Automatic air-venting, unaffected by dirt and aggressive condensate.

1.2.5 Thermostatic steam traps for condensate discharge without flash steam, UBK range.

This steam trap is a special version of the BK range with bimetallic Duo stainless steel regulator (see Fig. 5). With the factory setting, the condensate discharge temperature is < 100°C for pressures up to 19 barg (275 psig) and < 116°C for pressures up to 32 barg (465 psig).
The UBK traps are suitable for all applications where banking-up of condensate does not impair the heating process. A typical case is steam tracing with condensate discharge to atmosphere, and another example is steam trapping of instrument heating, i.e. all heating processes where a reduction of the heating capacity (by banking-up) is of advantage.
With no additional effort, the UBK traps ensure noticeable steam savings besides reducing environmental pollution by preventing flash-steam clouds and utilizing the sensible heat of the condensate.

1.2.6 Ball float traps, UNA range (Fig. 8a)

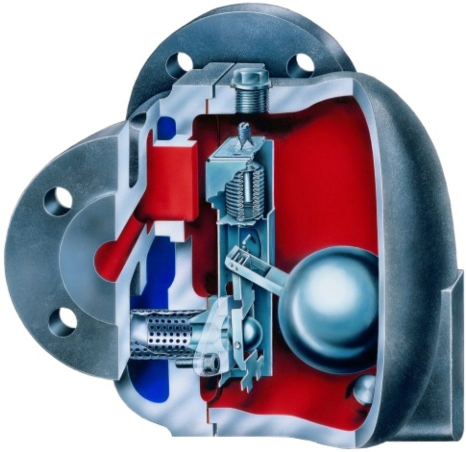


Fig. 8a GESTRA float trap UNA 23/25/26h

Condensate discharge is controlled directly by the float-operated valve as a function of the amount of condensate formed. The condensate is discharged immediately as it is formed. The operation of the trap is unaffected by the condensate temperature, by back pressure or by any pressure fluctuations (see Fig. 5).
Automatic air-venting of the plant is ensured by the UNA 2 float traps with "Duplex" control (thermostatic bellows). Thanks to its functional principle, this trap range is suitable for all process applications. It is ideal in plants controlled on the steam side: for heating processes with extreme pressure and flowrate fluctuations and very low pressures down to vacuum, and for trapping steam driers and flash vessels whilst maintaining the level at the required height. If the steam is relatively wet, trapping of steam mains with float traps might be advantageous.
Float traps are the only traps that can be used for removing air and also for draining condensate (e.g. from compressed air installations), distillates and other chemical products having a saturation curve differing from that of water. The same applies for flash vessels or discharge controls for maintaining a certain condensate level (Simplex design).

Features:

- No banking-up of condensate
- Operation unaffected by back pressure
- Automatic air-venting with thermostatic bellows (Duplex design) opening the main valve
- Relatively small-sized for a float trap.
- **Versions for horizontal and vertical installation**
- UNA 2 v traps with Duplex control for vertical installation can withstand freezing

1.2.7 **Thermodynamic steam traps, DK range** (Fig. 8b)

Thermodynamic traps have a simple design and small size. In addition, they are resistant to waterhammer and freezing. During operation, these traps require a small amount of steam for control purposes.

The thermodynamic steam traps are made of stainless steel in the following variants:

DK 57 L - for small condensate flowrates
DK 57 H - for large condensate flowrates
DK 47 L - as above, additionally equipped with a strainer
DK 47 H - as above, additionally equipped with a strainer

Further data:

PN 63, DN 10/15/20/25 mm
Screwed sockets
3/8", 1/2", 3/4", 1" BSP or NPT

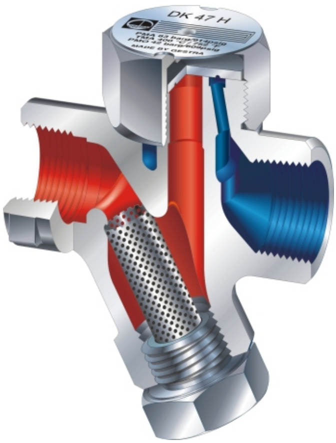


Fig. 8b Thermodynamic steam trap DK 47

1.2.8 Thermodynamic steam traps with stage nozzle, GK range, and with radial stage nozzle, ZK range (Fig. 9)

Fig. 9 GESTRA drain and control valve with radial stage nozzle ZK 29

The state of the condensate prevailing in the nozzle system (cold – condensate only; hot – condensate + flash steam; boiling hot – minimum condensate + maximum flash steam) controls the condensate flowrate without any modification of the cross-sectional area. The traps can therefore be used without any mechanical readjustment being necessary, even if the operating conditions vary to a certain extent; it suffices to adjust them once to suit the operational situation. Because of their excellent regulating characteristic and high wear resistance, the ZK valves are ideally suited as proven low-noise control valves in control systems with a high pressure drop, e.g. injection cooling, leak-off control and level control.
The stage-nozzle traps with handwheel operation are used for the discharge of high flowrates with a relatively constant amount of condensate forming, such as evaporators, tank heating, rotating drying cylinders etc.

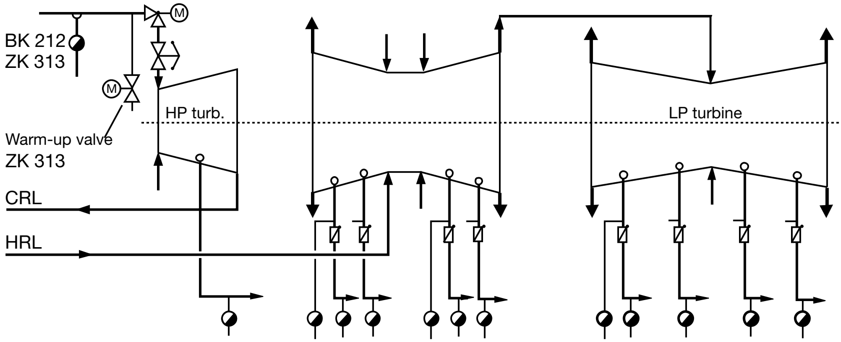
Features:
- High flowrates, little weight, reduced dimensions
- No moving parts, simple and reliable
- High wear resistance
- Unaffected by dirt

1.2.9 New drainage systems for use in power stations

In modern power stations, the demands on drain valves are increasing together with the efficiency. These valves are characterized by high resistance to wear, tight sealing and low maintenance costs, making a significant contribution to economical operation of the power station. In addition, new capacitance probes are able to detect condensate of low conductivity independently of the pressure and temperature. This now enables level-dependent (controlled) drainage at positions where the temperatures had previously ruled out their use. Plant components can be protected from damage caused by undetected quantities of condensate. The controlled drainage equipment is only opened when condensate is actually present. In presence of superheated steam, the valves are closed, thereby preventing steam losses and achieving a high degree of operating safety.

For instance, before the steam turbine of a power station can be started, the steam lines must be freed of condensate and warmed to their specified start-up temperature. Fig. 10a shows an example of the drainage for the turbine plant of a conventional power station. The live steam line is additionally heated by a separate warm-up valve.

The drainage points marked with the steam trap symbol consist of two independent traps. The ZK drain valve is used for the condensate discharge during start-up and for any further warming-up which may be needed. This valve is closed after a preset time has elapsed or when a certain temperature has been reached in the relevant part of the plant. It opens at the earliest when the power station block is shut down. In parallel to this procedure, controlled drainage using level probes is also possible. Owing to heat losses in the drain line, small quantities of condensate are produced and these are discharged by a thermostatic steam trap. This continuous drainage is necessary to prevent the condensate from rising in the drain lines, which sometimes extend over long distances.



Drainage equipment			
1) Continuous drainage	BK 212 BK 29	BK 29	BK 45
2) Start-up drainage	ZK 313	ZK 29	ZK 29

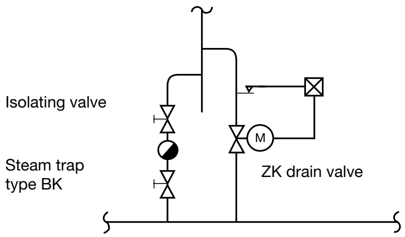


Fig. 10a Drainage scheme for a turbine plant

Steam-Line Drainage

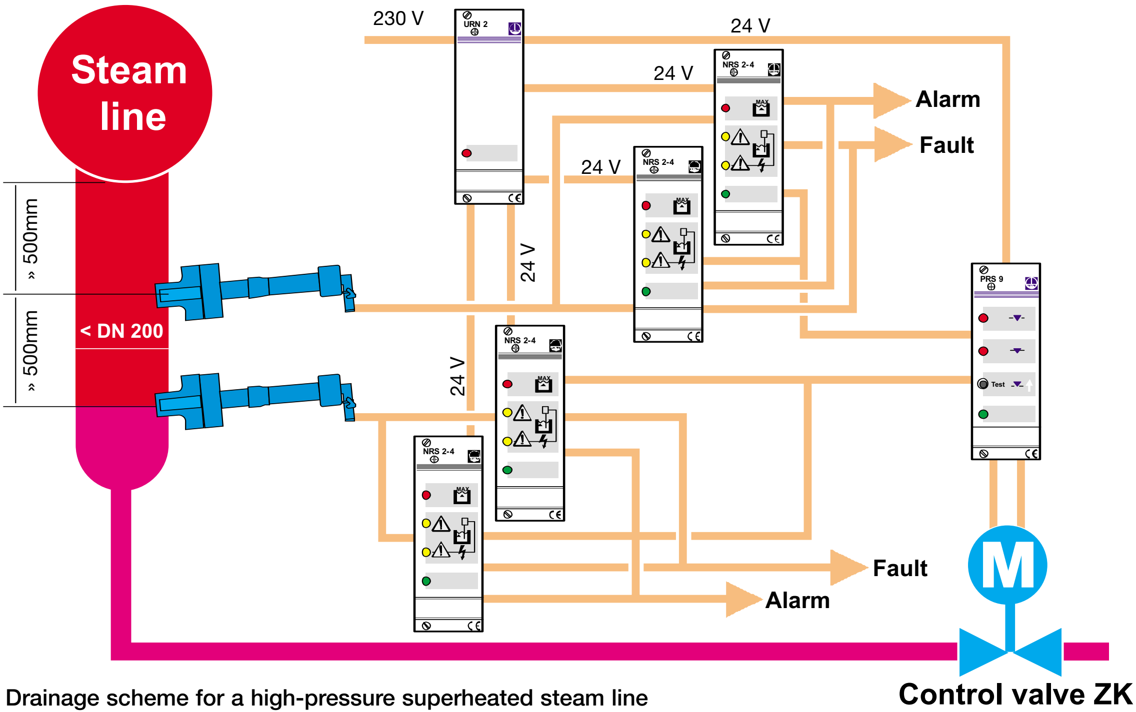


Fig. 10b Drainage scheme for a high-pressure superheated steam line

Control Valve ZK 29

H. P. preheater in a nuclear power plant equipped with a condensate drain control valve type ZK 29

K_{VS} 130 m^3/h,

1.4903

67 bar, (972 psig)

588 °C

Our Mobile Testing Station

For more information please contact ++49 - 421 - 35 03 311.

The mobile testing station will come directly to your plant accompanied by qualified and experienced engineers from GESTRA who will give practical demonstrations of steam and condensate applications. All we need from you is steam, water and electricity.

2. Basic Principles of Steam Trapping with Examples

2.1 The condensate should be freely discharged downwards from the heat exchanger (Fig. 11)

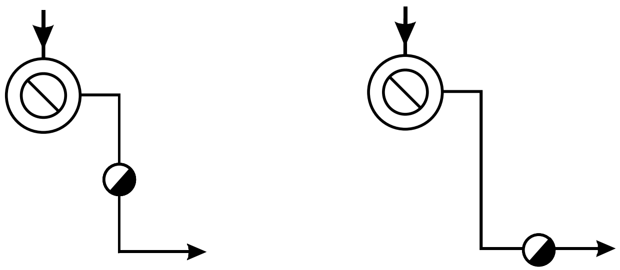


Fig. 11

2.2 A certain differential pressure (pressure drop) is required by the steam trap (Fig. 12)

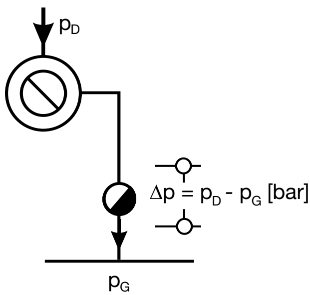


Fig. 12

2.3 If the condensate downstream of the trap is lifted, the differential pressure is reduced by approximately 1 bar for 7 m of lift, or 2 psi for 3 feet of lift (Fig. 13)

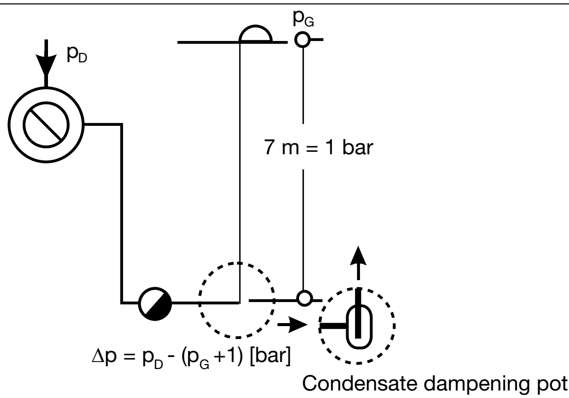


Fig. 13

2.4 **If the condensate upstream of the trap has to be lifted, a water seal or lift fitting is required** (Fig. 14)

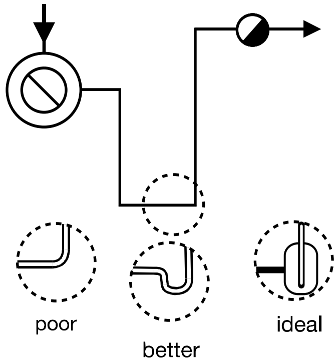


Fig. 14 Use of a condensate dampening pot, type ED

2.5 **Condensate pipework should be adequately sized to handle flash steam, so that high back-pressures do not build up** (Fig. 15)

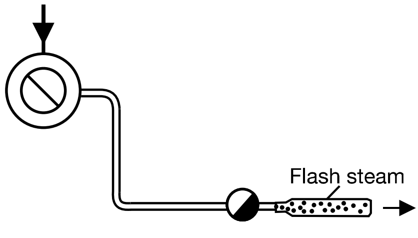


Fig. 15

2.6 **The condensate and, if possible the flash steam, should be collected and re-used** (Fig. 16)

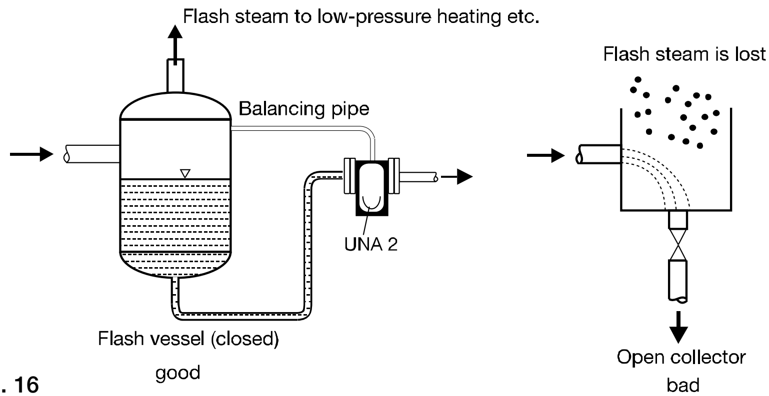


Fig. 16

2.7 Each heat exchanger should be trapped separately

2.7.1 Separate trapping of each individual heat exchanger (individual drainage) (Fig. 17)

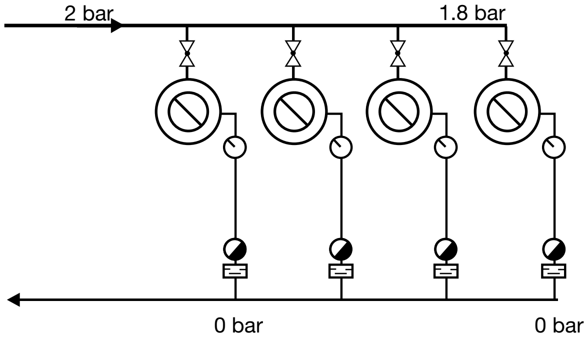


Fig. 17 Separate drainage ensures condensate discharge without banking-up. Individual steam-side control is then possible. Banking-up and waterhammer in the heating spaces is prevented. Additionally installed DISCO non-return valves RK stop condensate returning to the heat exchanger when, for example, the steam pressure in the heat exchanger drops owing to the control valve throttling or closing. Vaposcopes downstream of the heating surfaces permit visual monitoring. Banking-up is detected reliably.

2.7.2 Drainage of several heat exchangers connected in parallel with a single trap (group trapping = one large condensate tank instead of many small ones) (Fig. 18)

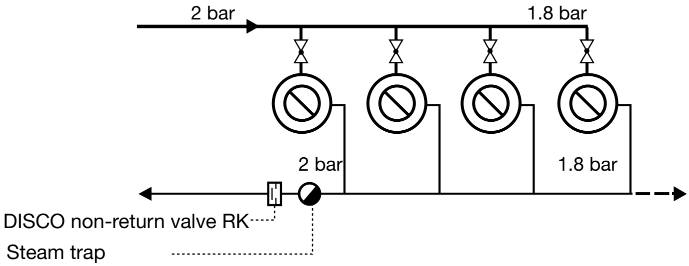


Fig. 18 Group trapping should be avoided. Pressure drops through each control valve and heat exchanger will inevitably be different. This leads to one or more heat exchangers being short-circuited on the condensate side. Condensate will bank up and waterhammer will occur.

2.7.3 Drainage of several heat exchangers connected in series (e.g. multi-platen presses) (Fig. 19)

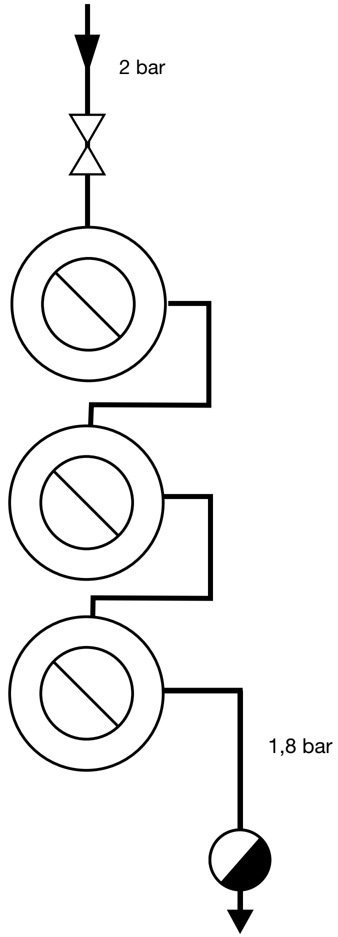


Fig. 19 Series connection of heat exchangers
Small identical heat exchangers (such as the steam plates of multi-platen presses) can successfully be connected in series, provided that there is a continuous fall from the steam inlet to the trap. To obtain perfectly equal surface temperatures in the heating spaces, there must be no banking-up of condensate in the steam space at all. In many cases, this can only be prevented by means of a certain steam leakage through the trap (BK regulated correspondingly). Because steam losses then occur, separate trapping may be the more economical solution, even for very small heat exchangers.

2.8 Banking-Up of Condensate (Pros and Cons)

2.8.1 Banking-up of condensate in the heating exchanger reduces the rate of heat transfer (Fig. 20)

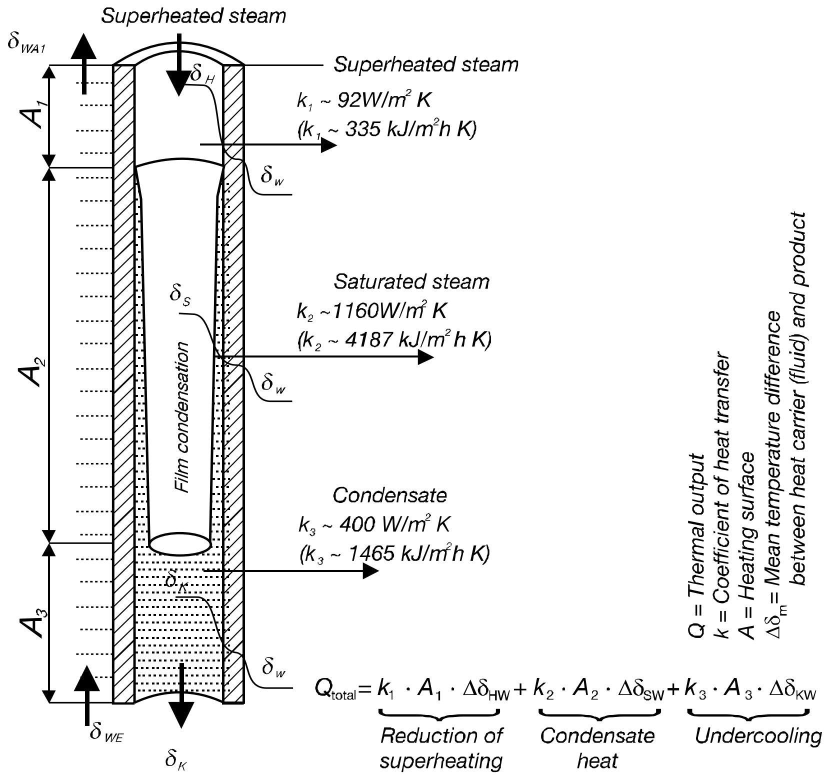


Fig. 20 Heating with superheated steam and banking-up of condensate
The above drawing shows the heat exchange and temperature gradient in a steam-heated water heater (counterflow heat exchanger).
Example: The heating surface is heated up with superheated steam, saturated steam and condensate in turn; the medium to be heated is water. This results in the following heat transition coefficients:

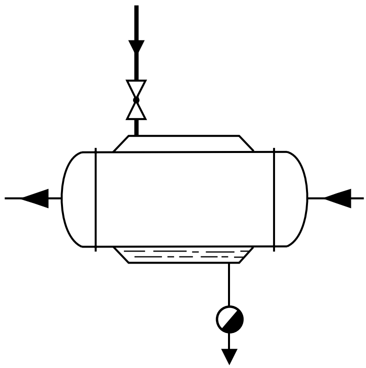
For superheated steam	k ~ 92 W/m²K (335 kJ/m²hK)
For saturated steam	k ~ 1160 W/m²K (4187 kJ/m²hK)
For condensate	k ~ 400 W/m²K (1465 kJ/m²hK)

The rate of heat transfer for saturated steam is about 12 times greater than for superheated steam and about 4 times greater than for condensate.

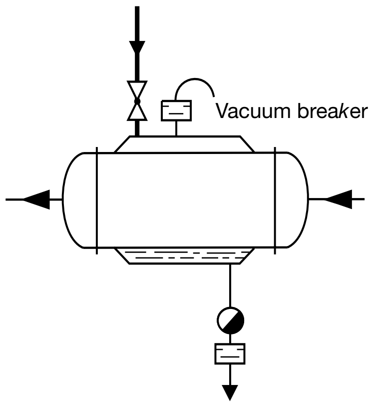
2.8.2 Banking-up of condensate in the heat exchanger will improve fuel economy by saving steam. It must, however, be considered that this may cause waterhammer.

2.9 Measures for Preventing Waterhammer

2.9.1 Condensate-free heating surfaces through proper installation
(Figs. 21, 22 and 23)



a) If the steam supply is cut off, vacuum is formed in the steam space as the remaining steam condenses. The condensate may then be sucked back into the heating space or not completely discharged. When the plant is restarted, the steam flows across the water surface, condenses suddenly and causes waterhammer.



b) Installation of a GESTRA DISCO non-return valve as a vacuum breaker prevents the formation of vacuum. The condensate cannot be sucked back, and the remaining condensate will flow off. Waterhammer is therefore avoided. If the condensate line is under pressure, the installation of a DISCO non-return valve downstream of the steam trap is recommended.

Fig. 21 Waterhammer in heat exchangers

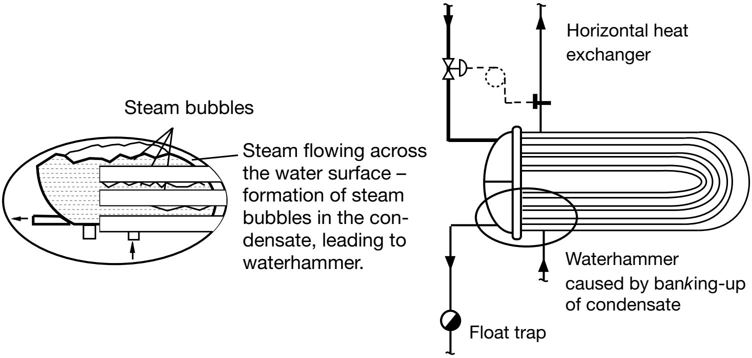


Fig. 22 Waterhammer in horizontal heat exchangers controlled on the steam side.
Waterhammer is avoided if the condensate is completely discharged from the heating surface at all load conditions (no banking-up). Waterhammer can occur if part of the heating surface is flooded. The condensate cools down, and so the steam flows across the cold water surface. This leads to steam bubbles in the condensate which condense abruptly, causing waterhammer.

Possible causes for banking-up.
Inadequate steam trap (e.g. wrong working principle, condensate discharge not instantaneous, insufficient trap size).
Trap operation imperfect (e.g. trap does not open, or opens with too high undercooling).
Differential pressure for steam trap too low, because of too high a pressure drop across the heat exchanger at low load conditions (e.g. back pressure in condensate line downstream of trap > 1 bar absolute, pressure in heat exchanger at low load < 1 bar absolute).

Measures for preventing waterhammer.
Use only float traps of the type UNA Duplex, to ensure instantaneous condensate discharge without banking-up.
Ensure that the trap is large enough, since at low load conditions the pressure upstream of the trap might be extremely low (even vacuum). The latter requires that there is no building-up of back pressure and no lifting of condensate downstream of the trap, and that an additional pressure head is provided by installing the trap at a lower point. If it is possible that a vacuum may form in the heat exchanger, the installation of a vacuum breaker (non-return valve RK) on the steam main downstream of the controller is recommended.

2.9.2 "Dry" condensate lines (sufficient fall, no formation of water pockets)

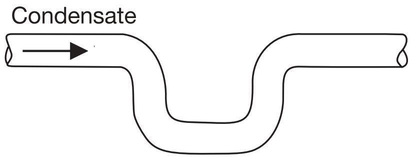


Fig. 23 Undesired formation of water pockets

2.9.3 Dry steam piping and steam manifolds (steam consumption from manifolds or piping always from the top; proper drainage, with installation of a steam drier if necessary) (see Figs. 23, 23a, 23b, 24 and 30).

Fit a drainage pocket at least every 100 m along the steam main, and also wherever the main rises.

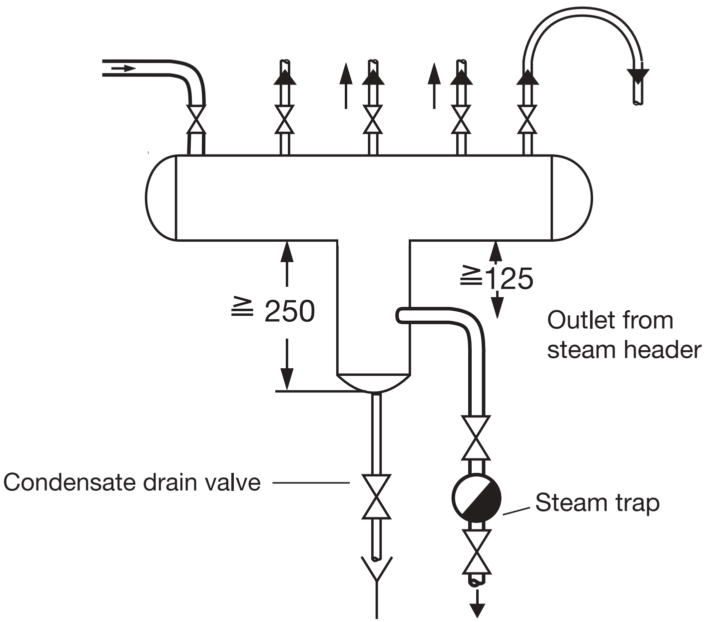


Fig. 23a Drainage and steam consumption from steam header

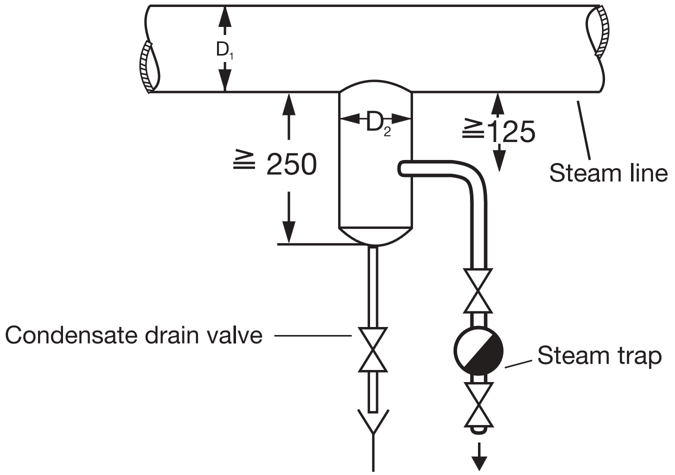


Fig. 23b Line drainage

D1	mm	50	65	80	100	125	150	200	250	300	350	400	450	500	600
D2	mm	50	65	80	80	80	100	150	150	200	200	200	250	250	250

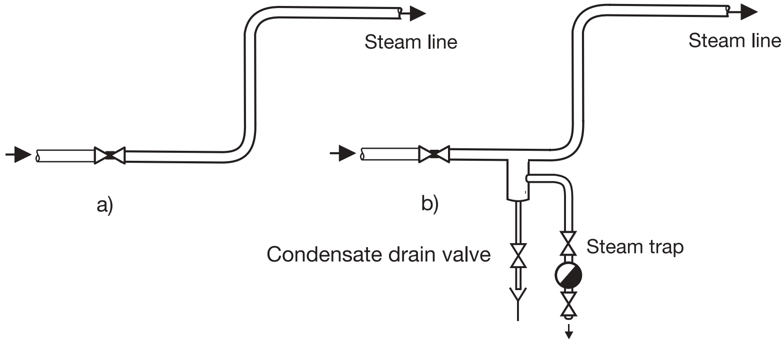


Fig. 24 Waterhammer in steam lines

a) Whenever the stop valve is closed, the steam remaining in the line condenses. The condensate collects in the lower part of the line and cools down. When the valve is reopened, the inflowing steam meets the condensate. The result is waterhammer.

b) If the run of the pipe cannot be changed, the line should be drained, even if it is relatively short.

2.9.4 Steam traps in continuous operation

2.9.5 Buffer vessels and water seals if condensate is lifted (Fig. 25)

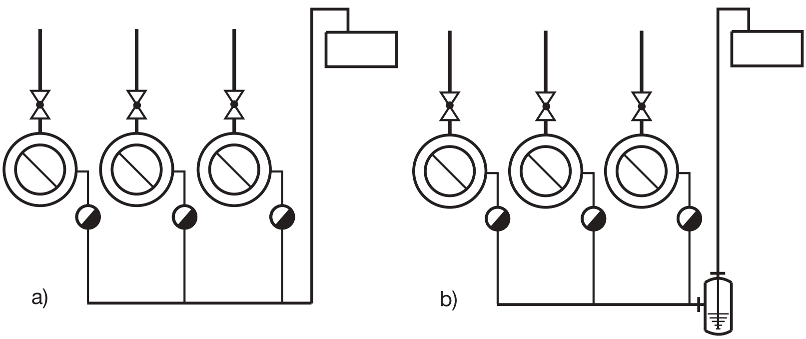
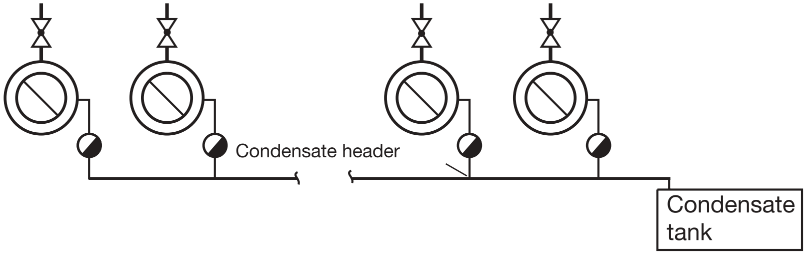


Fig. 25 Waterhammer if condensate is lifted

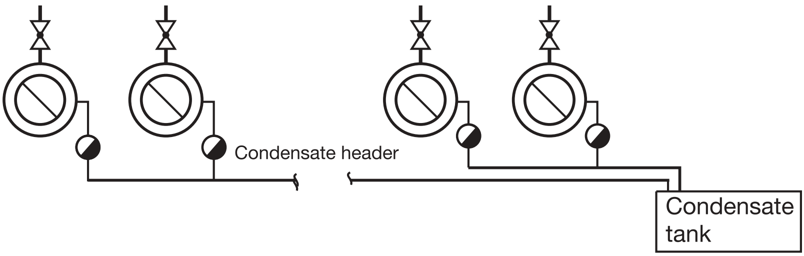
a) Waterhammer often occurs if condensate if lifted.

b) The remedy is to install a condensate dampening pot, which by its cushioning effect neutralizes the waterhammer.

2.9.6 **Proper planning and arrangement of the various condensate branches and the header** (Figs. 26 and 27)



a) The condensate from the heat exchanger on the far end cools down strongly on its way to the condensate tank. The condensate with the flash steam from the heat exchangers that are closer to the condensate tank mixes with this cold condensate. The flash steam condenses abruptly and waterhammer will result.



b) Waterhammer will be avoided if the condensate is sent to the condensate tank via separate headers. Condensate from heat exchangers using different steam pressures should also be fed to the condensate tank by separate headers.

Fig. 26 Waterhammer in condensate lines

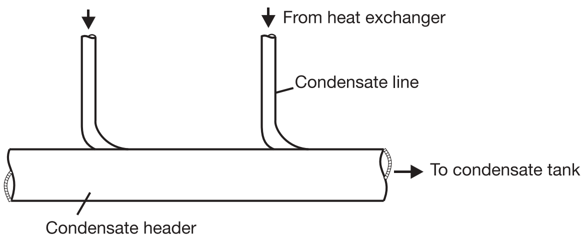


Fig. 27 The condensate from the various steam traps should be fed into the header in the direction of flow

2.10 **Air or other non-condensable gases in the steam reduce the temperature and heating capacity of heat exchangers, and may lead to uneven temperatures. For an air percentage of 10 %, the heating capacity drops by approx. 50 % (disadvantageous for e.g. presses, rotating drying cylinders)** (Figs. 3 and 28).

t_s	P	Percentage of air in steam by volume					
Saturated steam temperature [°C]	Gauge pressure with pure steam [barg]	1 %	3 %	6 %	9 %	12 %	15 %
		Necessary gauge pressure for air-contaminated steam [barg]					
120.23	1	1.02	1.06	1.13	1.20	1.27	1.35
133.54	2	2.03	2.09	2.19	2.32	2.41	2.53
143.62	3	3.04	3.12	3.25	3.40	3.52	3.71
158.84	5	5.06	5.18	5.38	5.60	5.82	6.06
184.05	10	10.11	10.34	10.70	11.09	11.50	11.94
201.36	15	15.16	15.48	16.02	16.58	17.20	17.82
214.84	20	20.21	20.65	21.34	22.07	22.87	23.70

Fig. 28

2.10.1 Large steam spaces may require separate air vents (Fig. 29, 29a)

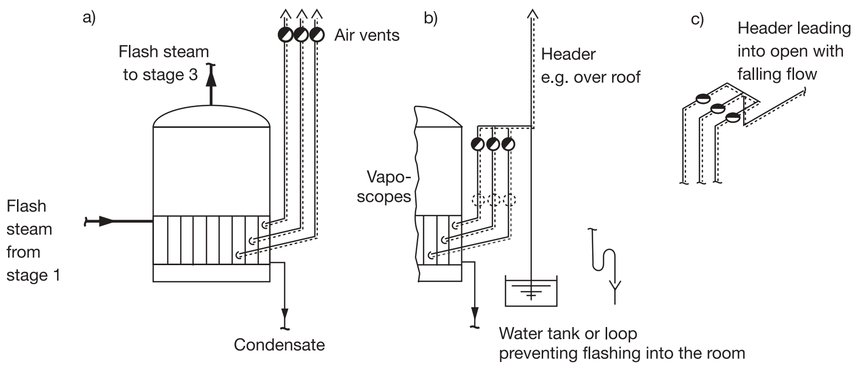
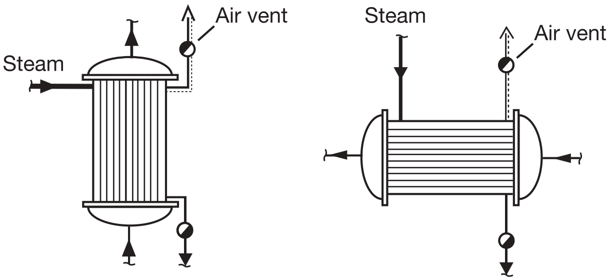
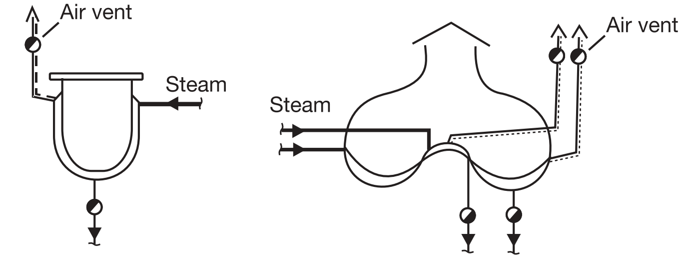


Fig. 29 Venting of evaporators heated with flash steam

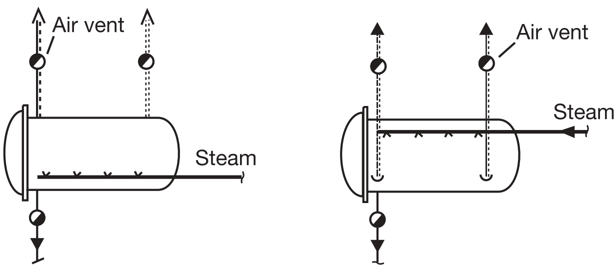
Small and medium-sized heat exchangers are adequately vented through steam traps with additional automatic air-venting.



a) Heat exchangers with tube bundles



b) Jacketed heat exchangers



c) Autoclaves

Fig. 29a For larger vessels 2 or more vents necessary.

3. Selection of Steam Traps

(For the sizing of steam traps, see Section 12.2)

Great care should be taken in choosing the steam trap best suited for a particular application.

3.1 The trap should be sized so that even the peak condensate flow is discharged properly. If the plant is operated with varying pressure (e.g. controlled plants), the capacity characteristics of heat exchanger and steam trap should be compared. The capacity characteristic of the steam trap must be at least equal to that of the heat exchanger at the possible service pressures (e.g. controlled plants) or, if possible, even higher. An insufficiently sized trap leads to banking-up of condensate, the inevitable consequences being waterhammer and a reduction in the heating capacity.

3.2 The traps should not be oversized either. They would then have a tendency towards overcontrolling and intermittent operation, which may lead to waterhammer. This point has to be considered particularly with thermodynamic disc-type traps and inverted-bucket traps.

3.3 The steam trap should provide automatic air-venting during operation. Air in the steam space will prolong the heating-up period and reduce the heating capacity during normal operation (see Fig. 28).

3.4 Normally, the steam trap should drain the condensate promptly so that it cannot waterlog the heating surface.

3.5 The design of the steam traps should allow condensate discharge with a certain amount of undercooling, so that part of the sensible heat of the condensate can be utilized, provided the system permits (heating surface large enough, and appropriate layout of heat exchanger and pipelines to avoid waterhammer). Suitable traps from the GESTRA range are: BK with large undercooling adjustment, MK with “U” capsule and UBK). The degree of undercooling allowable depends on the desired temperature of the product to be heated.

4. The Most Common Steam Trap Applications - Selecting the Most Suitable Steam Trap

4. The Most Common Steam Trap Applications - Selecting the Most Suitable Steam Trap

4.1 Steam Piping

4.1.1 Steam driers (steam separators) (Fig. 30)

Fig. 30 GESTRA steam separator drained by a UNA 2 steam trap

Steam that is not superheated (i.e. saturated steam) is always, in fact, wet steam and contains a certain quantity of water droplets in suspension which reduce its heating capacity. If the percentage of water is too high, water-hammer may be caused in the steam main. Too high a moisture content may also be undesirable for ironing presses, in air-conditioning plants etc.

Special requirements of the trap:

The condensate, which is very close to saturation temperature, should be discharged instantly. Furthermore, the steam trap should air-vent the steam line automatically.

It is necessary to use float traps.

Recommended equipment:
UNA Duplex ball float trap and GESTRA steam separator type TD.
Quite often, the usual drainage of the steam main by means of a steam trap is not sufficient. In these cases (e.g. if the steam is generated in a coil-type boiler, or if the steam is to be injected into the product), the use of a steam separator operating on the centrifugal principle is recommended, which will remove the water droplets and lead them to the trap.

4.1.2 Saturated steam mains (without steam separator)

The steam trap by itself can only remove the condensate formed in the steam line, but not the water droplets in suspension in the steam. The latter requires a steam separator (see Section 4.1.1). During warming-up of the pipeline (start-up), large amounts of condensate are formed; the low pressures then prevailing in the line further impede the process. During plant operation, small amounts of condensate are continuously being formed, depending on the pipeline insulation. Drain points should be provided, for instance at low points, at the end of the line, in front of risers, at the steam distribution manifold and, in the case of horizontal lines, at regular distances of not more than 100 m (300 ft) (see Figs. 23 and 24).
For effective steam-line drainage, a water pocket (e.g. a T-piece) should be provided (see Fig. 23). For large mains and long lines, the installation of a free-drainage valve (manually or automatically operated) of the type AK 45 is recommended to discharge the large start-up load and to blow the dirt directly to drain.

Special requirements of the trap:

- During start-up, the trap should air-vent the plant and simultaneously discharge the relatively large condensate load at rather low differential pressures without too much delay.
- In continuous operation, on the other hand, small amounts of condensate are continuously being formed at almost saturation temperature.
- During periods of shut-down, the trap – in outdoor plants at least – should drain the pipeline and itself to avoid freezing.

Recommended traps:

- UNA Duplex for vertical installation; alternatively for small condensate flowrates during continuous operation, BK and MK with N capsule. If the traps discharge into the open by way of exception, the flash steam formed may be a nuisance. If the trap is not installed close to the drainage point of the steam main, but a few metres away, the MK with U capsule or the BK with undercooling adjustment (Δt max. 30 – 40 K) may be used.

4.1.3 Superheated steam mains

Normally no condensate is formed during continuous operation. Heat losses through the pipeline, as a rule, reduce only the superheat temperature. Condensate is formed only during start-up of the plant and whenever there is no or very little steam consumption, i.e. when the steam flowrate along the main is very small. The amount of condensate reaching the trap during continuous operation depends solely on the heat losses of the line leading to the trap.

If the steam main operates at its design flowrate and no condensate is expected to be formed, only start-up drainage is needed in frost-proof areas. In outdoor plants which may freeze, the condensate formed in the pipe leading to the trap may be discharged at a temperature which just prevents freezing. This is of particular importance for open-air discharge, as the low discharge temperature reduces the unwanted flashing to a minimum (Fig. 31).

The amount of condensate, and consequently also the amount of flash steam formed, are the lower the shorter the condensate line is upstream of the trap. The trap should therefore be installed as close as possible to the steam main, with the condensate line and steam trap sufficiently insulated.

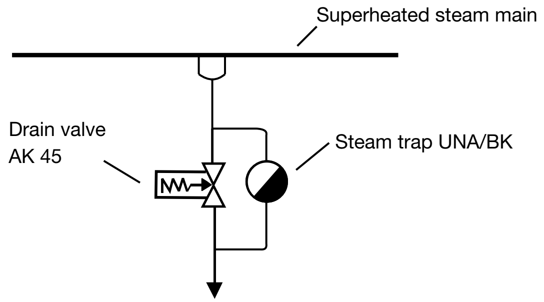


Fig. 31

Special requirements of the trap:

- Large flowrate during start-up (high cold-water capacity) at relatively low pressures and a good air-venting capability, steam-tight closure and, if required, condensate discharge with more undercooling but ensuring large cold-water capacity.

Recommended traps:

- If, even during continuous operation, condensate may form in the superheated steam line, if only for short periods: UNA or BK with factory setting.
- If condensate is only formed during start-up: BK with undercooling adjustment. For relatively large condensate flowrates at very low pressures during start-up, the GESTRA valve type AK is of particular advantage. During start-up, the AK is completely open and does not close unless the preset differential pressures reached. From this moment, the "normal" steam trap will ensure condensate discharge and air-venting.

- In outdoor plants which may freeze, the condensate line immediately upstream of the AK should be drained and, in addition, the AK and the condensate line should be insulated.

4.1.4 Pressure regulators - see Section 13.1

4.1.5 Temperature controllers - see Section 13.2

4.2 Steam Headers - see Section 4.1 “Steam Piping”

4.3 Steam Radiators, Finned-Tube Heaters, Radiant Panels, Convectors for Space Heating (Fig . 32)

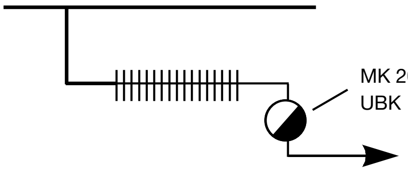


Fig. 32

Low heating temperatures with the correspondingly low vapour pressures (e.g. flash steam reduced from a higher pressure range) are advantageous from a hygienic and physiological viewpoint.
If the heating services are adequately sized (overdimensioned), they can be partly flooded with condensate, which will lead to steam savings, at least for higher pressures. The reduction in the heating temperature is not normally important.

Special requirements of the trap:

- In low-pressure plants, sufficient flowrate even at an extremely low pressure head
- At higher pressures, condensate discharge with a certain amount of undercooling
- Unaffected by dirt (e.g. particles of rust forming during intermittent operation and long periods of shutdown of the heating installation during the summer)
- Corrosion-resistant internals

Recommended traps:

- For low-pressure plants: MK 20. For higher pressures: MK 35/32 with U capsule
- BK with large undercooling adjustment
- If a condensate discharge temperature as low as 85 °C is acceptable (sufficiently large heating surface and no danger of waterhammer): UBK

4.4 Unit Air Heaters

4.4.1 Air heaters, controlled on the air side (Fig. 33)

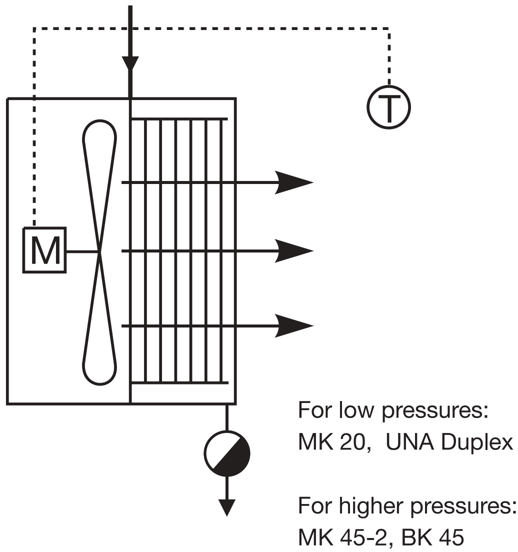


Fig. 33

Separate space heaters or unit heaters (not including those in air conditioning plants or for air preheating in manufacturing and drying plants) are, in general, controlled on the air side only, for instance by switching the fan on and off.
In this case, either very high or very low condensate loads are to be expected. In air heaters heated with low-pressure steam, the pressure in the steam space may vary considerably (the pressure drops with increasing condensate load).
At higher steam pressures, an additional utilization of the sensible heat of the condensate in the air heater through banking-up is advantageous if it is not used otherwise in operation.
A prerequisite here, however, is that the heating capacity of the air heater is still adequate and that the heating plates are arranged to prevent waterhammer (vertically).

Special requirements of the trap:

- In low-pressure plants, a relatively large flowrate, even at a low pressure head
- In high-pressure plants, in which it is possible to use the sensible heat of the condensate through banking-up, the steam trap must be able to discharge the condensate with undercooling. In both cases, the trap should air-vent the plant automatically.

Recommended traps:

- MK 45-2, UNA Duplex
- MK with U capsule

4.4.2 Air heaters, controlled.

See Section 4.6 “Air Conditioning Plants”.

4.5 Heating Coils, Horizontal Heaters (Fig. 34)

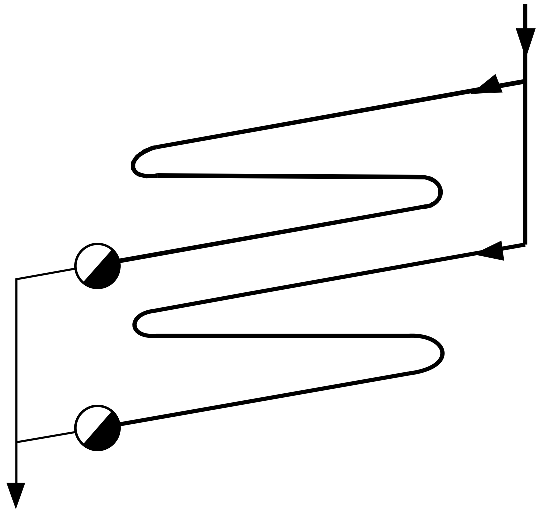


Fig. 34

To avoid waterhammer, the pipe run between the steam inlet and steam trap must be arranged to fall in the direction of flow. Groups of heaters should be connected in parallel and drained separately (see Section 2.7).

Special requirements of the trap:

- Discharge of the condensate without banking-up, even for high ambient temperatures (e.g. installation close to the heater)
- Automatic air-venting

Recommended traps:

- MK with N capsule (MK with H capsules for large flowrates); UNA Duplex

4.6 Air Conditioning Plants (Fig. 35)

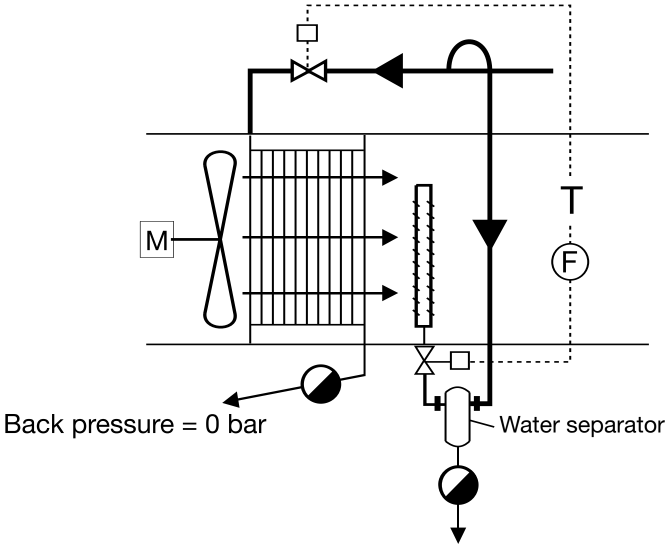


Fig. 35

4.6.1 Air heaters controlled on the steam side

For air heaters controlled on the steam side, the following applies with regard to condensate discharge (see also Section 4.8. “Counterflow Heat Exchangers, Controlled”):

The pressure in the steam space and the condensate load may vary considerably, and at low-load conditions even a vacuum may form at times. Air will then enter the steam space and will have to be discharged rapidly when the heating capacity has to be increased again. To avoid thermal stratification in the heated air and also to prevent waterhammer, banking-up of condensate must be avoided even at low load. This requires a sufficient pressure head (no back pressure); the condensate should drain by gravity.

Special requirements of the trap:

- As with all controlled systems, the steam trap must immediately respond to varying operating conditions (pressure, flowrate) to avoid the accumulation of condensate.
- Even at a very low pressure head, the condensate that is formed must be discharged.
- The steam trap should air-vent the plant automatically, both at start-up and in continuous operation.

Recommended traps:

- UNA Duplex, MK with N capsule (MK with H capsules for large flowrates)

4.6.2 Air humidifiers

To obtain a uniform air humidity without droplets of water, the steam should be dry. Therefore, it should be dried mechanically before being fed to the steam pipe (jet tube) (see Section 4.1.1 “Steam driers”).

Special requirements of the trap:

The condensate, which is practically at saturation temperature, should be discharged without any delay (no banking-up).

Recommended traps:

- UNA Duplex
- If there is a cooling leg, also MK with N capsule

4.7 Storage Calorifiers, Controlled

E.g. for heating water (Fig. 36)

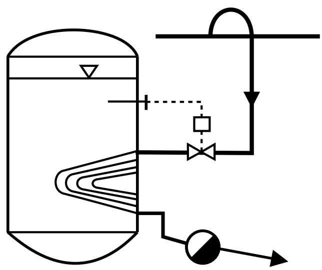


Fig. 36

Warm water is not withdrawn continually, but more or less intermittently. Consequently, the heating process is also intermittent. Periods with a very light condensate load (to make up the heat losses) at a very low pressure head alternate with periods of very heavy load at the maximum pressure head. To avoid waterhammer during low-load operation - where even a vacuum may form - the condensate should be allowed to drain by gravity (no back pressure).

Special requirements of the trap:

- Immediate response to large fluctuations in pressure and flowrate
- Good air-venting capacity, because air may enter the calorifier during periods of low load; this air will have to be discharged when the load is increased again.
- Relatively large flowrate at a very low pressure head

Recommended traps:

- UNA Duplex, MK with N capsule (MK with H capsules for large flowrates)

4.8 Counterflow Heat Exchangers, Controlled

4.8.1 Horizontal counterflow heat exchangers (Fig. 37)

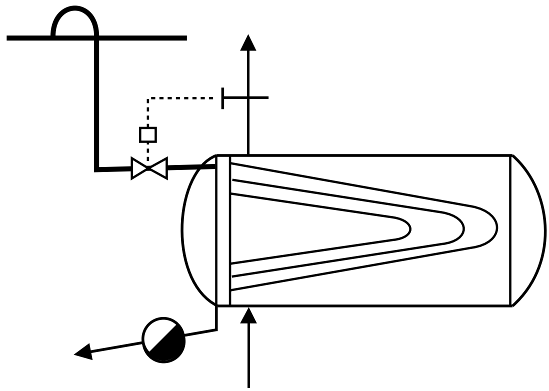


Fig. 37

These heat exchangers operate over the whole pressure range, from very low pressures (light load) down to vacuum, if only for short moments and up to the maximum admissible pressures.
The condensate flowrate varies accordingly. The extremely low operating pressures that are possible make drainage of the condensate by gravity desirable, not only upstream but also downstream of the trap.
Back pressure on the trap or lifting of the condensate is not recommended. If this rule is not followed, waterlogging of the heating surface during periods of low load may cause waterhammer (see also Figs. 21 and 22). Banking-up of condensate can also be caused if the steam trap is too small.
For sizing the trap, besides considering the maximum flowrate at the maximum admissible pressure, the capacity of the heat exchanger in the low-load range has to be compared with the capacity of the trap at the reduced operating pressure. The trap has to be suitable for the worst possible conditions. If the data for low load cannot be obtained, the following rule of thumb can be applied: Effective differential pressure (working pressure) is approximately 50% of the service pressure.
Assumed condensate flowrate for trap sizing = max. flowrate to be expected at full load of heat exchanger.

Special requirements of the trap:

No noticeable banking-up of condensate at all operating conditions, relatively large flowrate at low pressures, perfect operation even in the vacuum range, automatic air-venting at start-up and during continuous operation.

Recommended traps:

- UNA Duplex

4.8.2 Vertical counterflow heat exchangers

No special measures need be taken.

4.8.3 Vertical counterflow heat exchangers with use of the sensible heat

In horizontal heat exchangers, waterlogging of the heating surface tends to produce waterhammer, at least in cases where the steam is flowing through the tubes.

In vertical heat exchangers, waterhammer will not normally occur, even if the heating surface is flooded. The sensible heat of the condensate may be used directly by flooding part of the heating surface.

Quite often the heat output of the heat exchanger is controlled through a change in the size of the heating surface (more or less banking-up) by means of a temperature control valve fitted in the condensate outlet (see Fig. 38).

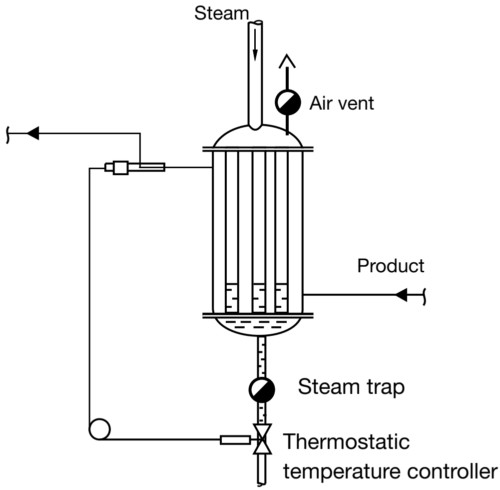


Fig. 38 Constant pressure in the heating space
Varying amounts of condensate accumulation, depending on load.

If the heat exchanger is controlled on the steam side, a constant level can be maintained by a float trap functioning as the level controller (see Fig. 16). If the heat exchanger is controlled on the condensate side, live steam can be prevented from passing (e.g. during start-up, at full load or on failure of the regulator), by fitting a steam trap upstream of the temperature controller.

Special requirements of the trap:

Control on the steam side:

- Maintenance of a given constant condensate level

Control on the condensate side:

- At low condensate temperatures, free passage as far as possible (little flow resistance); closed at saturation temperature, at the latest

Additional requirement:
As the condensate level has to be constantly maintained, the air in the steam space can no longer escape by the condensate line.
The steam space has to be provided with a separate air vent.
Recommended traps:
- Control on the steam side: UNA Duplex
- Control on the condensate side: MK with N capsule or BK
- For air-venting: MK or, for superheated steam, BK

4.9 Process Heat Exchangers

Heat exchangers (preheaters) are used for heating the most varied products continuously flowing through them. The steam supply pressures vary, depending on the product temperature required. The heat exchangers may be controlled as a function of the product outlet temperature or sometimes operated without any control.
It is therefore only possible to give a few basic hints.
Horizontal heat exchangers with the heating steam flowing through the tubes tend to produce waterhammer if condensate is banked up. Therefore steam traps should be used which discharge the condensate without any banking-up. U-tube

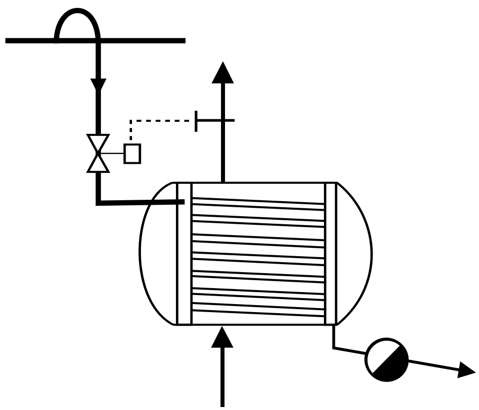


Fig. 39

bundles have less tendency to waterhammer (see Figs. 37 and 39).
Vertical heat exchangers with the heating steam flowing through the tube bundle operate without waterhammer, even if condensate is banked up (for an example, see Fig. 38). Heat exchangers with the product to be heated flowing through the tube bundle and the steam circulating around the individual tubes also normally have no tendency to waterhammer.
The rated capacity of a heat exchanger is generally based on calculations assuming that the heating surface is completely filled with steam. This point has to be considered when choosing and sizing the traps for all types of heaters.
Banking-up of condensate reduces the heating capacity.
As far as controlled heat exchangers are concerned, the recommendations given for controlled counterflow units apply as appropriate (see Section 4.8).

Special requirements of the trap:

- These depend on the individual operating conditions (pressure, flowrate, banking-up of condensate allowable or even desirable, controlled or uncontrolled).
- In any case, the steam trap should air-vent the preheaters automatically.

Recommended traps:

For controlled preheaters:

- UNA Duplex, MK with N capsule (MK with H capsules for large flowrates)

For uncontrolled preheaters, if banking-up is undesirable:

- MK with N capsule, UNA Duplex

For uncontrolled preheaters, if banking-up is desirable:

- MK with U capsule; BK with large undercooling adjustment

4.10 Digesters

4.10.1 Process digesters and pans
(e.g. sugar factories, chemical industry, cellulose production) (Fig. 40)

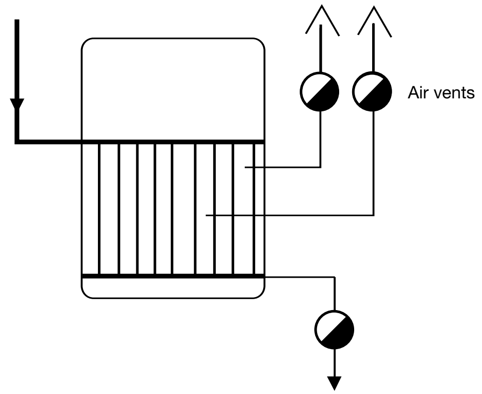


Fig. 40

During heating-up of a process batch, the steam consumption and consequently the amount of condensate formed are, in general, several times those during the boiling process. However, if the product is boiled and evaporated in one process (e.g. sugar boiling pans), the steam consumption and condensate flowrate remain quite high.
If the boiling process is not also an evaporation process (e.g. cellulose digesters), only the heat lost by radiation has to be replaced.
Compared to the starting condensate load - quite often even larger because of the low initial temperature of the product - the amount of condensate formed when boiling is extremely small. Considering the size of the heating surface, air-venting through the steam trap alone may not be sufficient. The steam space has to be air-vented separately by thermostatic traps. This is of the utmost importance if the heating steam contains a large percentage of incondensable gases (for instance, sugar boiling pans heated with beet-juice vapour containing a considerable percentage of ammonia).

Special requirements of the trap:

- Perfect discharge of very high condensate flowrates, the flowrate during the heating-up process (possibly even at lower pressures) being a multiple of that formed during the boiling process

Additional requirement:

- A separate air vent should be fitted to the steam space.

Recommended equipment:

- For sugar pans and similar heat exchangers with very little pressure head and no excessive differences in flowrate between the heating-up and boiling processes, the standard staged nozzle trap GK will do the job, otherwise TK.
- For higher pressures, UNA Duplex.
- As air vent, MK with N capsule

4.10.2 Boiling pans with heating coils (Fig. 41)

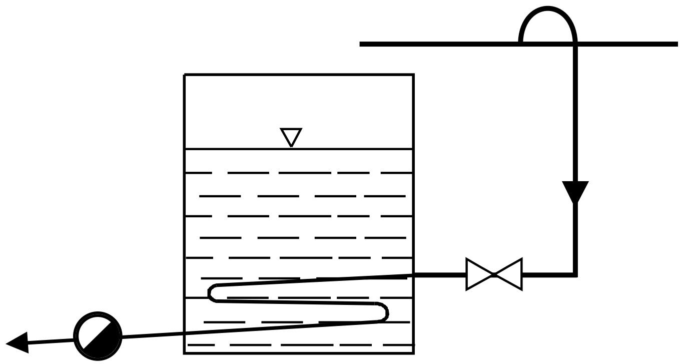


Fig. 41

The same considerations apply to all boiling processes: The amount of condensate formed during heating-up is a multiple of that formed during the boiling process. This point should be considered when choosing and sizing the trap, particularly as banking-up of condensate caused by an insufficient flowrate might lead to waterhammer. The steam trap should also air-vent the boiling pan automatically, otherwise the time required for heating-up will be longer.

Special requirements of the trap:

- Large start-up load
- Good air-venting capacity

Recommended traps:

- At low pressures and up to medium flowrates: MK 20, otherwise MK with N capsule

4.10.3 Jacketed boiling pans (Fig. 42)

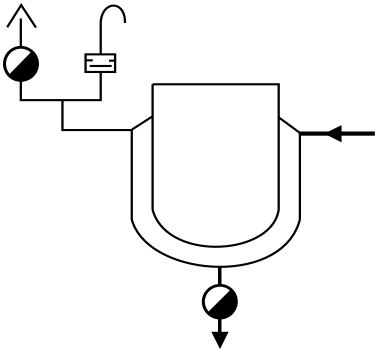


Fig. 42

The condensate load is highest during heating-up and lowest during the boiling process (see also Section 4.10.1). Because of the large steam space, a considerable amount of air has to be discharged during start-up. For small boiling pans, a steam trap with automatic air-venting capacity is sufficient. For large boiling pans, a thermostatic trap should be fitted as a separate air vent.
To prevent the jacket collapsing if a vacuum is formed, a GESTRA DISCO non-return valve RK should be used as vacuum breaker.

Special requirements of the trap:

- Large start-up and air-venting capacity

Additional requirement:

- In the case of large boiling pans, a separate air vent should be fitted to the steam space; provide a vacuum breaker if it is possible that a vacuum may form.

Recommended traps, also as air vents:

- MK with N capsule
- At extremely low steam pressures (< 0.5 barg): UNA Duplex
- RK as vacuum breaker

4.10.4 Tilting pans (Fig. 43)

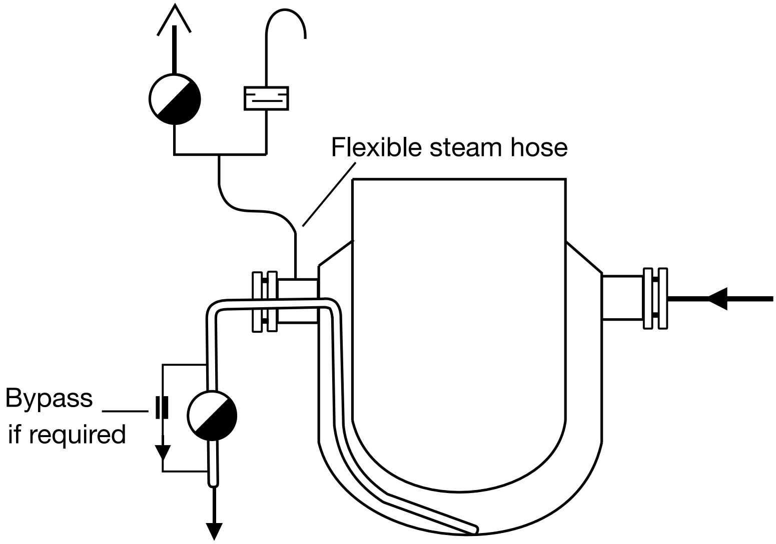


Fig. 43

The condensate is drained via a siphon which starts at the bottom of the steam jacket. The condensate must be lifted to the rotating joint of the pan and hence flow towards the trap. This process requires a trap with a constant and sufficiently large pressure head which if necessary must be produced artificially (e.g. using a bypass for a float trap).

Special requirements of the trap:

- Generation of a sufficient pressure head (the trap should not shut off tight) and good air-venting capacity

Additional requirement:

- For large boiling pans at least, a thermostatic trap should be fitted as air vent.
- Provide a vacuum breaker for the reasons mentioned in Section 4.10.3.
- Arrange air venting opposite to steam inlet.

Recommended traps:

- UNA 14/16 Simplex R with venting pipe
- MK with N capsule
- RK as vacuum breaker

4.11 Brewing Pans (Coppers, Mash Tubs) (Fig. 44)

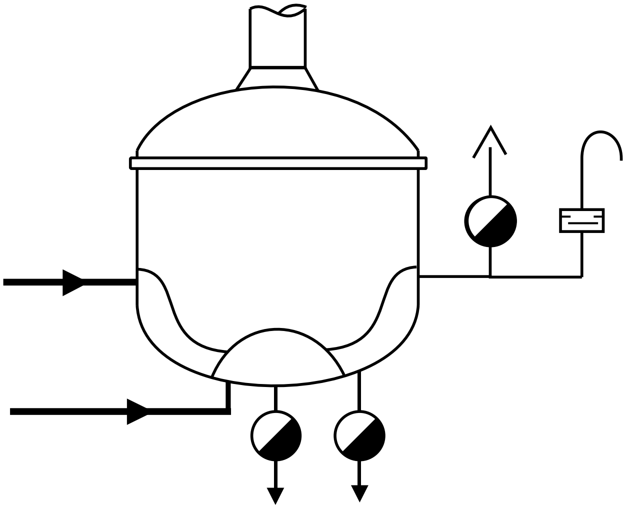


Fig. 44

These are mainly large jacketed heating pans, frequently with various heating zones and different steam pressures.

Characteristics of the mashing process:

- High steam consumption during heating-up,
- alternating with relatively low consumption during cooking.

Characteristics of the brewing process:

- Large steam consumption during heating-up, whereby the pressure may drop considerably as a result of overloading of the steam system

This is followed by a uniform steam consumption at constant pressure during the entire evaporation phase. In both cases, a large amount of air has to be discharged at start-up.

Special requirements of the trap:

- Discharge of very large condensate flowrates without any banking-up, to avoid waterhammer and to obtain the full heating capacity at each stage of the evaporation process
- Particularly good air-venting capacity

Additional requirements:

- Separate air-venting of the heating surface with thermostatic traps (type MK)
- Prevent the formation of vacuum

Recommended traps:

- For small and medium pans: UNA 14/16 Duplex; MK with N capsule
- For large pans: UNA 2 Duplex, large-capacity trap with thermostatic pilot control TK
- RK as vacuum breaker

4.12 High-Capacity Evaporators (Fig. 45)

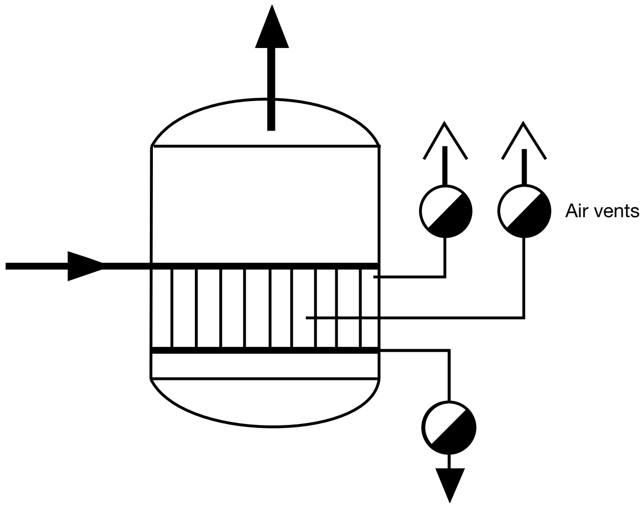


Fig. 45

Besides distilling (see Section 4.13) and brewing (see Section 4.11), there are many industries where evaporation processes are necessary to boil down (i.e. concentrate) the product by evaporating part of its liquid content. This can be effected in a continuous, multiple-effect evaporation plant (e.g. sugar factory) or in batches. During continuous evaporation, apart from the start-up phase, the condensate load remains stable at a relatively constant pressure head. Batch evaporation is different: the condensate load during heating-up is considerably larger (depending on the initial temperature of the product to be heated) than during the evaporation phase, and then remains relatively constant.

To obtain maximum evaporation capacity, proper air-venting of the steam space is of the utmost importance.

In this connection, the following has to be considered:

a) In the case of the continuous process, the vapours of the product to be evaporated – e.g. from an evaporator stage operating at higher pressure – can be reused as heating steam having a correspondingly high percentage of gas;

b) The steam space is relatively large, so that air-venting - even with batch evaporation - by the steam traps without causing steam losses is very difficult. It is therefore recommended that thermostatic traps be fitted as additional air vents.

Special requirements of the trap:

- Discharge of large flowrates, often at a very low pressure head
- Good air-venting capacity

Additional requirement:

- Separate air-venting of the steam space

Recommended traps:
- For the continuous evaporation process, the type GK can be used (manual stage nozzle; robust and simple design).
- For the batch evaporation process, the TK is better suited (thermostatic pilot control permits automatic adaptation to varying operating conditions).
- For high pressures, UNA Duplex.
- As air vent, MK with N capsule.

4.13 **Stills** (Fig. 46)

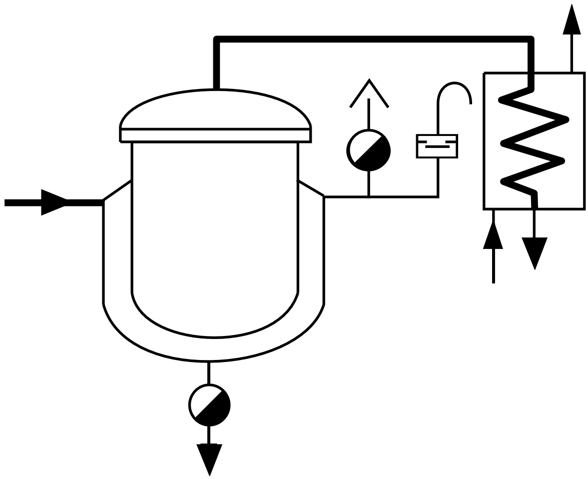


Fig. 46

To obtain maximum evaporation capacity, the heating surface should always be kept free of condensate. Even the slightest banking-up of condensate may considerably affect the capacity of small stills, such as those used in the pharmaceutical industry for the production of essences and in laboratories.

Special requirements of the trap:
- The trap should drain the condensate as it forms, which is of particular importance for small stills and is complicated by the fact that the condensate is relatively hot (very little undercooling).
- A frequent change of the batches requires perfect start-up venting of the still.

Additional requirement:
- If required, fit a separate air vent and vacuum breaker.

Recommended traps:
- MK with N capsule, UNA 14/16
- MK also as air vent
- RK as vacuum breaker

4.14 Rotating Drying Cylinders

(e.g. for paper machines, calenders, corrugated-cardboard machines) (Fig. 47)

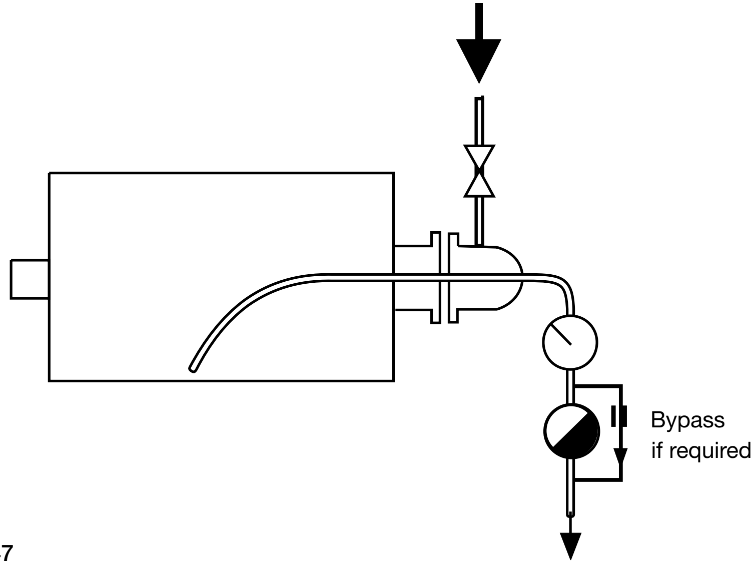


Fig. 47

For drying and glazing processes, exact and uniform maintenance of the required cylinder surface temperature is of prime importance. This can only be obtained by trouble-free condensate drainage from the cylinder. Air concentrations in the cylinder must be avoided, as they would lead to a local reduction in heating temperature and consequently lower surface temperatures. The condensate is lifted from the cylinder by a bucket or a siphon pipe.

If a bucket is used for condensate handling, the steam trap and the pipeline leading to the trap must be able to take up the whole bucket contents. Efficient air-venting of the cylinder, particularly during start-up, is important.

If the cylinder is provided with a siphon, an adequate pressure drop towards the trap must be provided to ensure that the condensate is lifted out of the cylinder. For low-speed machines in laundries etc. a standard thermostatic trap (MK) is normally adequate. For high-speed machines, it is necessary to ensure a certain leakage of steam in relation to the rotational speed, in order to prevent formation of a condensate film. This can be done with the BK through adjustment for a certain steam leakage and with the UNA through internal or external bypass.

Special requirements of the trap:

- Automatic air-venting at start-up and during continuous operation
- For cylinders with siphon drainage, the trap must ensure a constant pressure drop (i.e. must not close during operation) and must permit a slight leakage of live steam, particularly at higher cylinder speeds.

Additional requirements:
- The steam trap should be monitored for banking-up of condensate through a sightglass (to be installed upstream of the trap, see GESTRA Vaposcope). In some cases, it is required that the traps do not close when faulty.

Recommended traps:
- UNA Duplex, if necessary with internal or external bypass, with lifting lever and sightglass cover.

4.15 Baths and Tanks

(e.g. for cleaning and pickling)

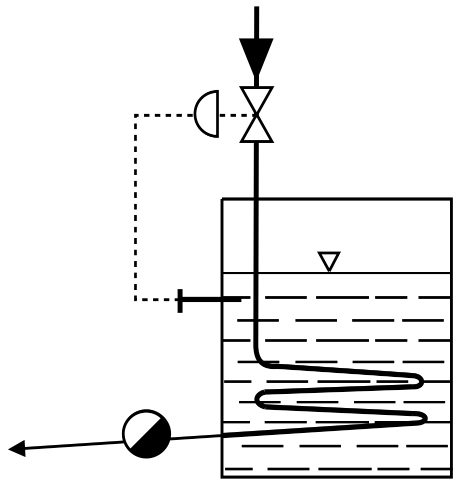


Fig. 48

4.15.1 Heating coils with uniform fall and condensate discharge at base

(Fig. 48)

With this arrangement, waterhammer does not normally occur. For temperature-controlled baths, this is the only recommended arrangement of the heating coils. In general, the following applies to controlled plants:
At low heating capacities, when the control valve is throttled strongly, the pressure in the heating coil may drop to vacuum. To prevent banking-up of condensate, the condensate should drain by gravity (no back pressure).

Special requirements of the trap:
- These depend on the operation of the heat exchanger (controlled or uncontrolled).

Recommended traps:
- For simple, manually controlled heating processes: BK, MK with N capsul.
- For controlled heating processes: UNA Duplex, MK with N capsule

4.15.2 Acid baths

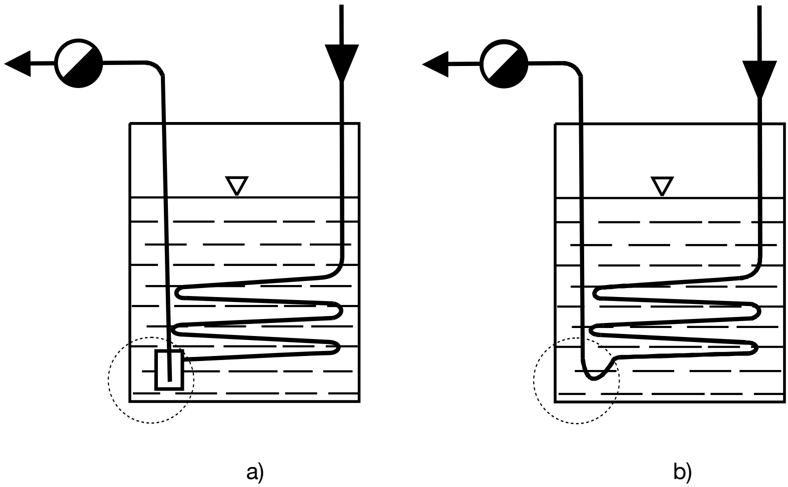


Fig. 49

For safety reasons, the heating coil must not be led through the wall of the vat. The condensate must be lifted (immersion heater principle). To prevent waterhammer, the condensate should fall towards a compensator (see Fig. 49a). For small-sized pipes, it suffices to provide a loop seal (see Fig. 49b).

Special requirements of the trap:

- No intermittent operation, which might cause waterhammer by an abrupt stop or start of the flow

Recommended traps:

- BK (if the plant layout is unfavourable, the tendency to waterhammer may be eliminated by special adjustment of the trap)
- MK with N capsule

4.16 **Band Driers** (Fig. 50)

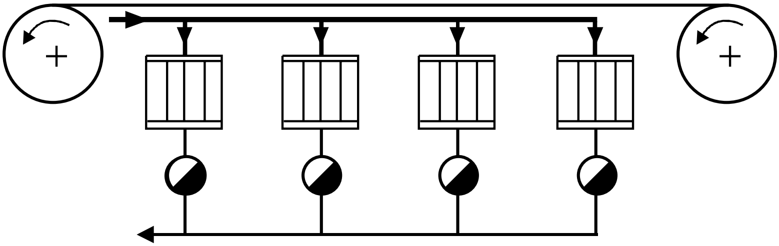


Fig. 50

To obtain the rated drying capacity (guaranteed performance), it is essential that the individual heating units can produce the maximum heat. This implies that the heating surfaces are completely filled with steam and there is no banking-up of condensate and no air in the steam spaces (efficient air-venting). The heating units require individual drainage by means of an appropriate trap. If the flash steam cannot be utilized anywhere else in the plant, it may be useful to heat an additional heating unit (e.g. inlet section) with the flash steam or even with all the condensate formed in the other heaters. When choosing the steam trap, the small space available for installation should be considered as well as the fact that the fitting of the steam traps inside the machine casing, which is frequently requested, results in relatively high ambient temperatures.

Special requirements of the trap:

- Condensate discharge without any banking-up at relatively high ambient temperatures
- Automatic air-venting
- Small dimensions

Recommended traps:

- MK with N capsule
- If there is sufficient space available, UNA Duplex

4.17 Hot Tables, Drying Platens (Fig. 51)

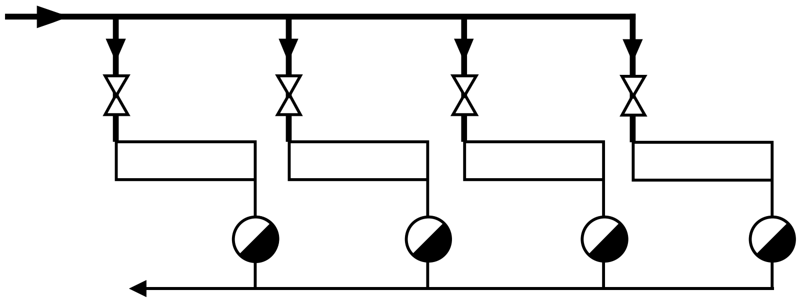


Fig. 51

These are used in many different process plants for drying and heating. The maintenance of uniform surface temperatures which may have to be varied is of fundamental importance.

The best method of achieving this is to connect the different sections in parallel and to provide a separate steam supply and steam trap for each section. This prevents the various sections interfering with each other (e.g. as a result of the different pressure drops).

If they are connected in series, which is often the case, condensate accumulates in heating platen at the end of the system, which may cause a reduction in the surface temperature. Furthermore, the single steam trap cannot air-vent the sections efficiently. To attain a heating performance which is equivalent to that of a parallel arrangement, at least “blow-through” steam traps are needed.

Special requirements of the trap:

- Condensate discharge without banking-up at relatively high temperatures
- Efficient air-venting

Recommended traps:

- MK with N capsule
- UNA Duplex

4.18 Multi-Platen Presses (Fig. 52)

4.18.1 Multi-platen presses connected in parallel

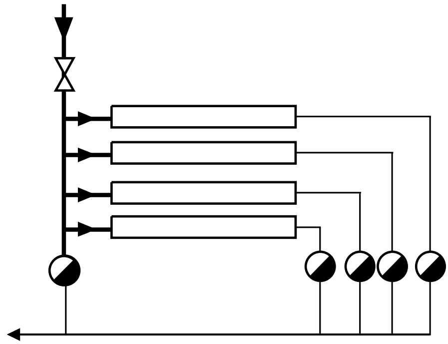


Fig. 52

These presses require uniform and equal temperatures over the complete surfaces of individual platens, which means that the individual heating surfaces must be fed with steam of the same heating capacity. The steam should therefore be dry (drainage of steam main), the steam pressure in all platens must be equal (no air inclusions reducing the partial steam pressure) and the steam space must be free of condensate (poor heat transmission, lower heating temperature than steam). The letter requires a free flow of the condensate towards the trap.

There is no guarantee that the pressure drop across the various platens is the same. To avoid banking-up of condensate, each parallel heating surface should be drained by its own trap.

Special requirements of the trap:

- As the condensate is to be discharged without any banking-up, the steam trap must drain the condensate practically at saturation temperature. At the same time, it must air-vent the plant properly. The faster this is done at start-up, the shorter the heating-up period.

Recommended traps:

- MK with N capsule
- UNA Duplex

4.18.2 Multi-platen presses connected in series (Fig. 53)

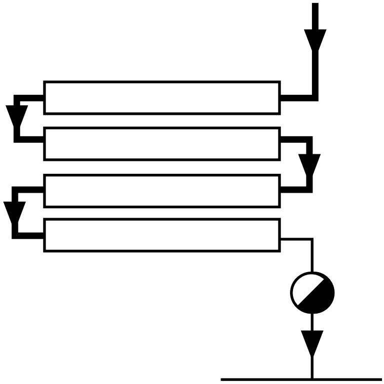


Fig. 53

As already explained in Section 4.18.1, the drainage of heating platens connected in parallel by a single trap is problematic, as this may lead to banking-up of condensate in the individual platens and consequently to a reduction in the surface temperatures.
Small heating platens may be connected in series, provided the condensate is free to flow towards the trap.

Special requirements of the trap:

- The trap must discharge the condensate as it forms, so that banking-up of condensate in heating space is reliably avoided.

Recommended traps:

- MK with N capsule
- UNA 14/16 Duplex

4.19 Tyre Presses (Vulcanizing Presses) (Fig. 54)

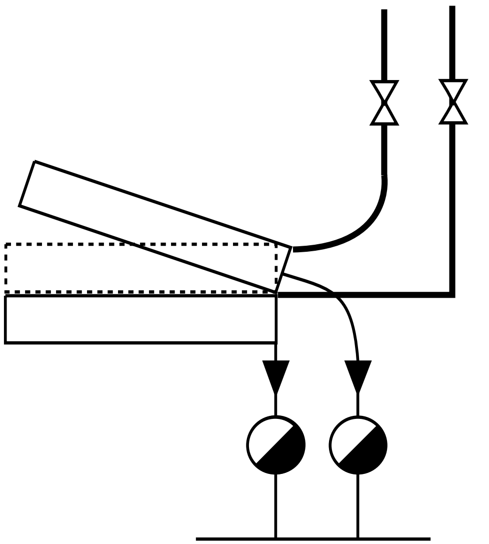


Fig. 54

For vulcanizing, uniform surface temperatures are absolutely vital. This necessitates feeding of the heating surface with pure steam only (no condensate in the steam space), equal steam pressures in the individual sections (same temperature drop) and no air inclusions in the steam (impairing the heat transfer).
The layout of the press, the steam line and the condensate line should guarantee a free flow of the condensate.
Good steam distribution giving equal steam pressures in the individual sections is not possible unless the sections are connected in parallel. To avoid banking-up of condensate, each section should be drained by its own trap.

Special requirements of the trap:

- Condensate discharge without banking-up, but also without loss of live steam
- Good air-venting capacity (for short heating-up periods)

Recommended traps:

- MK with N capsule

4.20 **Vulcanizers** (Fig. 55)

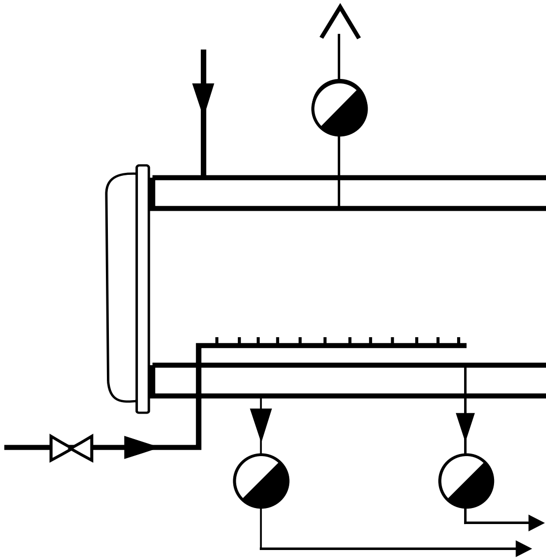


Fig. 55

The jacket and the steam-injected vulcanizing chamber require separate drainage. Draining the jacket is no particular problem.

In general, any steam trap with good air-venting capacity will do the job satisfactorily.

The vulcanizing chamber must be drained (see Section 4.21 "Autoclaves") without any condensate remaining. In addition, when selecting the steam trap, it should be noted that the condensate may be acidic.

Separate air-venting of the large chamber by means of a thermostatic trap is recommended, even if the air is initially vented through a manually operated valve.

Special requirements of the trap:

- Drainage of the chamber without any banking-up of condensate
- Resistant to acid condensate

Additional requirement:

- Efficient air-venting of the steam spaces, whereby the vulcanizing chamber should be vented separately

Recommended traps:

- For the jacket: MK, BK
- For the vulcanizing chamber: MK with N capsule, BK, UNA Duplex
  For contaminated condensate, UNA Duplex is the better choice.
  For acid condensate, the particularly robust BK and UNA Duplex with control unit completely of austenitic materials (18% chromium steel) should be used.
- As air vent, MK with N capsule

4.21 **Autoclaves** (Fig. 56)

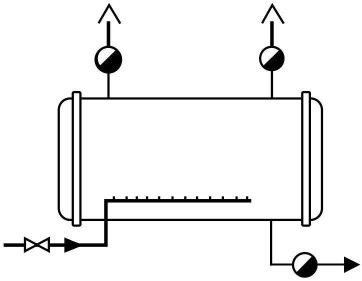


Fig. 56a

The steam is fed directly into the chamber containing the product. There should not be any condensate in the autoclaves, as splashes from the boiling condensate might damage the product and condensate collecting in the bottom of the autoclave may cause high thermal stresses. Frequently, air accumulations in the relatively large steam space (which may lead to layers of varying temperature) cannot be discharged by the steam trap alone and air vents are also required. As a rule, the condensate is more or less heavily contaminated.

Special requirements of the trap:

- Condensate discharge without any banking-up, even at start-up, with the low pressures and large amounts of condensate formed; unaffected by dirt; high start-up air-venting capacity

Additional requirement:

- Automatic thermostatic air-vent
- For heavily contaminated condensate, provide a vessel for trapping the dirt particles upstream of the trap (e.g. settling tank with GESTRA blowdown valve; see Fig. 56b)

Recommended traps:

- UNA Duplex
- MK with N capsule

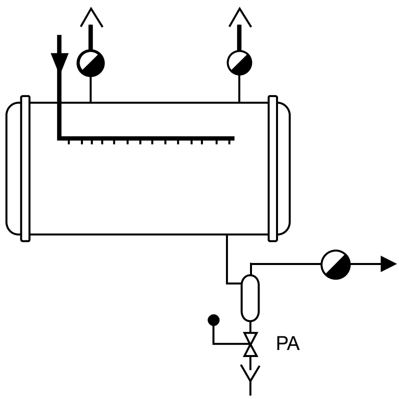


Fig. 56b

4.22 Ironing Presses, Garment Presses (Fig. 57)

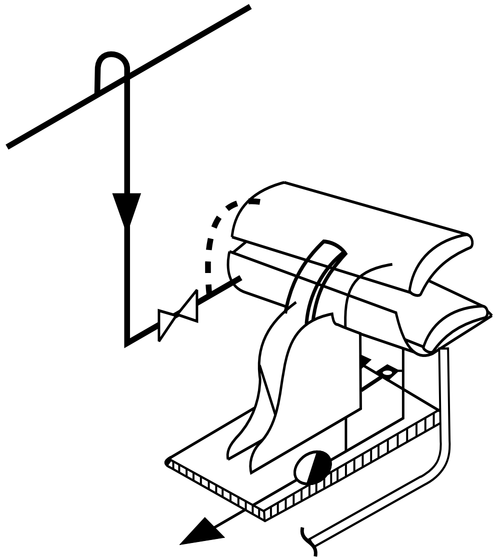


Fig. 57

Here we have to differentiate between presses used only for ironing and those used for ironing and/or steaming.
In the first case, only the heating surfaces have to be drained, which presents no real problems. Most important is that the condensate is free to flow towards the trap.
Fundamental rule: Each ironing unit is drained by its own trap.
Under unfavourable conditions, it may happen that the upper and lower part of a press are not properly drained by a single trap unless the trap is adjusted to pass a slight amount of live steam.
As this causes live-steam wastage, it is more economic in the long run to drain each part individually by its own trap.
Dry steam is required for the steaming process; if necessary, a steam drier should be mounted upstream of the press. Sudden opening of the steaming valve must not cause carry-over of condensate particles, as this would spoil the garment. If difficulties occur due to a poor plant layout, these may perhaps be compensated by a trap adjusted to pass live steam, which of course leads to steam losses.
The replacement of a trap operating entirely without live-steam loss (e.g. in the case of wet ironing presses) by a trap passing live steam in order to change a "wet" press into a "dry" press is therefore not recommended.

Special requirements of the trap:

- Operation without steam loss, and as far as possible without banking-up of condensate
- Good air-venting capacity, which reduces the heating-up period when starting the unit

Additional requirement:

- Provide steam driers to obtain dry steam

Recommended traps:

- MK with N capsule

4.23 Steaming Mannequins

(See Section 4.22, steaming process) (Fig. 58)

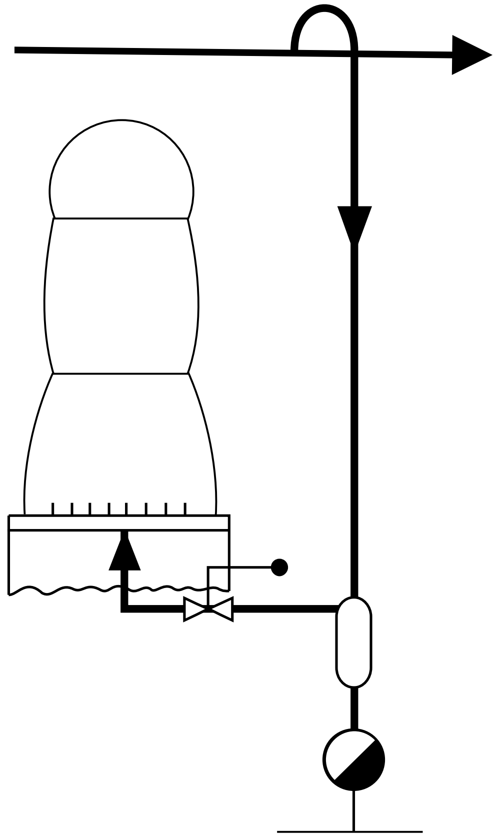


Fig. 58

4.24 Ironers and Calenders

(Hot mangles) (Fig. 59)

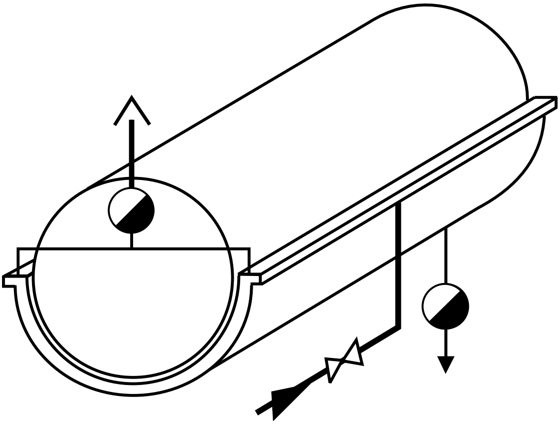


Fig. 59

High and uniform temperatures over the whole heating surface are very important. A large drying capacity is also expected (for a high ironing speed). This requires steam traps discharging the condensate as it forms and efficient air-venting of the bed. For multi-bed machines, each bed should be drained separately by its own trap. As the bed is rather wide, even a trap with a good air-venting capacity may not be able to properly air-vent the bed without causing live-steam loss. If air is included in the steam, the temperature drops in some places, mostly at the ends of the bed. Therefore the bed should be air-vented separately at either end by a thermostatic trap.

Special requirements of the trap:

- Condensate discharge without any banking-up, even at high ambient temperatures, as the steam traps are usually installed within the enclosed machine
- Good air-venting capacity, both at start-up and during continuous operation

Additional requirement:

- Air-venting the beds is of particular importance. Frequently, surface temperatures that are too low can be caused by insufficient air-venting. A good solution is to fit MK traps as thermostatic air vents at both ends of the bed.

Recommended traps:

- UNA Duplex
- MK with N capsule, MK with H capsules for large flowrates (if required for the first bed)

4.25 Dry-Cleaning Machines

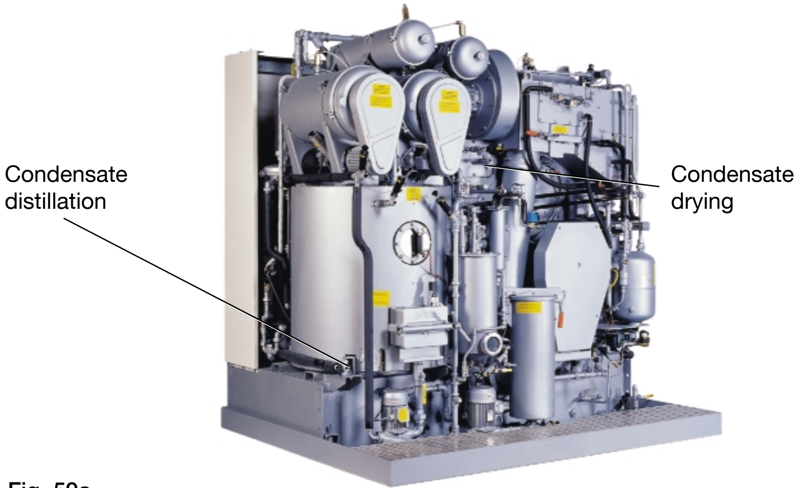


Fig. 59a

The air heater, the still and, if possible, the steam supply line at its lowest point have to be drained. The batch operation requires rapid discharge of the air entering the machine when it is shut down (reduction of the heating-up times). Steam traps ensuring automatic air-venting should therefore be preferred. Particularly in the still, banking-up of condensate may be undesirable, as the distilling time will be extended. New machines can also present a problem, since there may well be dirt (such as welding beads, scale etc.) still left inside the machine.

Special requirements of the trap:

- Condensate discharge without banking-up (important for the still); automatic air-venting
- Unaffected by dirt or protected against dirt particles
- Small dimensions; installation in any position to be able to fit the traps inside the machine without any difficulty
- Unaffected by waterhammer, as the steam is frequently admitted by solenoid valves

Recommended traps:

- MK with N capsule

4.26 Tracer Lines (Fig. 60)

In many cases, the heating steam does not transmit any heat to the product during normal operation. Steam tracing only ensures that in the case of pump failure, for example, the product temperature does not fall below the minimum temperature allowable.

The condensate flowrate during normal operation is therefore mainly determined by the heat losses (through radiation and convection) of the condensate line between tracer and steam trap. Noticeable heat savings can be obtained by reducing the heat losses of the condensate lines. Apart from the obvious methods of good insulation and the shortest possible distance between the product line and steam trap, banking-up in the condensate line (reduction of the length of pipe filled with steam) can further limit heat losses. One point, however, must be considered: in the case of a failure (such as a product pump stopping), the condensate flowrate can increase considerably, producing a larger accumulation of condensate with a corresponding undercooling. The maximum allowable degree of undercooling depends on the minimum product temperature to be maintained.

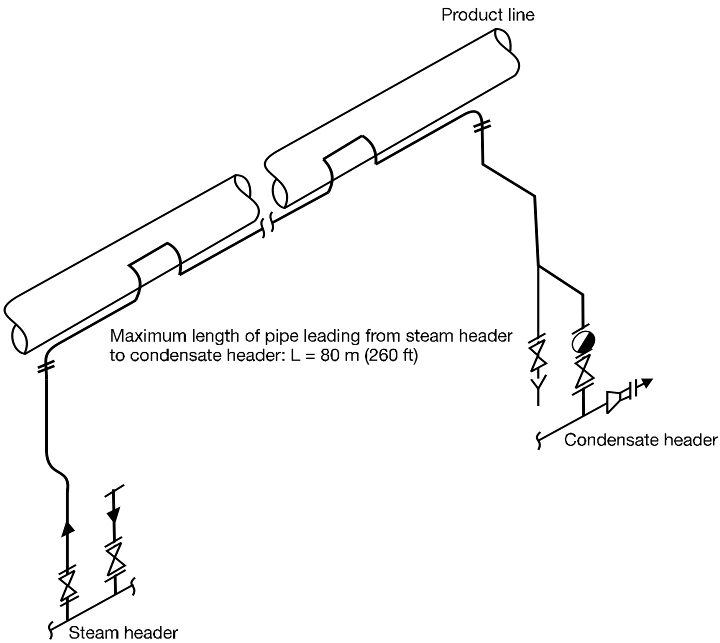


Fig. 60 Maximum length of tracer lines

The maximum length of the tracer lines depends on the number of risers and water pockets as well as on the number of pipe bends. A tracer line with a relatively straight run might have a length of 80 m (260 ft), including the supply line from the steam header and the length to the condensate header. In process plants, the tracer lines must be considerably shorter, because of the many risers and changes in direction. The sum of all rising lines should then not exceed 4 m.

For products with pour points < 0 °C, heating is only required if there is frost. The amount of steam required for winterizing can be considerably reduced if heating of the product is restricted to periods with actual frost or the risk of frost.

Special requirements of the trap:

- If the heating process permits, a certain amount of banking-up in the condensate line upstream of the trap is advantageous (heat savings)

Recommended traps:

- Thermostatic traps only, such as BK, possibly with large undercooling adjustment
- MK with U capsule (t ≈ 30 K below saturation temperature)
- UBK for low discharge temperatures ≥ 80 °C, e.g. with open condensate discharge

4.27 Jacketed Tracing Lines (Fig. 61)

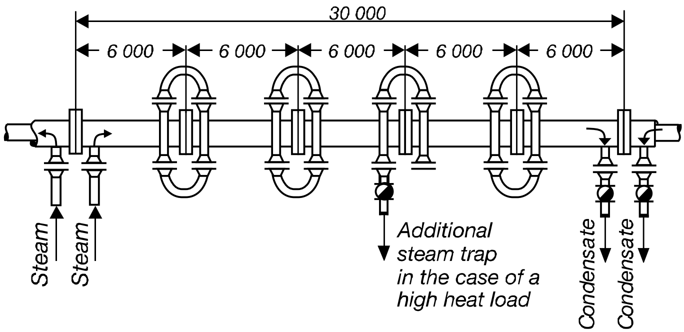


Fig. 61

Jacketed tracing lines are normally used for heating heavy products, such as sulphur and bitumen. The entire heating surface should be fed only with dry steam. Each tracer line should not exceed a length of 30 m (100 ft).

In the case of a high heat load, the tracer line should be provided with an additional steam trap.

Special requirements of the trap:

- No banking-up of condensate in the heating surface

Recommended traps:

- BK
- MK with N capsule

4.28 Instrument Tracing (Fig. 62)

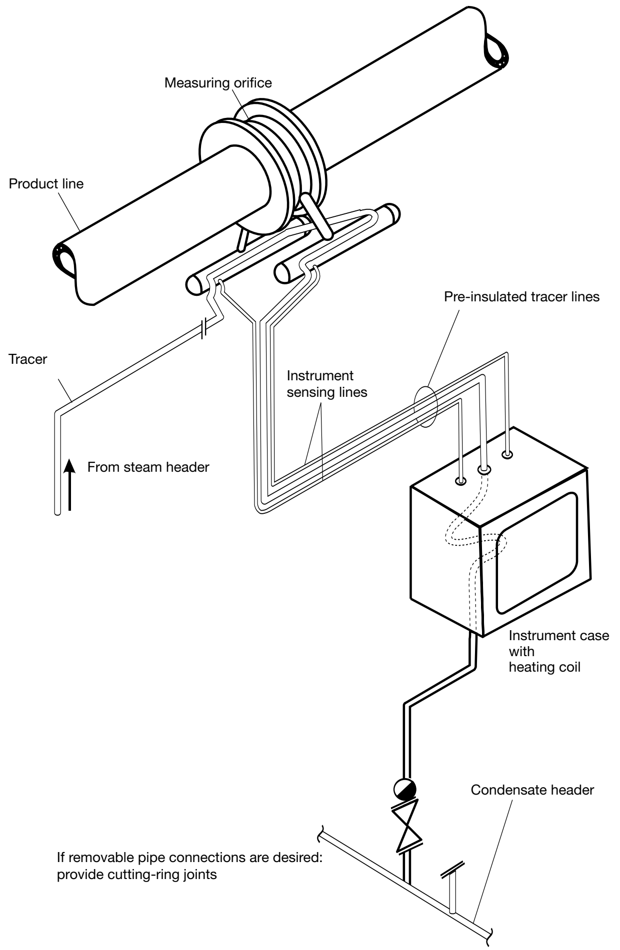


Fig. 62

Instrument tracing in refineries and petrochemical plants is characterized by very small condensate flowrates, while often the individual instruments must be heated only to low temperatures. In this case, the effective heating surface should be heated with condensate only.

Special requirements of the trap:

- Discharge of very low flowrates with a high undercooling

Recommended traps:

- MK with U capsule (t ≈ 30 K below saturation temperature)
- UBK with a discharge temperature ≥ 80 °C

4.29 Tank Heating (Fig. 63)

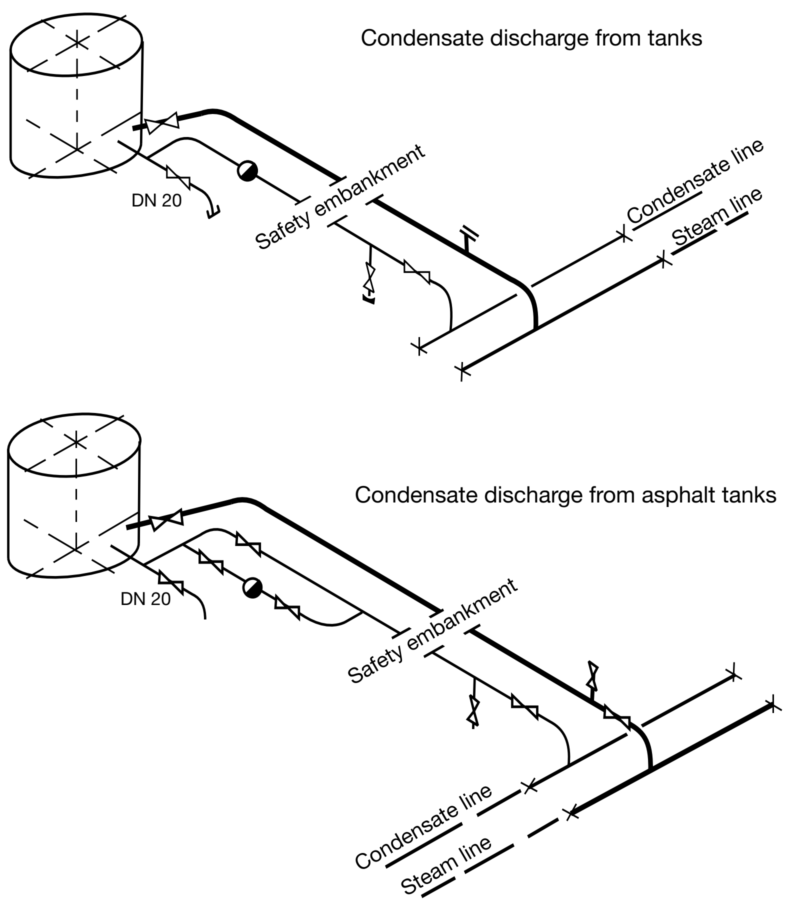


Fig. 63 Condensate discharge from heated tanks

Tank heating may vary considerably, depending on the size and the purpose of the tank.

Heating may be temperature-controlled or uncontrolled, which affects the condensate discharge. Condensate discharge is further influenced by the layout of the heating sections (horizontal, in the form of heating coils or finned-tube heaters with little fall towards the trap, or vertical as immersion heating elements).

Uncontrolled heating is frequently applied if little heat is required to maintain the product storage temperature. Because of the reduced steam flow (perhaps because of a manual control valve heavily throttled), the pressure in the heating section is decreased considerably. It is possible that the small pressure head available may no longer be sufficient to completely discharge the condensate. The consequence is banking-up of condensate, which may be desirable for reasons of heat savings (use of the sensible heat of the condensate), but on the other hand may cause waterhammer. As a basic rule for uncontrolled heating systems, the following applies:

It is essential that the heating elements and condensate lines to the trap be arranged to maintain a constant fall in the direction of flow. For the use of the sensible heat of the condensate by banking-up upstream of the trap, vertical heating sections are ideal (no danger of waterhammer). The steam trap should be sized to ensure a sufficient flowrate.

As regards controlled tank heating (with immersion heat exchangers, for instance), in principle the same applies as for storage calorifiers (see Section 4.7). The condensate line leading to the trap should be arranged to provide a constant fall, i.e. no back pressure downstream of the trap.

Special requirements of the trap:

- Discharge of relatively large condensate flowrates, also at a low pressure head
- If necessary and required, discharge of the condensate with undercooling
- For controlled tanks, a rapid response to fluctuations in pressure and flowrate
- Automatic air-venting
- Ability to withstand frost

Recommended traps:

- For uncontrolled plants: BK, MK with U capsule
- TK for large flowrates
- For controlled plants: UNA Duplex, MK with N capsule
- MK with H capsules for large flowrates

5. Monitoring of Steam Traps

FLOWSERVE® GESTRA

Steam Trap Technology Tailored to Your Needs

RHOMBUS*line*®

Rhombus*line* – Fitted for the Future

Features

- Compact, rhombus-shaped cover design makes for easy installation and maintenance
- Recessed cover gasket
- Large-surface strainer
- Wide variety of end connections: flanges to DIN and ANSI, butt-weld ends, socket-weld ends, screwed sockets
- Optional extra: integrated steam trap monitoring

5. Monitoring of Steam Traps

Effective checking that steam traps are operating correctly without banking-up or loss of live steam is a subject often discussed. The many checking methods that are used in practice range from useful to practically useless.

5.1 Visual Monitoring of the Discharge

5.1.1 This involves checking traps with open discharge by the size of the "steam cloud". This is the most uncertain method, since it is not possible to distinguish between flash steam and live steam. The size of the steam cloud depends mainly on the service pressure and the amount of condensate formed; they determine the amount of flash steam (see Fig. 64).

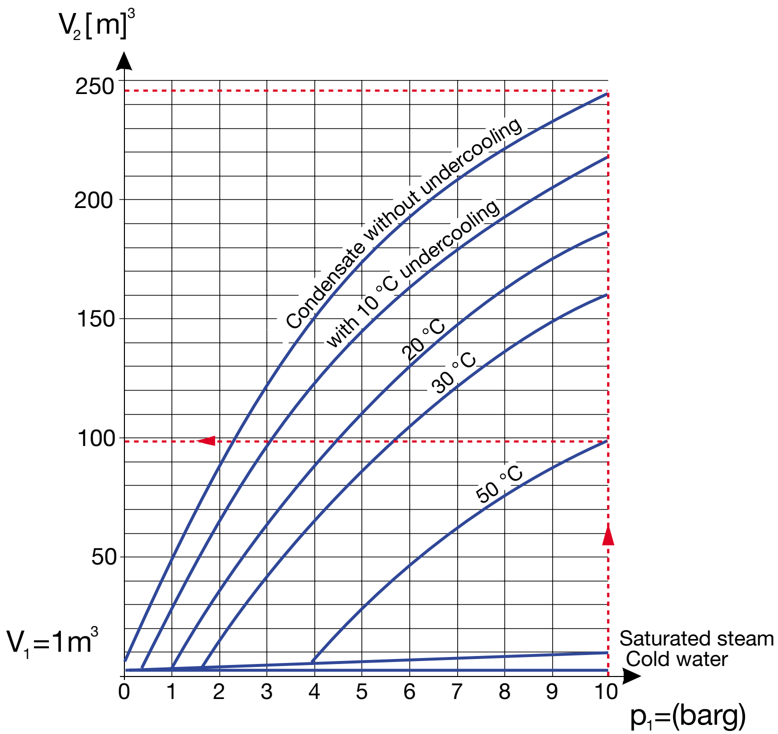


Fig. 64 Example

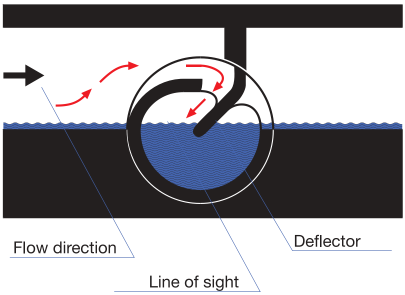
For an expansion from p_1 = 10 bar to p_2 = 0 bar; the volume of cold water remains practically the same,
that of saturated steam increases from V_1 = 1 m³ to V_2 = 9.55 m³,
that of boiling hot water increases from V_1 = 1 m³ to V_2 = 245 m
(due to the formation of flash steam), and
that of hot water 20 °C below saturation temperature increases
from V_1 = 1 m³ to V_2 = 189 m³.

Particularly at high service pressures, it is impossible to determine whether live steam is escaping with the condensate or not. Only with steam traps operating intermittently (e.g. thermodynamic, disc-type traps) may it be possible to detect increasing wear over a period resulting in a higher lift frequency of the valve disk.

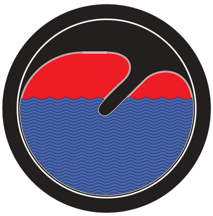
5.1.2 Checking with a sightglass downstream of the trap.
In principle, the same applies as mentioned in Section 5.1.1. However, there is even less evidence of trap operation, because in the small sight-glass space a small amount of flash steam produces a relatively high flow velocity with the corresponding turbulence. In the case of steam traps operating intermittently, it is only possible to determine whether the trap is open or closing, but not whether live steam is escaping.

5.1.3 Checking with a sightglass upstream of the trap or with a test set.
A properly designed sightglass installed upstream of the trap enables the steam trap to be checked exactly. Checking is not masked by flash steam. In comparison to sightglasses mounted downstream of the trap, the ones mounted upstream must be capable of higher pressures and temperatures. This requires high-pressure bodies and glasses of high quality, which is an explanation of their higher price.
The Vaposcopes available from the GESTRA product range are perfectly suited for visual monitoring of steam traps (see Fig. 65). Vaposcopes installed immediately upstream of the trap ensure ideal monitoring of the trap. They then not only reveal the slightest live steam loss, but also the smallest amount of banking-up of condensate. Banking-up in the condensate line only is of no importance for the heating process. To monitor the heating surface for banking-up, the installation of a second Vaposcope immediately downstream of the heat exchanger is recommended for the more critical heating processes (see Fig. 66).

5.1.4 Checking the operation of float traps.
The UNA 23 is available with a sightglass cover, so that it is possible to see whether the trap is waterlogged or whether live steam can escape via its orifice.

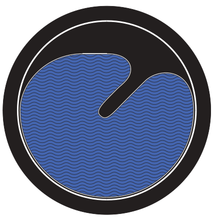


Condensate, steam and air are directed through the water seal by the deflector. As the specific gravity of steam is lower than that of condensate, the steam passes over the condensate and depresses the condensate level.



Normal service condition

The deflector is immersed in the water.



Banking-up of condensate

Complete flooding of the Vaposcope indicates banking-up of condensate. If the Vaposcope is installed immediately downstream of the heat exchanger, it is to be expected that this too will be at least partially filled with water.

Loss of live steam

The water level is being considerably depressed by passing live steam. The steam, which is invisible, fills the space between deflector and water level.

Fig. 65 Functional principle of the GESTRA Vaposcope

5.2 Checking by Temperature Measurement

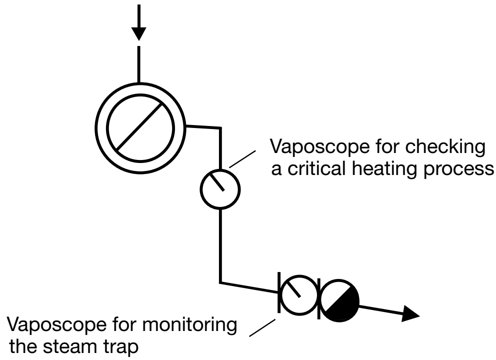


Fig. 66

The measurement of the temperature in the pipeline upstream of the steam trap is another problematic method frequently applied to heat exchangers where banking-up of condensate is undesirable.

Under certain circumstances, the operation of a trap may be judged by measuring the surface temperature at different points of the pipeline, e.g. immediately upstream of the trap, immediately downstream of the heat exchanger, or at the steam inlet.

It must, however, not be forgotten that the temperature depends on the service pressure at the measurement point, the percentage of incondensable gases in the heating steam (with the consequent reduction in the partial steam pressure and hence the temperature) and the condition of the pipeline surface. When selecting the measurement point, it must also be considered that even without banking-up the condensate temperature may be below the saturated steam temperature.

Measuring the temperature downstream of the trap can only serve as an indication of the pressure in the condensate line. Checking the steam by this method is not possible.

5.3 Checking by Sound

The method of checking trap operation by means of a stethoscope, which is quite often encountered, is only of some practical use in the case of traps with intermittent operation. With these traps, the opening and closing process can be clearly differentiated. The lift frequency of the valve disc permits conclusions to be drawn as to the mode of operation of the trap; whether live steam is escaping or not, however, cannot be determined.

Ultrasonic measurements of the structure-borne noise produced by the trap are of far greater importance. This method is based on the fact that steam flowing through a throttling element produces higher ultrasonic vibrations than flowing water (condensate) does. The GESTRA Vapophone ultrasonic detector VKP has given proof of its excellent performance.

The mechanical ultrasonic vibrations picked up by the probe of the VKP are converted into electrical signals which are amplified and indicated on a meter; the Vapophone is particularly sensitive to the frequencies produced by flowing steam (40 - 60 kHz).

When evaluating the measurement results, however, it must be taken into account that the noise intensity depends only partly on the amount of flowing steam. It is also influenced by the condensate amount, the pressure head, and the source of sound, i.e. the trap type. With some experience on the part of the tester, good results are obtained when checking traps with condensate flowrates up to about 30 kg/h and pressures up to 20 bar (290 psi), whereby steam losses as low as 1 - 4 kg/h can be detected.

Fig. 66a Ultrasonic detector for checking trap operation - Vapophone VKP-10

Fig. 66b Ultrasonic system for monitoring trap operation - TRAP*test* VKP 40

Thanks to the GESTRA steam trap testing and diagnostic system VKP 40, the checking of steam traps has been automated. The system can be used individually for all types and makes of steam traps. A preprogrammed data collector is used in the system to record the measurement values. Trap-specific software settings are taken into account during the measurement! After the data have been transferred and stored in a PC, their evaluation can commence. Comparison with the historic data within the software package forms the basis of a steam trap management system.

5.4 Continuous Monitoring of Steam Traps

The test set VKE is used for monitoring steam traps to detect leakage of live steam, either by measurement locally with the manual test unit or by automatic remote monitoring.

Indication by light-emitting diodes: green LED = "steam trap operating correctly", red LED = "steam trap blowing steam".

For remote monitoring, up to 18 steam traps can be monitored continuously with a single test unit.

For steam traps that are not easily accessible, the manual test unit may be connected by the wall-mounting connection box.

Steam traps of all types and makes can be monitored.

Wear-resistant and maintenance-free.

For horizontal pipelines.

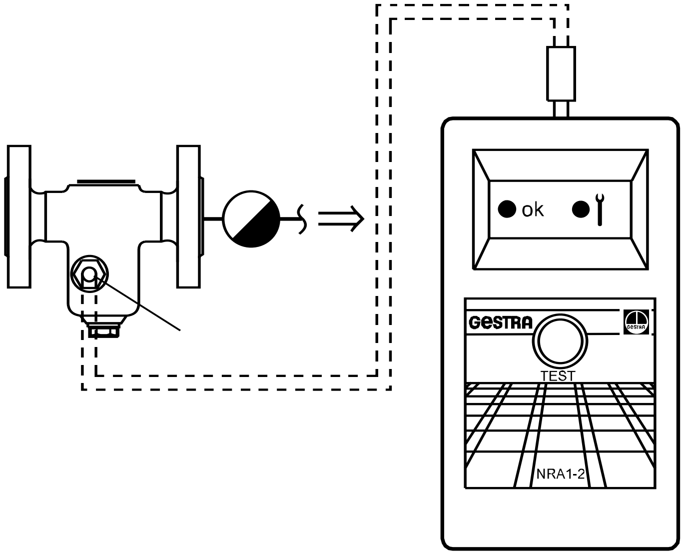
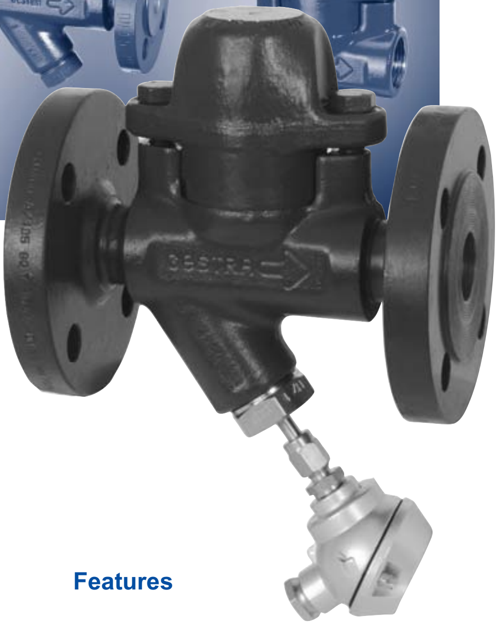


Fig. 67

FLOWSERVE® GESTRA

Steam Trap Technology Tailored to Your Need



RHOMBUS*line*®

Rhombus*line* – Fitted for the Future

The following optional items for Rhombusline steam traps BK 45, BK 46, MK 45 and UBK 46 are available on request.

- Integrated temperature monitoring (PT 100 element with connector for monitoring steam traps for banking-up of condensate). Strainer remains fitted.
- Integrated level probe for detecting steam loss (in combination with hand-held test unit NRA 1-2 or remote test unit NRA 1-1). Strainer omitted.

Features

- Compact, rhombus-shaped cover design makes for easy installation and maintenance
- Recessed cover gasket
- Large-surface strainer
- Wide variety of end connections: flanges to DIN and ANSI, butt-weld ends, socket-weld ends, screwed sockets
- Optional extra: integrated steam trap monitoring

6. Using the Sensible Heat of the Condensate

6.1. Basic Considerations

In a steam-heated heat exchanger, normally only the heat of vaporization (latent heat) is transmitted to the product being heated. To achieve the maximum rate of heat transfer, the condensate has to be discharged immediately it is formed. The heat contained in the condensate (the sensible heat) is discharged with the condensate. It forms a considerable percentage of the total heat content, which increases with the pressure. At a service pressure of 1 bar, for example, the proportion of sensible heat is ≈ 19 % of the total heat content of the steam, whilst at a pressure of 10 barg it is ≈ 28 % and at a pressure of 18 barg ≈ 32 % (see steam tables in Fig. 83).

If the condensate is discharged into the open and not re-used, a large part of the heat energy required for steam generation is lost. In addition, further costs are incurred because the feedwater has to be completely made up.

It is therefore general practice to collect the condensate as far as possible and to re-use it for steam generation or at least as service water for the plant.

The use of the flash steam formed as a result of the pressure drop of the condensate - from the service pressure in the heat exchanger to the pressure in the condensate line - poses greater problems. If the condensate is discharged to atmosphere (open condensate system) then flashing, besides being a nuisance to the environment, may lead to considerable heat losses even if the condensate is re-used. Thus the heat losses referred to the total heat energy produced are 3.2 % at a service pressure of 1 barg, 13 % at 10 bar, and 17 % at 18 bar. The amount of flash steam formed at various pressures and back pressures is shown in Fig. 68.

6.2 Examples for the Use of the Sensible Heat of Condensate

6.2.1 Banking-up in the heat exchanger

Through banking-up, part of the heat contained in the condensate is used directly for the heating process. In extreme cases, the amount of heat withdrawn from the condensate can be so high that flashing no longer occurs when the condensate is discharged. This requires, however, an extra-large heat exchanger so that the necessary heating capacity and temperature are reached. In addition, the heat exchanger must be designed to avoid waterhammer (e.g. vertical counterflow heat exchanger or preheater, as shown in Fig. 38).

In heat exchangers without temperature control, banking-up can easily be effected with thermostatic traps discharging the condensate with a given undercooling (BK with undercooling adjustment; MK with U capsule; UBK).

In controlled heat exchangers, the control valve must be fitted on the condensate side and not on the steam side.

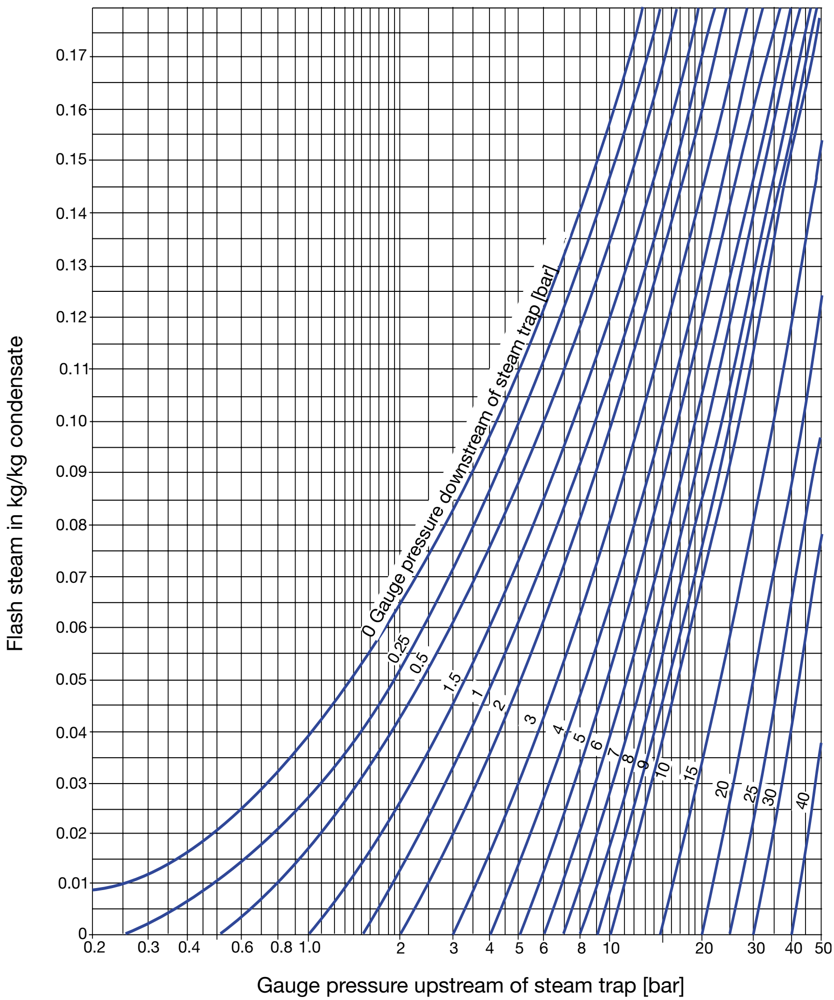


Fig. 68 Amount of flash steam
Amount of flash steam formed when boiling condensate is reduced in pressure.

6.2.2 Flash-steam recovery (closed condensate system). The flash steam is used for heating secondary heat exchangers and the condensate is returned to the boiler house. This method cannot be applied unless at least two different steam pressures are required in a plant (Fig. 69).

Use of flash steam

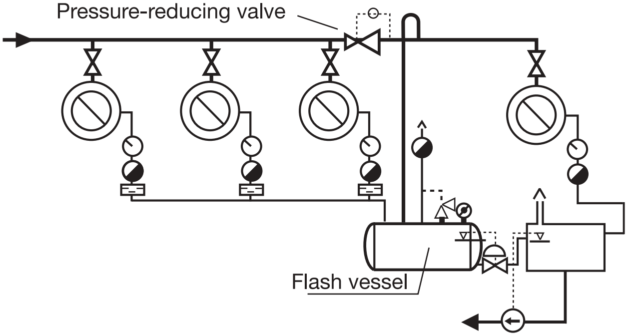


Fig. 69 If the steam supply from the flash vessel is not sufficient, live steam is added via the pressure-reducing valve.

In smaller plants, the flash steam formed may be completely used in a single heat exchanger, such as a calorifier, heat exchanger for the production of warm water etc. (see Fig. 70).

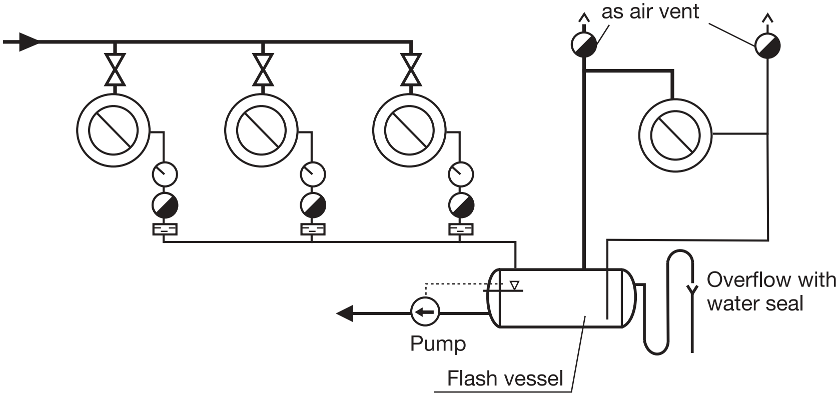


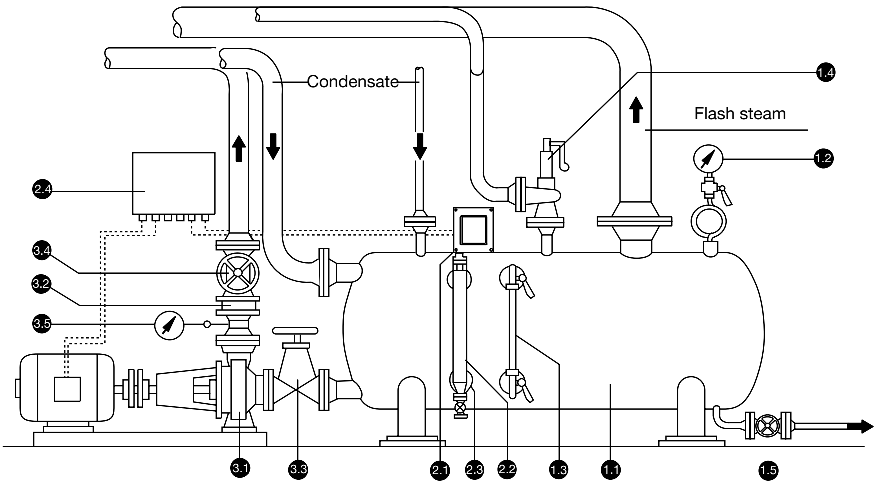
Fig. 70 Simple flash steam recovery with thermosiphon circulation. The amount of flash steam depends on the condensate flowrate and cannot be adapted to varying demand.

7. Air-Venting of Heat Exchangers

Air and other incondensable gases enter a steam plant particularly during periods of shut-down. Insufficient deaeration of the feedwater is another way gases can get into the plant. The use of vapours from evaporation processes as heating steam is yet another cause in some industries.
Air and the other gases impair the heat transfer and, in addition, reduce the partial pressure of the steam and consequently the steam temperature. If a mixture of steam and air exists, the pressure gauge will indicate the total pressure in the steam space; the temperature measured here, however, corresponds only to the partial steam pressure and is lower than the saturation temperature relative to the total pressure. The heat transfer rate drops in accordance with the reduced temperature difference between steam and product (see Fig. 28).
At a total pressure of 11 bara, for example, the temperature is ≈183 °C with no air present. The temperature drops to ≈180 °C with a proportion of air present of 10 % and to ≈ 170 °C with an air proportion of 35 %. We can conclude from this example that the air concentration is highest where the heating surface is coldest. This fact has to be considered when fitting the air vents.
For small and medium heat exchangers, sufficient air-venting is generally provided by steam traps with automatic air-venting capacity (all GESTRA steam traps ensure automatic deaeration).
In large heat exchangers, such as boiling pans, evaporators and autoclaves, gases tend to concentrate at certain points, owing to the design of the steam space and the resulting flow conditions. In these cases, the steam space has to be deaerated separately at one or several points. GESTRA thermostatic traps of the BK and MK range are perfect as air vents, with the MK type especially suited for saturated steam systems.
To speed up the air discharge from the steam space, it is recommended that an uninsulated pipe having a length of at least 1 m is fitted upstream of the air vent. The condensation of the steam in this pipe causes a local concentration of air with a corresponding temperature reduction, so that the trap opens more quickly and wider.
An effective arrangement of air vents on a large heat exchanger is shown in Fig. 29.

8. Condensate Return Systems

To convey the condensate back to the steam generating plant, for example, a sufficient pressure head is required, be it purely by gravity, by using the steam pressure or by a combination of both.
In large plants (with large condensate flowrates) or if the condensate has to be lifted, the back pressure might rise to an unacceptable level (e.g. in control plants, see inter alia Section 4.8.1). In this case, it is best to collect the condensate from the various sections of the plant separately.
The condensate from the condensate tank is conveyed to the feedwater tank by level-controlled pumps (see Fig. 71).



Equipment

1. Condensate recovery system consisting of
1.1 GESTRA condensate tank
1.2 Pressure gauge assembly
1.3 Water-level indicator
1.4 Pressure relief valve
1.5 Drain valve

2. Level control equipment
2.1 GESTRA level-control electrode
2.2 GESTRA measuring pot
2.3 Slide valve
2.4 GESTRA switch cabinet

3. Pump unit
3.1 Condensate pump
3.2 GESTRA DISCO non-return valve
3.3 GESTRA stop valve
3.4 GESTRA stop valve with throttling cone
3.5 Pressure gauge assembly for pressure line

Fig. 71 GESTRA condensate collecting and return systems

To convey small to medium flowrates from distant parts of the plant, the use of a GESTRA condensate return system operating with a pump is a very economical solution. In this arrangement, steam is used to drive the condensate. The condensate flows into the condensate tank, which is at atmospheric pressure. As soon as the condensate reaches the other level, a level-control electrode transmits a closing pulse to the solenoid valve in the vent line and simultaneously an opening pulse to the solenoid valve in the booster steam line. As soon as the minimum condensate level required in the tank is reached, a second electrode transmits a closing pulse to the steam valve and an opening pulse to the vent valve (see Fig. 72).

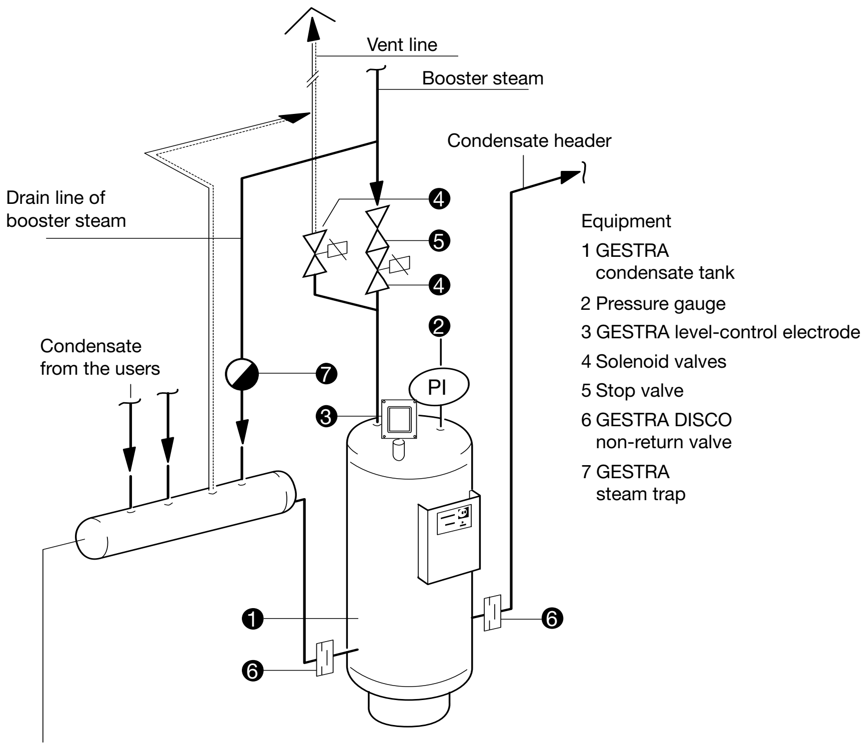


Fig. 72 GESTRA condensate-return system operating without a pump

FLOWSERVE®

GESTRA

What are the advantages of GESTRA steam traps?

✎Easy maintenance – our traps can be checked, cleaned and repaired without being removed from the pipework

✎Interchangeable – our various trap types have standardized face-to-face dimensions, sizes and end connections and are therefore interchangeable without any modification to the pipe layout.

✎Tight shut-off, without loss of live steam.

✎Automatic air-venting.

✎Unaffected by dirt.

✎Production tested – besides the legally required tests (e.g. hydraulic test) our trap regulators are tested under operating conditions (steam, condensate).

✎Complies with recognized standards – our traps meet the relevant DIN standards and regulations and are in accordance with the AD bulletins (AD – Arbeitsgemeinschaft Druckbehälter = German pressure vessel regulations authority) with regard to choice of material, pressure and temperature ratings. On request test certificates to EN 10204.

9. Drainage of Compressed Air Lines

Atmospheric air always contains a small amount of water vapour. This amount can be equal to 100 % saturation, but not higher. 100 % saturation may be expressed as the maximum weight of water vapour in grams contained in 1 cubic metre of air and depends solely on the air temperature (Fig. 73).
The amount of water vapour in the air - also called the absolute atmospheric humidity - is identical to the specific gravity of the saturated vapour at this temperature. The absolute humidity increases with rising temperatures and decreases with falling temperatures. The amount of vapour exceeding the saturation limit will condense.
The actual weight of water vapour contained in 1 m^3 of air, expressed as a percentage of the maximum amount of water vapour, is the relative humidity (100 % relative humidity = saturation quantity = absolute humidity).

Example:
1 m^3 of saturated air at 23 °C contains 20.5 g of vapour (absolute humidity). If this air is compressed from 1 bara to 5 bara and the air temperature is kept constant at 23 °C by cooling, the air volume will drop to 1/5 m^3. This air volume can no longer hold the 20.5 g of vapour contained in the original 1 m^3 of air, but only 1/5 of it, i.e. 4.1 g. The rest of 20.5 - 4.1 = 16.4 g condenses in the form of water.
The maximum amounts of condensate that are possible at an intake pressure of 0 barg, but with different intake temperatures and a compressed-air temperature of 20 °C, are given in Fig. 74. The values indicated in this table each have to be multiplied with the actual amount of air in m^3, which may have to be derived from the flowrate, e.g. m^3/h or litres/min.

Example:
Every hour, 1000 m^3 of air are compressed to 12 barg. Intake temperature 10 °C, compressor-air temperature 20 °C. According to the table, the maximum amount of condensate is 8 g/m^3, i.e. for 1000 m^3/h = 8,000 g/h = 8 kg/h.
The water separated from the compressed air has to be removed from the plant, as it would lead to erosion and corrosion, amongst other things. The entire air system should be drained, as water is continually being separated from the air until the air has cooled down to ambient temperature.
It is recommended that the coolers of the compressors are drained, together with the air receivers, the air lines at regular intervals, and at least at the lowest points and upstream of risers if the line changes its direction (see Fig. 75).
In all cases where dry air is required, water separators operating on the centrifugal principle should be used (GESTRA drier and purifier TP) or, for more critical applications, water absorbers. If oil-free air is required in addition, oil absorbers or oil separators should be used.
For automatic drainage, special design combinations of GESTRA float traps are available.

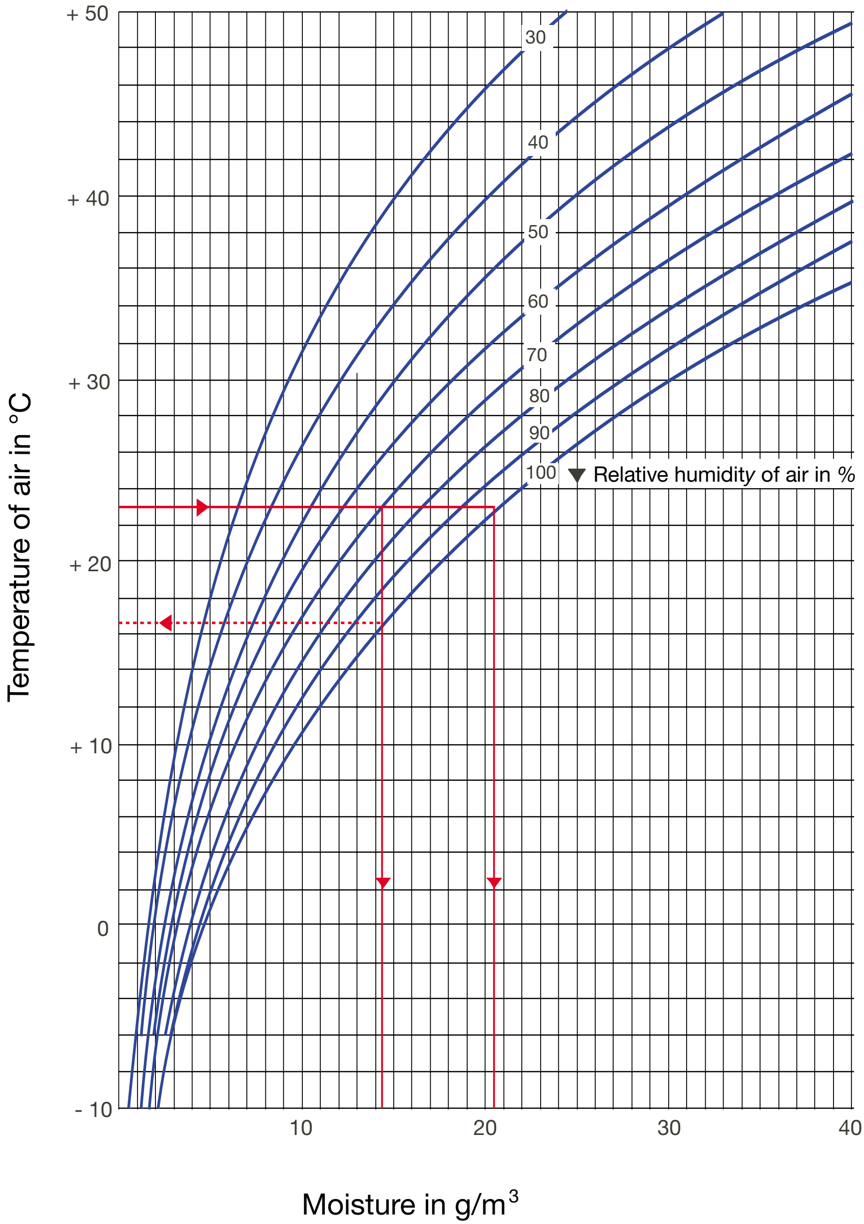


Fig. 73 Moisture content of air

Intake temperature	Moisture content at 100 %/ saturation (see Fig. 74)	Maximum amount of condensate in g per m³ of intake air at gauge pressure					
		4 bar	8 bar	12 bar	16 bar	22 bar	32 bar
-10 °C	2.14 g/m³	0	0	0.6	1	1,3	1.5
0 °C	4.84 g/m³	1	2.7	3.4	3.7	4	4.2
+10 °C	9.4 g/m³	5.8	7.3	8.0	8.3	8.6	8.8
+20 °C	17.3 g/m³	13.7	15.3	16.0	16.2	16.5	16.8
+30 °C	30.4 g/m³	26.9	28.5	29.1	29.4	29.6	29.9
+40 °C	51 g/m³	47.7	49.1	49.7	50	53	50.5

Fig. 74 Maximum amount of condensate formed in 1 m³/h of intake air, p = 0 barg, intake temperature see table above, temperature of compressed air 20 °C, moisture content of air on intake = 100 %.

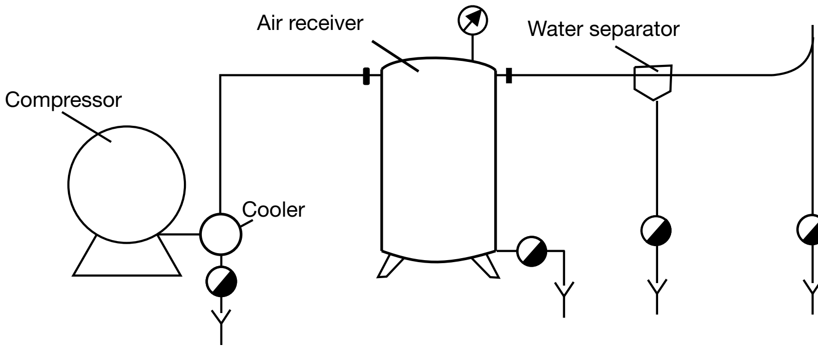


Fig. 75

For the correct drainage of compressed-air lines, the following points have to be considered when laying the pipework and installing the steam traps:

a) The condensate should drain by gravity with a constant slope from the drain point to the trap;

b) The pipeline should be laid to provide a sufficient fall. In horizontal lines, a water pocket may even form in a stop valve. As upstream and downstream of the water pocket there is the same pressure, the water cannot be pushed out, and it becomes a water seal. As a result, the condensate can no longer flow towards the trap;

c) Float traps require a certain condensate level in the trap body to open. This cannot form unless the air pocket has escaped from the body.
With a very small amount of condensate and with a relatively large pipeline (with regard to the flowrate) provided with a sufficient and constant fall (vertical if possible), GESTRA float traps ensure that the air can escape. As condensate enters the trap, air can flow back up the line in the opposite direction to the condensate.
If the amount of condensate formed is rather large, e.g. if the condensate line is completely filled on start-up of the plant or by a surge of water, the air is confined within the trap body. The condensate level required to open the trap is formed rather slowly, if at all, and condensate discharge is insufficient. In this case, it is recommended that a connection be provided between trap and air-line by a “balance pipe”. The air can then escape and the condensate is discharged without any delay (Fig. 76).

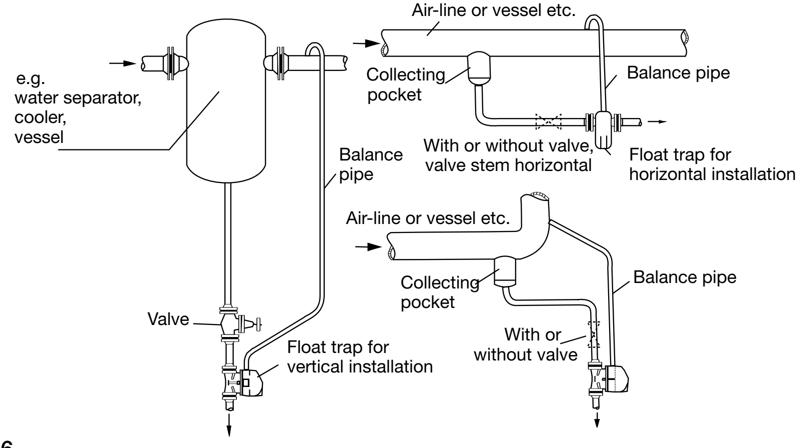


Fig. 76

d) Small oil quantities, as are normally contained in the air of oil-lubricated compressors, do not impair the operation of the GESTRA traps. If the condensate is heavily oil-contaminated, the installation of a settling tank upstream of the trap is recommended. Hence the oil foam may be discharged from time to time, e.g. by a hand-operated valve (Fig. 77).

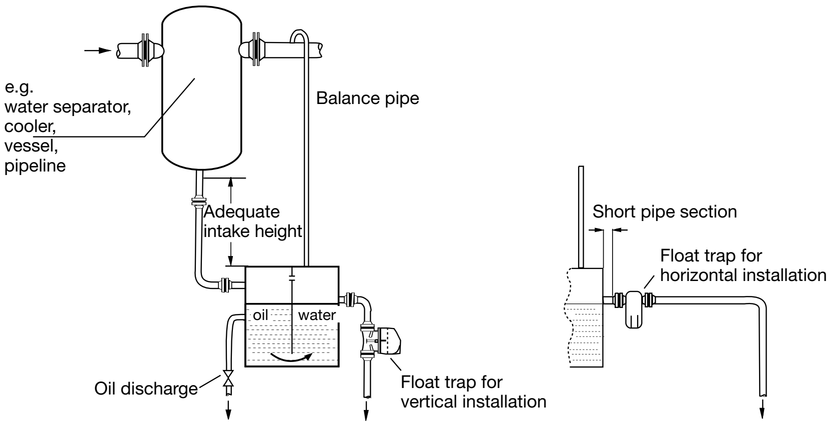


Fig. 77

Instead of the trap, it is also possible to use a solenoid valve operated by a timing delay. This valve is opened for a few seconds at predetermined intervals. The outflowing air will at the same time clean the valve seat. Note: Air losses!

e) Outdoor plants: Provide heating for pipeline and traps, otherwise there is the danger of freezing.
Before commissioning a new plant for the first time, fill the float trap with water.

Steam Trap Testing

Live steam leakage is detected by sound in the ultrasonic range caused by flowing steam. The mechanical ultrasonic vibrations are detected by the probe and converted into electric signals which are amplified in the measuring instrument and indicated on a meter. The equipment is intrinsically safe acc. to classification EEx ib IIC T4 (Test No. PTB Ex-84/2063) and suitable for use in explosion-risk areas. Protection: IP 41

10. Sizing of Condensate Return Lines

FLOWSERVE® GESTRA

What are the advantages of GESTRA steam traps?

- ✎ Easy maintenance – our traps can be checked, cleaned and repaired without being removed from the pipework
- ✎ Interchangeable – our various trap types have standardized face-to-face dimensions, sizes and end connections and are therefore interchangeable without any modification to the pipe layout.
- ✎ Tight shut-off, without loss of live steam.
- ✎ Automatic air-venting.
- ✎ Unaffected by dirt.
- ✎ Production tested – besides the legally required tests (e.g. hydraulic test) our trap regulators are tested under operating conditions (steam, condensate).
- ✎ Complies with recognized standards – our traps meet the relevant DIN standards and regulations and are in accordance with the AD bulletins (AD – Arbeitsgemeinschaft Druckbehälter = German pressure vessel regulations authority) with regard to choice of material, pressure and temperature ratings. On request test certificates to EN 10204.

10. Sizing of Condensate Return Lines

10.1 Basic Considerations

10.1.1 The diameter of the pipeline between the heat exchanger and the steam trap is normally chosen to fit the nominal size of the trap.

10.1.2 When choosing the diameter of the condensate line downstream of the trap, flashing has to be considered. Even at very low pressure differentials, the volume of flash steam is many times that of the liquid if the condensate is at saturation temperature upstream of the trap (e.g. during flashing from 1.2 bara to 1.0 bara, the volume increases approximately 17 times).
In these cases, it is sufficient to dimension the condensate line solely in accordance with the amount of flash steam formed. The flow velocity of the flash steam should not be too high, otherwise waterhammer (e.g. through the formation of waves), flow noises and erosion may occur.
A flow velocity of 15 m/s at the end of the pipeline before the inlet into the collecting tank or pressure-relief unit is a useful empirical value.
The required inside diameter of the pipeline can be taken from Fig. 78.
For long pipelines(≥ 100 m) and large condensate flowrates, the pressure drop should be calculated to prevent the back pressure becoming too high; here the velocity of the flash steam may be used as a basis for the calculations (Figs. 79 and 80).

10.1.3 When the condensate is mainly in the liquid state (e. g. high degree of undercooling, extremely low pressure), the flow velocity of the condensate should, if possible, be rated at ≤ 0.5 m/s when determining the pipeline diameter. The pipeline diameter as a function of the selected flow velocity can be chosen from the chart in Fig. 81. If the condensate is pumped, the condensate in the pump discharge line can only be in the liquid phase.
For choosing the pipeline diameter, the mean velocity can be rated at 1.5 m/s. Again, the chart in Fig. 81 may be used to obtain the pipe diameter.

State of the condensate before flashing: Pressure bara absolute	Related boiling temperature °C	Pressure at the end of the condensate line [bar absolute]: 0.2	0.5	0.8	1.0	1.2	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6	7	8	9	10	12	15	18	20
1.0	99	35.7	16.0	7.4																			
1.2	104	37.9	18.0	10.0	6.1																		
1.5	111	40.1	20.6	12.9	9.5	6.8																	
2.0	120	44.2	23.5	15.8	12.6	10.3	7.6																
2.5	127	46.8	25.5	17.7	14.5	12.3	9.2	5.3															
3.0	133	48.8	27.1	19.2	16.0	13.9	10.7	7.3	4.5														
3.5	138	50.4	28.4	20.4	17.1	15.0	11.9	8.5	6.0	3.8													
4.0	143	52.0	29.6	21.5	18.2	18.0	12.9	9.7	7.3	5.3	3.5												
4.5	147	53.3	30.5	22.3	19.0	16.9	13.7	10.5	8.1	6.3	4.7	3.0											
5	151	54.3	31.5	23.1	19.8	17.7	14.4	11.2	8.9	7.1	5.6	4.2	2.8										
6	155	55.7	32.3	23.9	20.5	18.4	15.2	11.9	9.6	7.9	6.5	5.1	4.0	2.7									
7	158	56.5	33.0	24.5	21.1	18.9	15.7	12.4	10.1	8.4	7.0	5.7	4.6	3.5	2.1								
8	170	59.9	35.5	26.7	23.1	20.9	17.6	14.2	11.9	10.2	8.9	7.7	6.7	5.8	4.8	4.0							
9	175	61.3	36.4	27.5	23.9	21.7	18.3	14.9	12.6	10.9	9.5	8.4	7.4	6.6	5.5	4.8	2.4						
10	179	62.3	37.2	28.2	24.6	22.3	18.9	15.5	13.1	11.4	10.0	8.9	7.9	7.1	6.0	5.3	3.3	2.1					
12	187	64.4	38.7	29.5	25.7	23.5	19.9	16.5	14.1	12.3	11.0	9.8	8.9	8.0	7.0	6.2	4.5	3.6	2.8				
15	197	66.9	40.5	31.0	27.2	24.8	21.5	17.7	15.2	13.4	12.0	10.8	9.9	9.1	8.0	7.2	5.6	4.8	4.2	2.9			
18	206	69.0	42.0	32.3	28.4	26.0	22.3	18.7	16.2	14.3	12.9	11.7	10.8	9.9	8.8	8.0	6.5	5.7	5.1	3.9	2.5		
20	211	70.2	42.9	33.0	29.0	26.6	22.9	19.2	16.7	14.8	13.4	12.2	11.2	10.4	9.2	8.4	7.0	6.2	5.6	4.4	3.1	1.7	
25	223	72.9	44.8	34.7	30.6	28.1	24.2	20.4	17.9	15.9	14.5	13.2	12.2	11.4	10.2	9.3	7.9	7.1	6.5	5.4	4.2	3.1	2.5
30	233	75.1	46.3	36.0	31.8	29.2	25.3	21.4	18.8	16.8	15.3	14.0	13.0	12.1	10.9	10.0	8.6	7.8	7.2	6.1	4.9	4.0	3.4
35	241	76.8	47.5	37.0	32.7	30.1	26.1	22.1	19.5	17.5	15.9	14.6	13.6	12.7	11.4	10.5	9.2	8.4	7.8	6.7	5.5	4.5	4.0
40	249	78.5	48.7	38.0	33.6	31.0	26.9	22.9	20.1	18.1	16.5	15.2	14.1	13.2	12.0	11.0	9.7	8.6	8.2	7.1	6.0	5.0	4.5
45	256	80.0	49.7	38.8	34.4	31.7	27.5	23.5	20.7	18.6	17.0	15.7	14.6	13.7	12.4	11.4	10.1	9.3	8.6	7.5	6.3	5.4	4.9
50	263	81.4	50.7	39.6	35.2	32.5	28.2	24.1	21.2	19.1	17.5	16.2	15.1	14.2	12.8	11.8	10.5	9.6	9.0	7.9	6.7	5.7	5.2

To determine the actual diameter (mm), the above values must be multiplied with the following factors:

kg/h	100	200	300	400	500	600	700	800	900	1.000	1.500	2.000	3.000	5.000	8.000	10.000	15.000	20.000
Factor	1.0	1.4	1.7	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.9	4.5	5.5	7.1	8.9	10.0	12.2	14.1

Fig. 78 **Sizing of condensate lines** (calculation examples on page 107 and following)
Basic assumptions for determining the inside pipe diameter:
1. Only the flash steam amount is considered.
2. The flow velocity of the flash steam is assumed to be 15 m/s.

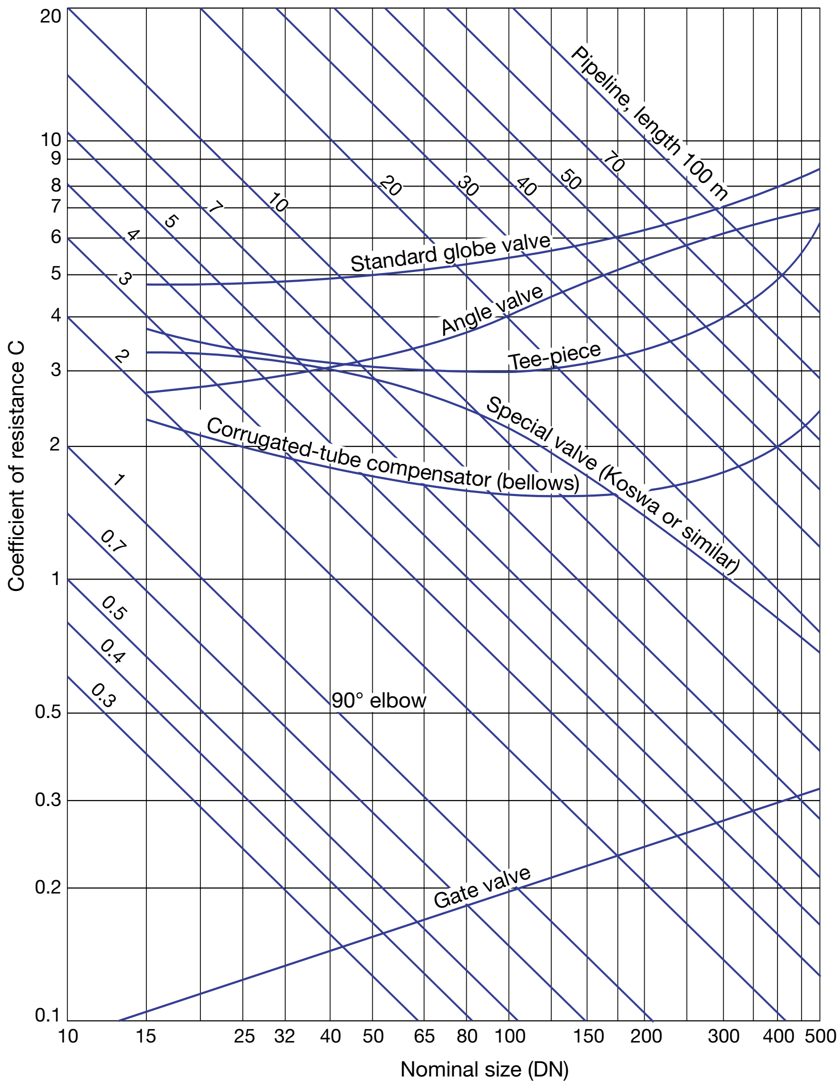


Fig. 79 Pressure drop in steam lines
The coefficients of resistance C for all pipeline components of the same size are read from Fig. 80. The total pressure drop Δp in bar can be determined from the sum of all individual components ΣC and the operating data; see Fig. 81.

Example.

Pipeline components DN 50:

Pipeline length 20 m	C = 8.11
1 angle valve	C = 3.32
2 special valves	C = 5.6
1 tee-piece	C = 3.1
2 elbows 90°	C = 1.0
	$\sum C$ = 21.1

Operating data:

Temperature	t	= 300 °C
Steam pressure, abs.	p	= 16 bar
Velocity	w	= 40 m/s

Result Δp = 1.1 bar

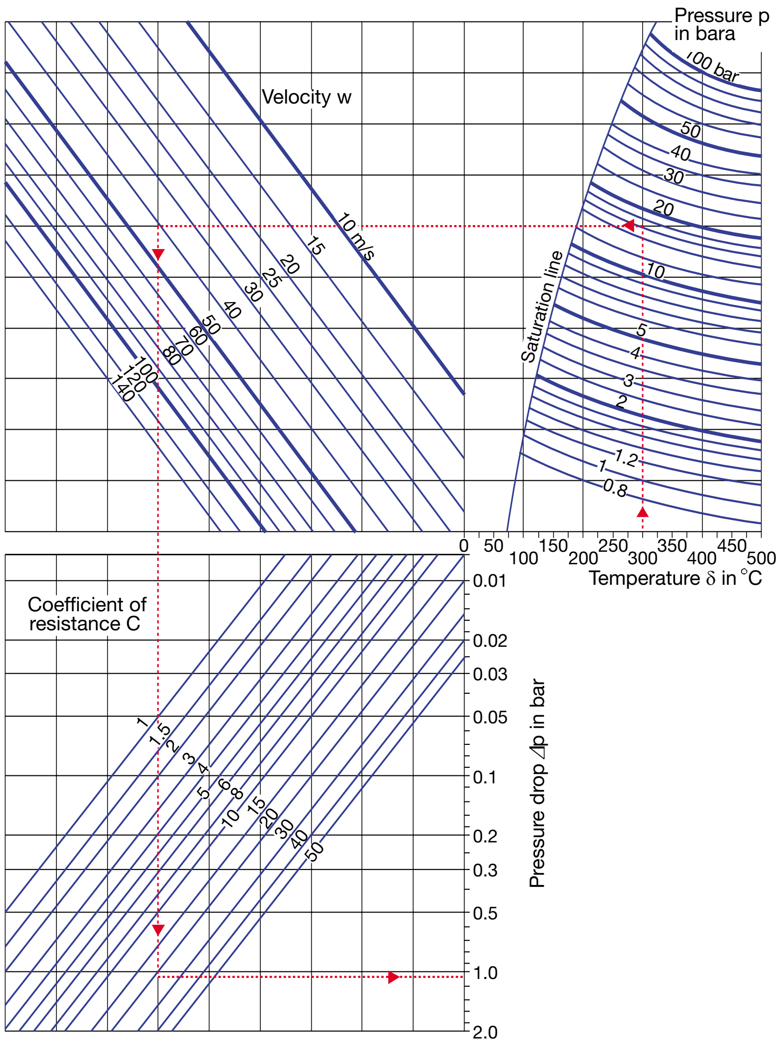


Fig. 80

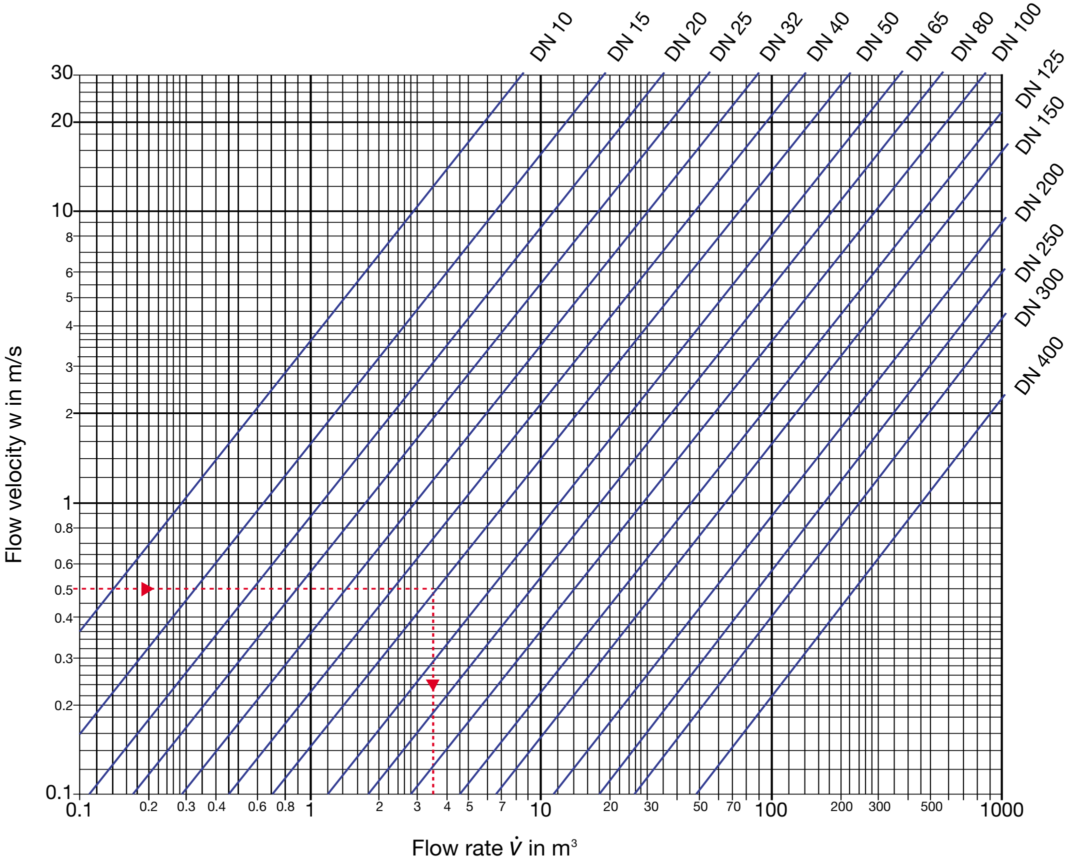


Fig. 81 Flowrates in pipelines

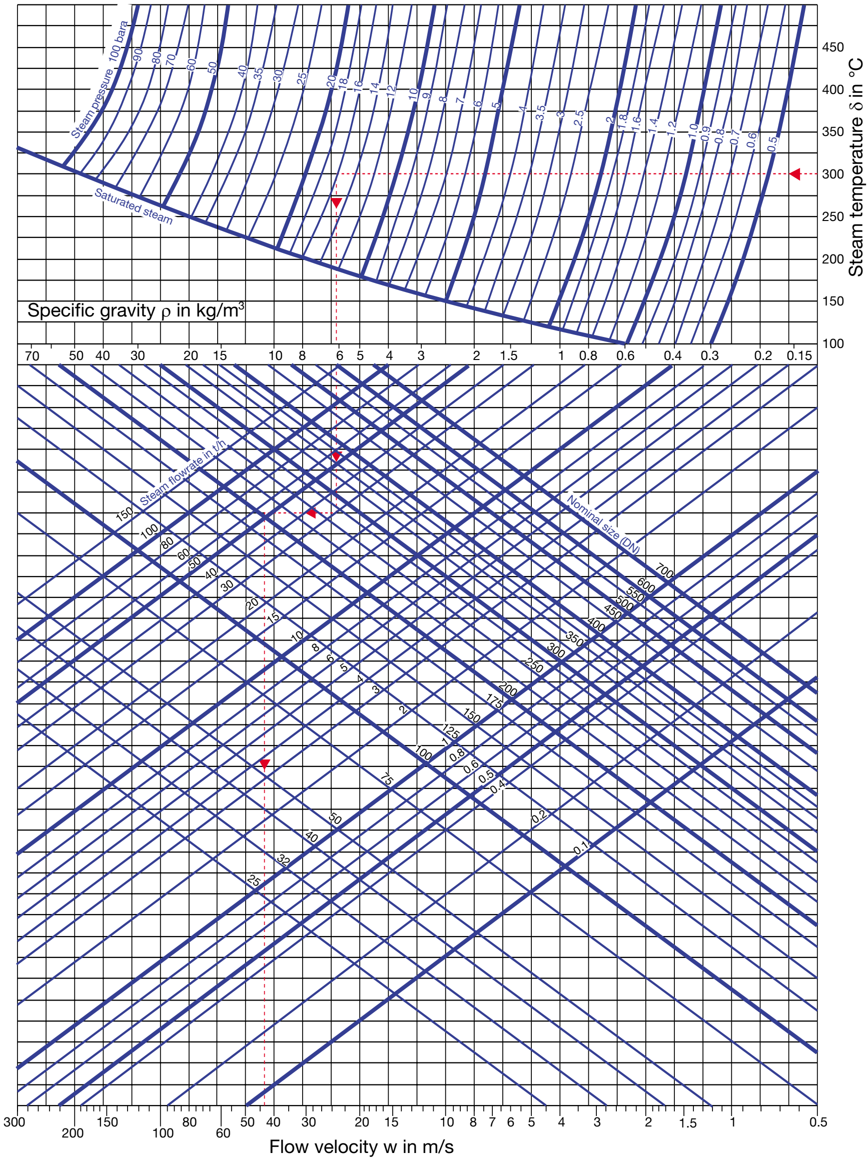


Fig. 82 Flow velocity in steam lines
Example: Steam temperature 300 °C, steam pressure 16 bara, steam flowrate 30 t/h, nominal size (DN) 200.
Result: Flow velocity = 43 m/s.

10.2 Examples

10.2.1 Choosing the pipe size from the amount of flash steam

10.2.1.1 Pressure before flashing (service pressure) 5 bara, pressure at end of condensate line 1.5 bara, condensate temperature approximately at boiling temperature, 151 °C
Condensate flowrate 1200 kg/h
From Fig. 78, Table 1, the diameter coefficient = 14.4.
From Fig. 78, Table 2, the diameter factor for 1200 kg = 3.5.
Therefore
diameter = 14.4 x 3.5 = 50.4 mm
Choose **DN 50 mm**.

10.2.1.2 Same operating data as for 10.2.1.1, but condensate with 20 K undercooling (20 K below t_s).
According to Table 1, the boiling temperature at 5 bar is 151°C, and so
the actual condensate temperature is 151 - 20 = 131 °C,
and the diameter coefficient at 131 °C ≈10.2
(by interpolation of diameter coefficients at 127 °C and 1.5 bar back pressure = 9.2
and at 133 °C at 1.5 bar back pressure = 10.7),
multiplied by the factor 3.5 (from Table 2 for 1200 kg/h)
this yields a diameter of 10.2 x 3.5 = 35.7 mm.
Choose **DN 40 mm**.

10.2.2 Choosing the pipe size from the water flowrate, i.e. if there is no or hardly any flash steam being formed.

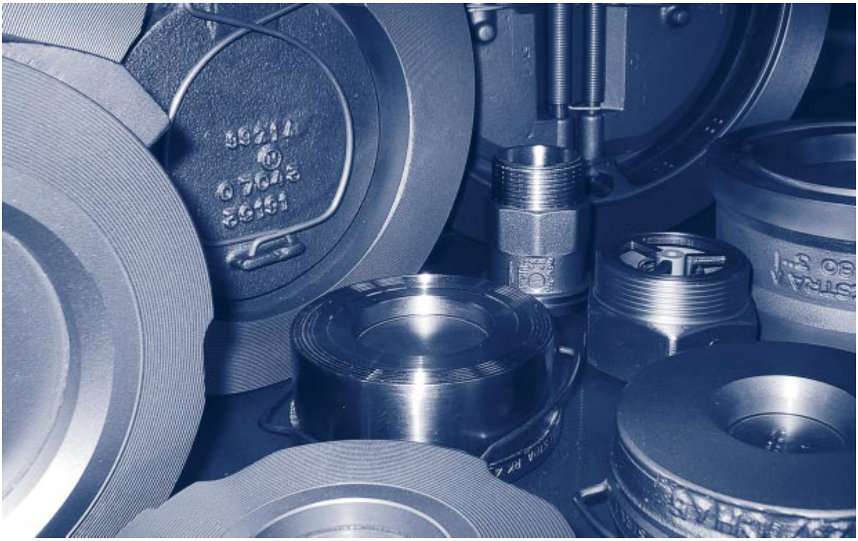
Same operating data as for 10.2.1.1 above, i.e. condensate flowrate 1200 kg/h ≈ 1200 l/h ≈ 1.2 m^3/h, upstream pressure 5 bara, back pressure 1.5 bara,
but condensate with 40 K undercooling (40 K below ts).
According to Fig. 78, Table 1, the boiling temperature at 5 bar is 151 °C; therefore the actual condensate temperature 151 - 40 = 111 °C,
the boiling temperature at 1.5 bar = 111 °C, and hence no flash steam is formed.
Determination of the diameter of condensate line from Fig. 81, based on a flow velocity of 0.5 - 0.6 m/s:
Choose **DN 25 mm**.

Absolute pressure ρ, bara	Temperature t_s, °C	Specific steam volume v'', m³/kg	Steam density ρ'', kg/m³	Enthalpy of water h', kJ/kg	Enthalpy of steam h'', kJ/kg	Heat of evaporation r, kJ/kg
0.10	45.84	14.6757	0.06814	191.83	2584.8	2392.9
0.15	54.00	10.0231	0.09977	225.97	2599.2	2373.2
0.20	60.08	7.6511	0.1302	251.45	2609.9	2358.4
0.25	64.99	6.2035	0.1612	271.99	2618.3	2346.3
0.30	69.12	5.2301	0.1912	289.30	2625.4	2336.1
0.40	75.88	3.9936	0.2504	317.65	2636.9	2319.2
0.50	81.35	3.2404	0.3086	340.56	2646.0	2305.4
0.60	85.95	2.7315	0.3661	359.93	2653.6	2293.6
0.70	89.97	2.3646	0.4229	376.77	2660.1	2283.3
0.80	93.52	2.0868	0.4792	391.72	2665.8	2274.0
0.90	96.72	1.8692	0.5350	405.21	2670.9	2265.6
1.00	99.64	1.6938	0.5904	417.51	2675.4	2257.9
1.50	111.38	1.1590	0.8628	467.13	2693.4	2226.2
2.00	120.23	0.8857	1.129	504.70	2706.3	2201.6
2.50	127.43	0.7184	1.392	535.34	2716.4	2181.0
3.00	133.54	0.6057	1.651	561.43	2724.7	2163.2
3.50	138.87	0.5241	1.908	584.27	2731.6	2147.4
4.00	143.62	0.4623	2.163	604.67	2737.6	2133.0
4.50	147.92	0.4137	2.417	623.16	2742.9	2119.7
5.00	151.84	0.3747	2.669	640.12	2747.5	2107.4
5.50	155.46	0.3367	2.970	655.78	2751.7	2095.9
6.00	158.84	0.3155	3.170	670.42	2755.5	2085.0
7.00	164.96	0.2727	3.667	697.06	2762.0	2064.9
8.00	170.42	0.2403	4.162	720.94	2767.5	2046.5
9.00	175.35	0.2148	4.655	742.64	2772.1	2029.5
10.00	179.88	0.1943	5.147	762.61	2776.2	2013.6
11.00	184.05	0.1774	5.637	781.13	2779.7	1958.5
12.00	187.95	0.1632	6.127	798.43	2782.7	1984.3
13.00	191.60	0.1511	6.617	814.70	2785.4	1970.7
14.00	195.04	0.1407	7.106	830.08	2787.8	1957.7
15.00	198.28	0.1316	7.596	844.67	2789.9	1945.2
16.00	201.36	0.1237	8.085	858.56	2791.7	1933.2
17.00	204.30	0.1166	8.575	871.84	2793.4	1921.5
18.00	207.10	0.1103	9.065	884.58	2794.8	1910.3
19.00	209.78	0.1047	9.555	896.81	2796.1	1899.3
20.00	212.37	0.0995	10,05	908.59	2797.2	1888.6
21.00	214.84	0.0948	10.54	919.96	2798.2	1878.2
22.00	217.24	0.0907	11.03	930.95	2799.1	1868.1
25.00	223.93	0.0799	12.51	961.96	2800.9	1839.0
30.00	233.83	0.0666	15.01	1008.4	2802.3	1793.9
40.00	250.33	0.0498	20.10	1087.4	2800.3	1712.9
50.00	263.91	0.0394	25.36	1154.5	2794.2	1639.7
60.00	275.56	0.0324	30.83	1213.7	2785.0	1571.3
70.00	285.80	0.0274	36.53	1267.4	2773.5	1506.0
80.00	294.98	0.0235	42.51	1317.1	2759.9	1442.8
90.00	303.32	0.0205	48.79	1363.7	2744.6	1380.9
100.00	310.96	0.0180	55.43	1408.0	2727.7	1319.7
120.00	324.63	0.0143	70.01	1491.8	2689.2	1197.4
140.00	336.36	0.0115	86.99	1571.6	2642.4	1070.7
160.00	347.32	0.0093	107.4	1650.5	2584.9	934.3
180.00	356.96	0.0075	133.4	1734.8	2513.9	779.1
200.00	365.70	0.0059	170.2	1826.5	2418.4	591.9
220.00	373.69	0.0037	268.3	2011.1	2195.6	184.5
221.20	374.15	0.0032	315.5	2107.4	2107.4	0

Fig. 83 Steam table
(The detailed steam tables are commercially available.).

FLOWSERVE® GESTRA

GESTRA DISCO® Non-Return Valves



Today GESTRA can look back with pride on hundred years of experience in valve manufacture. The company offers a broad range of DISCO® non-return valves tailored to fulfil the most diverse of applications and customer requirements. All valves are made of diverse materials to meet particular demands, and the individual valve components are optimally coordinated with each other. Through this ideal mixture of different components in the range of standard valves, the best valve can be delivered for almost every application. Here it does not matter whether a thermally critical application must be safeguarded, or whether a non-return valve must be designed for operation in oxygen, for example. It is even possible to manufacture the DISCO® valve, which has proven its worth a million times over, in a special material to answer specific needs.

All GESTRA non-return valves are of the wafertype and have extremely short overall lengths. Thanks to their excellent design and hydrodynamic features, these valves offer clear advantages over conventional types:

- Compact design
- Low weight
- Mounting in any position
- Low installation costs
- Wide choice of materials
- Space-saving stockkeeping
- Safe operation of industrial plants
- Low pressure drop

The name GESTRA is a guarantee of high manufacturing quality for the GESTRA DISCO® non-return valves.

11. Sizing of Steam Lines

When sizing steam lines, care must be taken that the pressure drop between the boiler and steam users is not too high. The pressure drop depends mainly on the flow velocity of the steam.

The following empirical values for the flow velocity have proven to be satisfactory:

Saturated steam lines	20 - 40 m/s
Superheated steam lines	35 - 65 m/s

The lower values should be used for smaller flowrates.

For a given flow velocity, the required pipe diameter can be chosen from the chart in Fig. 82.

The pressure drop can be calculated from the charts in Figs. 79 and 80.

12. Calculation of Condensate Flowrates

12.1 Basic Formulae on the Basis of SI Units [J, W]

12.1.1 If the amount of heat required is known (e.g. specified on the name plate of the heat exchanger), then the condensate flowrate $\dot{M}$ can be calculated from

$$\dot{M} = 1.2 \cdot \frac{kW}{2100} \cdot 3600 \qquad [kg/h]$$

and hence

$$\dot{M} \approx 2.1 \cdot kW \qquad [kg/h]$$

Here kW is the amount of heat required in kJ/s (kilo-Joule per second) and the quotient 2100 is the latent heat of steam kJ/kg for medium pressures; the factor 1.2 is added to compensate for heat losses.

12.1.2 If the amount of heat $\dot{Q}$ required per hour is not known, it can be calculated from the weight $\dot{M}$ of the product to be heated up in one hour, the specific heat

$$c \left[\frac{kJ}{kg\,K}\right]$$

and the difference between the initial temperature t_1 and the final temperature t_2 ($\Delta t = t_2 - t_1$) as follows:

$$\dot{Q} = \dot{M} \cdot \frac{c}{3600} \cdot \Delta t \qquad [kW]$$

Example:
50 kg of water are to be heated from 20 °C to 100 °C in one hour.
The amount of heat required is

$$\left(c_{water} = 4.190 \; \frac{kJ}{kg\,K}\right)$$

$$\dot{Q} = 50 \cdot \frac{4.190}{3600} \cdot (100 - 20) = 4.656 \; [kW]$$

The amount of condensate is then

$$\dot{M} = 2.1 \cdot 4.656 \approx 9.8 \; [kg/h]$$

Now if the 50 kg of hot water are to be vapourized in one hour, the latent heat of approx. 2100 kJ/kg has to be added.

$$\dot{Q} = 50 \cdot 2100 = 105{,}000 \text{ kJ/h} = \frac{105{,}000}{3600} = 29.167 \quad [\text{kW}]$$

The total amount of heat required, and consequently the total amount of condensate formed, can be calculated as follows:
$\dot{M} \approx 2.1\ (4.656 + 29.167) \approx 71.0$ kg/h
It must be noted that each product has its own specific heat.

Specific heat c	$\frac{kJ}{kg\ K}$
Water	4.190
Milk	3.936
Mash	3.894
Jam	1.256
Wax	2.931
Iron	0.502
Fats	0.670
Rubber	1.424
Saline solution, saturated	3.266
Sulphur	0.754
Alcohol	2.428
Air	1.005
Machine oil	1.675
Benzine	2.093

Further properties of substances can be found in the applicable specialist literature.

12.1.3 If the size of the heating surface and the temperature rise (difference between initial and final temperature) of the product are known, the condensate flowrate $\dot{M}$ can be calculated with sufficient accuracy as follows:

$$\dot{M} = \frac{F \cdot k \cdot \left(t_D - \frac{t_1 + t_2}{2}\right)}{r} \cdot \frac{3600}{1000}$$

Where

$\dot{M}$ = amount of condensate in kg/h
F = heating surface in m^2

k = coefficient of overall heat transfer in $\left[\frac{W}{m^2\,K}\right]$

t_D = temperature of steam
t_1 = initial temperature of product
t_2 = final temperature of product (quite often, it is sufficient if the average temperature is known, e.g. room temperature)
r = latent heat in kJ/kg (as an approximation for medium pressures, 2100 can be assumed)

A few empirical values for the coefficient of overall heat transfer k are given below.
The lower values apply to unfavourable operating conditions (such as low flow velocity, viscous product, contaminated and oxidized heating surfaces), whereas the higher values apply to very favourable conditions (e.g. high flow velocity, highly fluid product, and clean heating surfaces).

	$\left[\frac{W}{m^2\,K}\right]$
Insulated steam line	0.6 – 2.4
Non-insulated steam line	8 – 12
Heating unit with natural circulation	5 – 12
Heating unit with forced circulation	12 – 46
Jacketed boiling pan with agitator	460 – 1500
As above, with boiling liquid	700 – 1750
Boiling pan with agitator and heating coil	700 – 2450
As above, with boiling liquid	1200 – 3500
Tubular heat exchanger	300 – 1200
Evaporator	580 – 1750
As above, with forced circulation	900 – 3000

12.2 Sizing of Steam Traps

(See also Sections 3.1 and 3.2)

The formulae given in the Section 12.1 above make it possible to calculate the average amount of condensate formed during entire heating process. However, these formulae show clearly that, other conditions being equal, the amount of condensate increases with the difference between the steam temperature and the temperature of the product. This means that the condensate flowrate is largest when the product is at its lowest temperature, i. e. at start-up.

A further point is the fact that the pressure drop in the steam line and the heating surface is highest when the steam consumption is largest. This means that the service pressure and consequently the differential pressure (difference between inlet and outlet pressure), which determines the capacity of the trap, are lowest at start-up.

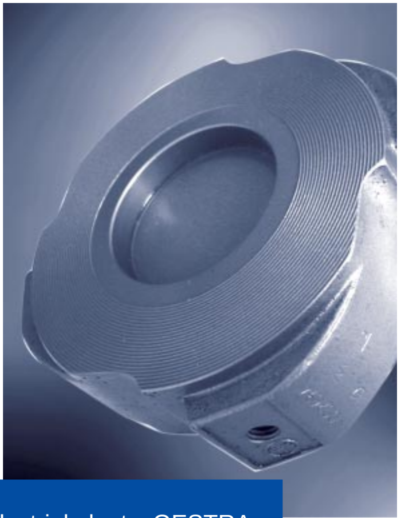
Extreme conditions are, for example, encountered in the case of steam line drainage. If saturated steam is used, the quantity of condensate formed at start-up may be twenty times that formed in continuous operation. If superheated steam is used, there is practically no condensate formed during continuous operation.

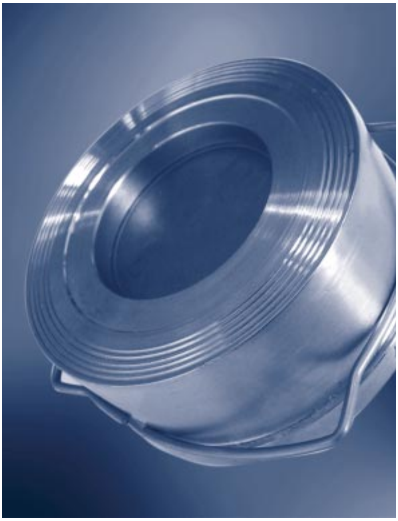
Very high flow and pressure fluctuations also occur in controlled plants and in many boiling processes.

If only the mean steam consumption (condensate flowrate) is known, a safety factor has to be added for float traps. Their maximum capacity at medium pressures (at a condensate temperature of $\leq$ 100 °C) can be assumed to be 1.4 times that of the hot-water capacity indicated in the capacity chart.

The maximum capacity of thermostatic traps (cold-water capacity) on the other hand is several times their hot-water capacity, and is given in the capacity charts.

GESTRA DISCO® Non-Return Valves RK





For industrial plants, GESTRA offers a broad spectrum of non-return valves which are designed for diverse pressure ratings and media.

For pressures from PN 6 to PN 40, the RK 86/86A can be used, for example – and for the pressure range PN 10–40 the RK 16C of Hastelloy. The RK 49 valve covers the pressure rating up to PN 160.

Depending on the medium flowing through the piping of your installation, a valve is then selected from the most suitable material. For neutral liquids or gases, valve ranges are available in the materials brass, bronze, steel and chromium steel. In the case of corrosive vapours and gases, acids and alkalis, the versions of austenitic steel and Hastelloy are used. For special requirements, e.g. in the foodstuff industry, at low temperatures or for applications with drinking water, valve ranges of cast bronze, austenitic steel and Hastelloy C are available.

Special features:

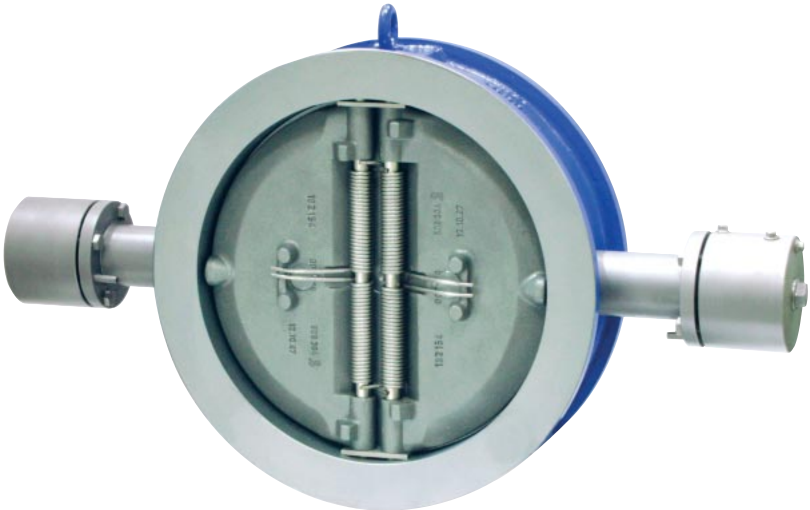
- ✎Springs for low opening pressures
- ✎Springs for reduced closing times
- ✎Springs for applications at high temperatures
- ✎Soft seats
- ✎Antistatic connection
- ✎Pickled, free of oil and grease
- ✎Special connections

Page

13. Pressure and Temperature Control

FLOWSERVE® GESTRA

GESTRA DISCOCHECK® Dual-Plate Check Valves BB



The answer in tight spots

Valves with adjustable dampers from DN 200 (8")

In complex pipeline systems, major flow decelerations may be caused when pumps are switched off or as a result of failures, leading to water-hammer and possibly disastrous consequences for the plant. Our engineers will be happy to assist you with the correct design of the dual-plate check valves for your installation.

13. Pressure and Temperature Control

13.1 Pressure-Reducing Valves

The boiler pressure is often higher than the pressure required for the heating process. In such cases, it is generally more economical to reduce the steam pressure in a pressure-reducing valve. The purchase price for low-pressure heat exchangers is lower, the amount of latent heat that can be utilized is higher, and the amount of flash steam is lower.

13.1.1 In most cases, the control accuracy of a proportional controller, as shown below, is sufficient. It is a balanced single-seat valve operating without auxiliary energy. The reduced pressure acts via the water-seal pot and the pilot line onto the lower side of the diaphragm.
The force of the spring acts in the opposite direction. It is adjusted with the handwheel and determines the reduced pressure.

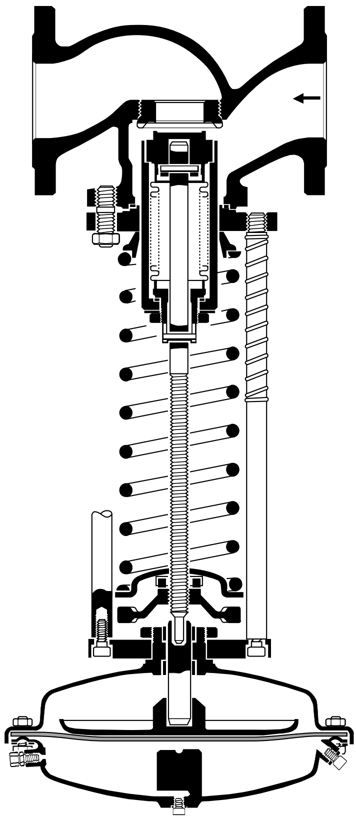


Fig. 84 GESTRA pressure-reducing valve

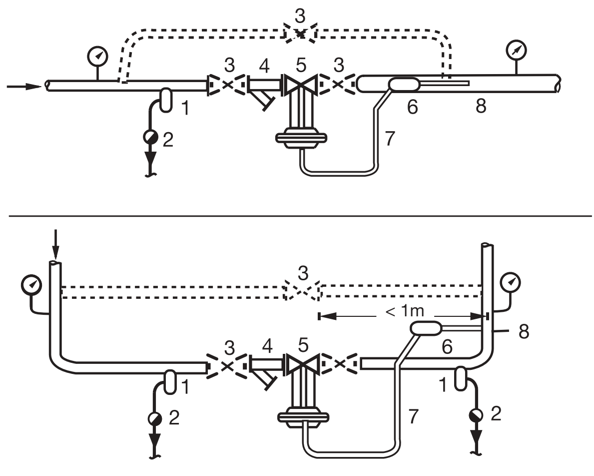
13.1.2 Correct installation is important to obtain good control of the reduced pressure (Fig. 85).

Pressure-reducing valves operate for most of time in the throttled position. Even small dirt particles may therefore lead to trouble. Every pressure-reducing valve should therefore be protected by a strainer. Water particles entrained in the steam passing through the strongly throttled valve at high velocity will, through cavitation and erosion, cause wear and eventual destruction of the valve and seat.

Also, when the plant is shut down, the remaining steam condenses in the pipeline. The condensate collects at the lowest point upstream of the pressure-reducing valve. At start-up, the steam flows across the cold condensate.

Waterhammer may result, and the resulting shock may lead to premature failure of the regulating membranes and the pressure-balance bellows. For these reasons, the steam line upstream of each pressure-reducing valve should be drained. If the line downstream of the reducing valve rises, a second drain point should be provided downstream.

Drainage immediately upstream of the valve can be omitted if it is installed in a vertical line with upward flow.

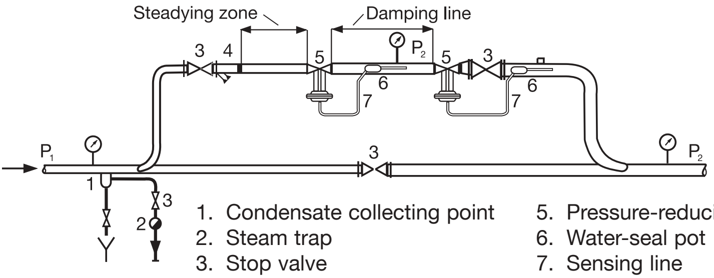


1. Condensate collecting point
2. Steam trap
3. Stop valve
4. Strainer
5. Pressure-reducing valve
6. Water-seal pot
7. Sensing line
8. Sensing point

Fig. 85 Examples for installation of steam pressure-reducing valves

Examples for the correct installation of pressure-reducing valves are given in Fig. 85, whereby for the valve according to Fig. 84 it is recommended that the sensing point is approximately 1 m downstream of the valve to allow the flow to stabilize.

13.1.3 If a relatively high pressure must be reduced to a very low pressure, it is possible that the reducing capability of one valve is no longer sufficient. It is then necessary to install two pressure-reducing valves in series (see Fig. 86). If the pressure drop is relatively high ($P_2 < P_1/2$), it is recommended that a valve with a perforated plug be used, operated by an electrical or pneumatic actuator. If this is not possible, two pressure-reducing valves can be connected in series (see Fig. 86). The steadying zone upstream of the first pressure-reducing valve should be designed with a length of 8 x DN. The damping line should have a length of 5 m.

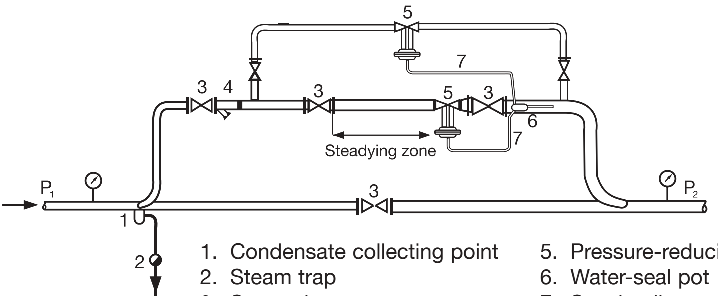


1. Condensate collecting point
2. Steam trap
3. Stop valve
4. Strainer
5. Pressure-reducing valve
6. Water-seal pot
7. Sensing line

Fig. 86 Series-connected pressure regulator for the stepped reduction of high steam pressures

The most favourable reduction relationship is obtained for the two valves when the second is dimensioned to be two nominal sizes larger.
The same applies for the downstream pipeline.

13.1.4 If the steam pressure fluctuates greatly between the minimum and maximum values and if the pressure is to be regulated precisely even for minimum demand, two valves of differing size must be connected in parallel (Fig. 87)



1. Condensate collecting point
2. Steam trap
3. Stop valve
4. Strainer
5. Pressure-reducing valve
6. Water-seal pot
7. Sensing line

Fig. 87 Parallel-connected pressure regulators for strongly fluctuating steam consumption

The larger valve must be adjusted so that it closes at a slightly higher reduced-pressure than the smaller one. This ensures that both pressure regulators are open at full load. At low load, the reduced pressure increases a little, so that the larger valve closes and the smaller one alone performs the task of pressure regulation.

13.2 Temperature Control at the Heat Exchangers

13.2.1 Temperature control is mainly applied to the steam side. A common temperature controller from the GESTRA product range that functions without auxiliary power is shown in Fig. 88. Here a thermostat measuring the temperature of the product transfers its pulses to a positioning cylinder that controls the throttling valve, which is closed when the desired temperature is attained.
For the steam trapping, it must be considered that, due to the opening and throttling of the controller, the steam pressure in the heat exchanger fluctuates constantly within a wide range (see also Section 4.7).

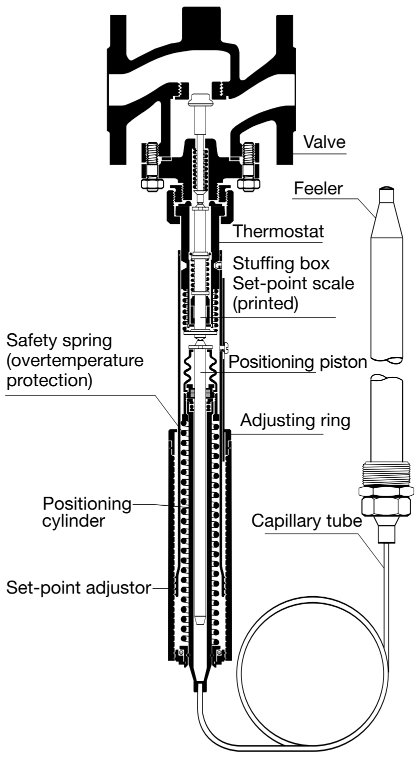
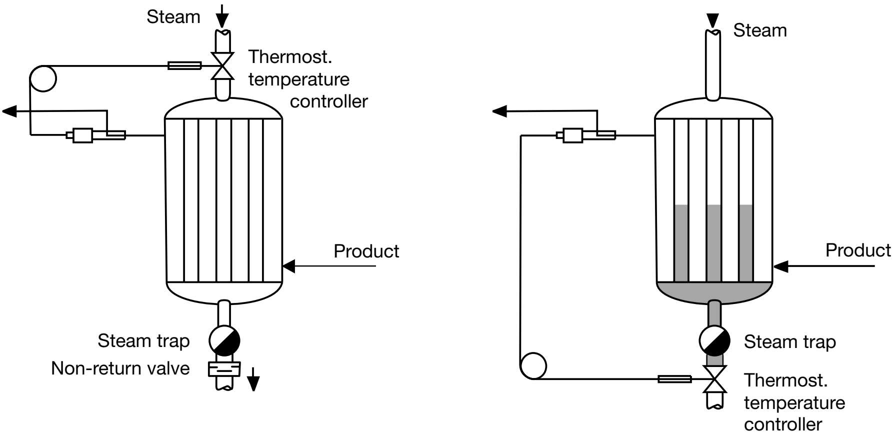


Fig. 88 Self-acting temperature controller. Thermostat with rod feeler and two-way closing valve (single-seated valve, closes with increasing temperature).

13.2.2 Control on the condensate side (see Section 4.8.3 and Fig. 38) offers the advantage that a constant pressure is maintained in the heat exchanger. At the same time, it is possible to utilize the sensible heat of the condensate. However, in comparison to control on the steam side, a noticeably more sluggish operation (overshooting) must be taken into account. Furthermore, heating surfaces that are unaffected by waterhammer (e.g. vertical preheaters) must be provided.
For control on the condensate side, the valve shown in Fig. 88 can also be used, with the valve arranged on the condensate side. A steam trap must be fitted between the heat exchanger and the valve. This is required to prevent the loss of live steam when the valve is fully open (e.g. on start-up of the plant).

Control on the steam side | **Control on the condensate side**



Depending on the load, the pressure in the heating space will vary.
No banking-up of condensate.

Constant pressure in the heating space. Varying amounts of condensate accumulation, depending on load.

Fig. 89 Control of heat exchangers

GESTRA DISCO® Non-Return Valves RK 86 and 86A

Our experience gives you the quality, our visions give you the innovative energy. On this foundation, GESTRA has developed a non-return valve for industrial applications that combines many requirements in a single valve – and therefore not only fulfils but also far surpasses your wishes and expectations.

Patented centering

The new centering mechanism of the RK 86/86A (patents pending) functions directly through the body itself. It has four integrated guide ribs arranged so that, independently of the flange standard, the valve disc of the RK 86/86A always lies against two of the guide ribs. The non-return valves of other manufacturers are fitted with only three guide ribs at best, which means that the valve disc, depending on installation, usually only has contact with one of them.

All international standards

Whether for DIN, ASME or BS flange, this new DISCO non-return valve is prepared for all international standards.

FLOWSERVE® GESTRA

The Power of Quality

GESTRA's extensive customer adaptation and uncompromising quality standards guarantee outstanding product reliability coupled with economic efficiency and increased plant safety

No early wear on hinge pins or springs
Dual-plate check valves BB feature two hinge pins and four closing springs for lower opening pressures.

Seat not subject to wear or damage
During the opening process the hinge side of the plates opens first, thereby eliminating wear of the seating surfaces (soft or metal-to-metal seat) and extending the service life of the dual-plate check valves BB.

A positive safeguard against waterhammer
Dual-plate check valves BB are available with patented adjustable dampers to protect the installation against damage caused by waterhammer.

Leakproof body
The body of the dual-plate check valve has no external through-hole, hence no need for unnecessary plate replacements due to a leaky valve body.

Suitable for use in aggressive fluids
The dual-plate check valves BB are available with Levasint® or hard-rubber lining for application in seawater and corrosive fluids.

14. The Use of GESTRA DISCO Non-Return Valves

Non-return valves are important in steam and condensate systems. They contribute to the automation of the process, increase safety and may even replace an expensive valve.
The space-saving GESTRA DISCO design simplifies the installation of the non-return valves. With their extremely short face-to-face dimensions, valves of the type RK are simply sandwiched between two flanges. Figs. 90a and 90b below illustrate their operation and installation.

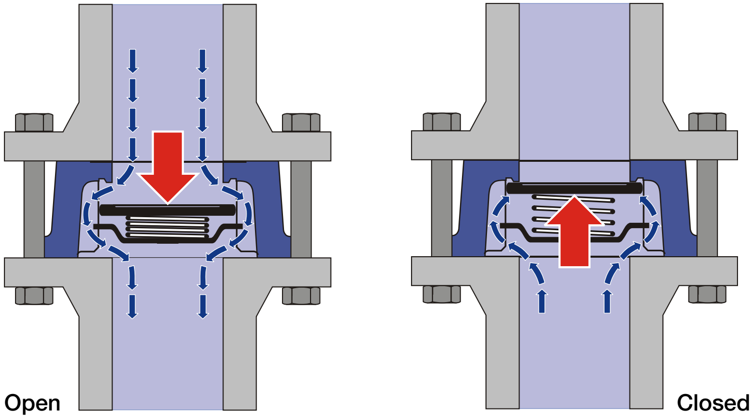


Fig. 90a The valves are opened by the pressure of the fluid and closed by the integral spring as soon as the flow stops - before any back flow occurs. The valve spring can also prevent gravity circulation, if required.

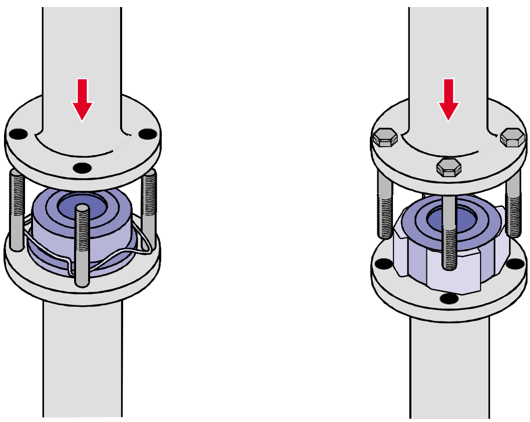


Fig. 90b DISCO-RK, PN 6 – 40, DN 15 – 100 with spiral centering ring or body centering cams for sandwiching between pipe flanges to DIN, BS or ASME 150/300 RF.

14.1 If heat exchangers are installed in parallel, non-return valves prevent the return of condensate when the heat exchanger is shut down (prevention of waterhammer at the next start-up) (Fig. 91).

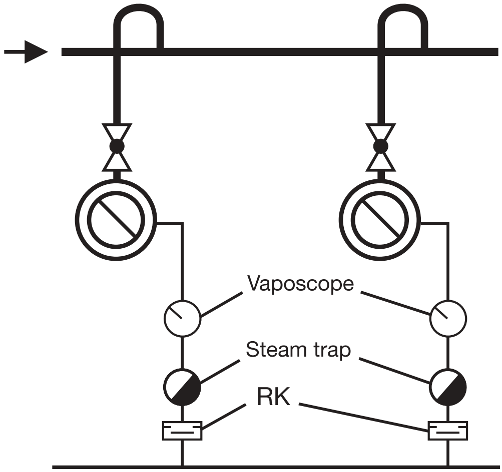


Fig. 91

14.2 Preventing the formation of vacuum in the steam space:

a) By fitting an RK in parallel with the steam trap. The RK will open as soon as the pressure in the heat exchanger drops below that in the condensate line (see Fig. 92). Note: Only meaningful for vertical heat exchangers.

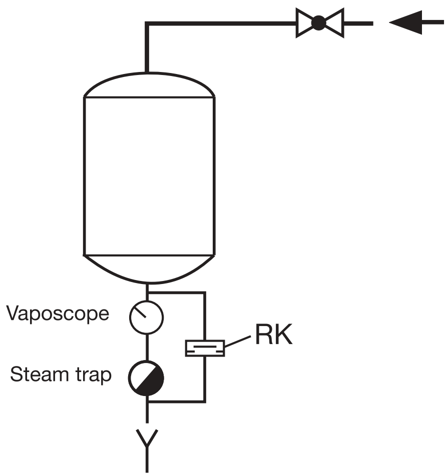


Fig. 92

b) By fitting an RK in parallel with a thermostatic air vent or by itself, as shown in Fig. 93. The RK will open as soon as the pressure in the heat exchanger drops below atmospheric pressure.

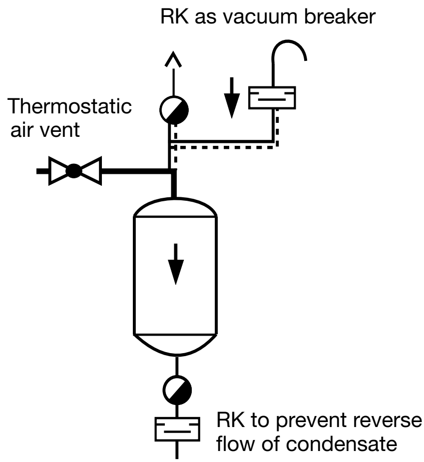


Fig. 93

c) By fitting an RK at a flash vessel (see Fig. 94).

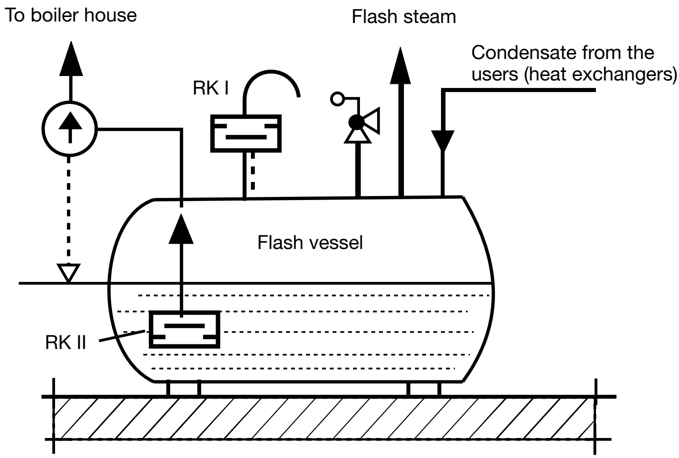


Fig. 94 RKI: Vacuum breaker
RK II: Pump foot valve

14.3 If one coil is used for both heating and cooling, the installation of RKs protects the plant against damage caused by operating errors (see Fig. 95). Here steam cannot enter the cooling water line nor cooling water the steam line.

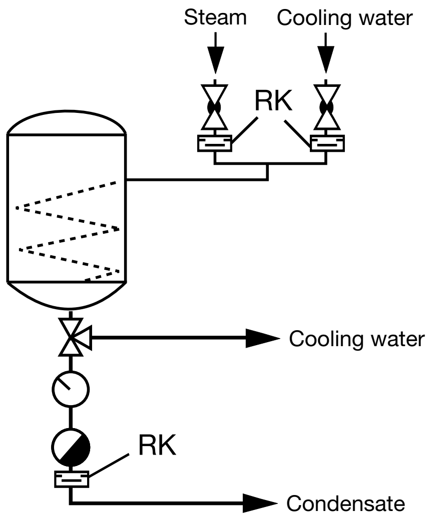


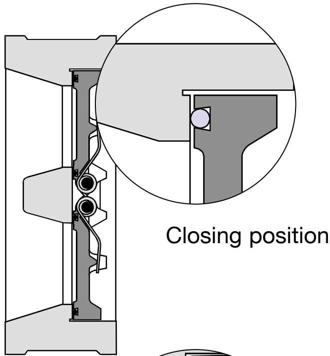
Fig. 95

15. GESTRA DISCOCHECK® Dual-Plate Check Valves BB

These GESTRA valves are a logical extension of the GESTRA DISCO non-return valves, e.g. in the range of larger sizes.
Their special advantages include extremely low flow resistances, short overall lengths, e.g. to DIN API, ISO and EN up to “extremely short versions”, and a wide range of materials for practically all media. The GESTRA DISCOCHECK dual-plate check valves of the type BB are designed for an especially long service life and extremely low pressure drops.

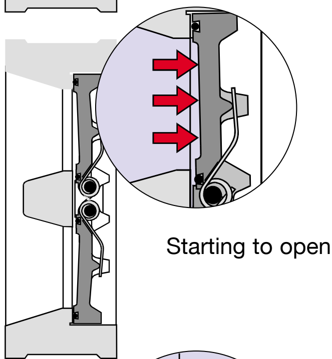
Closing position

The valve plates – with metal-to-metal or O-ring sealing – make even contact with the seat.



Starting to open

The opening process begins with the hinge sides of the plates first lifting off the centre pin, thereby reducing wear of the seating surfaces by the kinematic effect.



Valve fully open

The rotary movement of the plates is limited by stop lugs to 80°. Additional hinge stop lugs ensure a stable position of the plates when fully open.

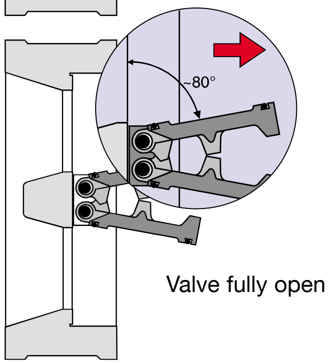


Fig. 96 Functional principle of the GESTRA DISCOCHECK dual-plate check valves BB

Tailored to Your Needs

GESTRA – always one step ahead.

Measuring up to market needs has been the GESTRA philosophy for decades. Backed by many years' experience in the design and manufacture of non-return (check) valves, we offer our customers superior solutions for their specific requirements.
Whether your are looking for economical non-return valves for hvac services, special non-return valves for chemical applications or dual-plate check valves with (adjustable) dampers – we guarantee performance without compromise.

These are just some examples of customer requirements which are met by our new DISCO non-return valve RK 86.

"We need non-return valves that conform to as many international standards for end connections as possible."

"The flange design should prevent squashing of the gasket during installation and guarantee leakproof sealing."

"Non-return valves should feature dependable bonding connections."

16. Capacity Charts for GESTRA Steam Traps

FLOWSERVE® GESTRA

GESTRA DISCOCHECK®
Dual-Plate Check Valves BB

The answer in tight spots

These GESTRA check valves are of the wafer type with short overall lengths. The reduced weight offers significant advantages for transport, stockkeeping and installation. All three basic types BB, CB and WB are characterized by excellent hydrodynamic properties.

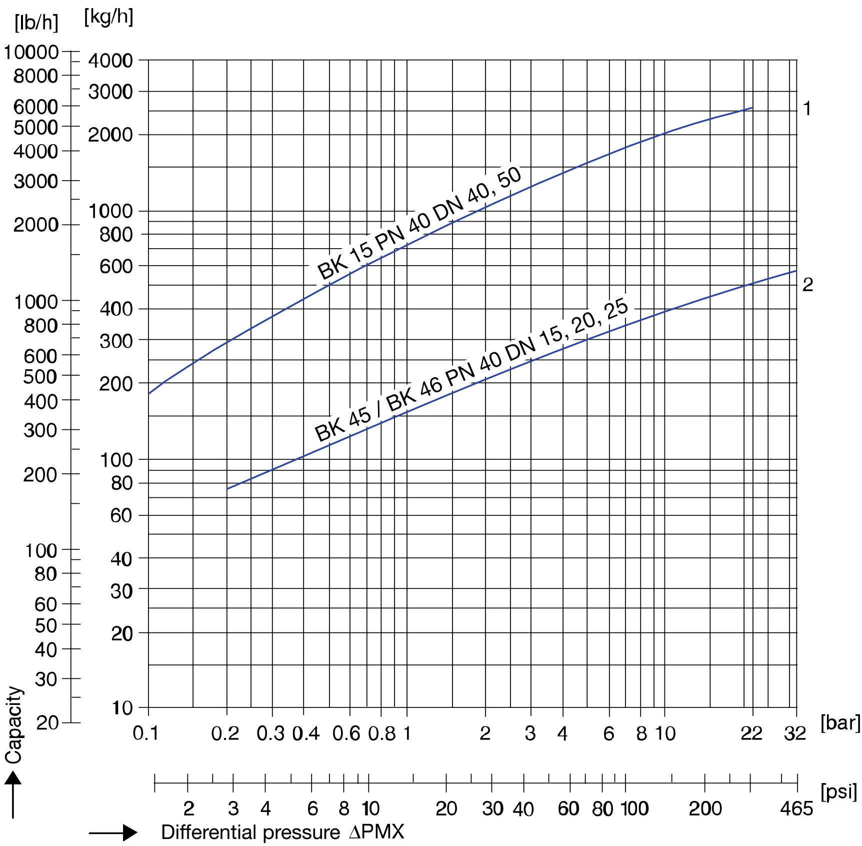
These high-quality dual-plate check valves keep your running costs very low – by cutting the costs for pumping power and maintenance, and providing safe, low-wear operation with a long service life.

The low zeta value means that the required pump output is reduced, so that you save energy and can use a pump with lower power consumption. Stress and wear are reduced because the plate halves lift off from the centre pin before the main opening action, the plates are separately suspended (two pivots), and two springs are provided per plate half. Stop lugs at the plate halves, with additional lugs on the body, limit the opening angle to 80° and ensure a stable open position. As a result, a long and maintenance-free product lifetime is achieved.

16. Capacity Charts for GESTRA Steam Traps

16.1 Thermostatic/Thermodynamic Steam Traps, up to PN 40, BK Range

The capacities given in the chart are those obtained with approximately 10 K undercooling below saturation temperature.
Traps with larger capacities have more undercooling. The capacities of cold condensate (during start-up of the plant) are several times the capacities indicated in the chart. See the individual data sheets.
BK45 PN 40 DN 15, 20, 25 up to 22 bar of differential pressure
BK15 PN 40 DN 40, 50
BK46 PN 40 DN 15, 20, 25 up to 32 bar of differential pressure

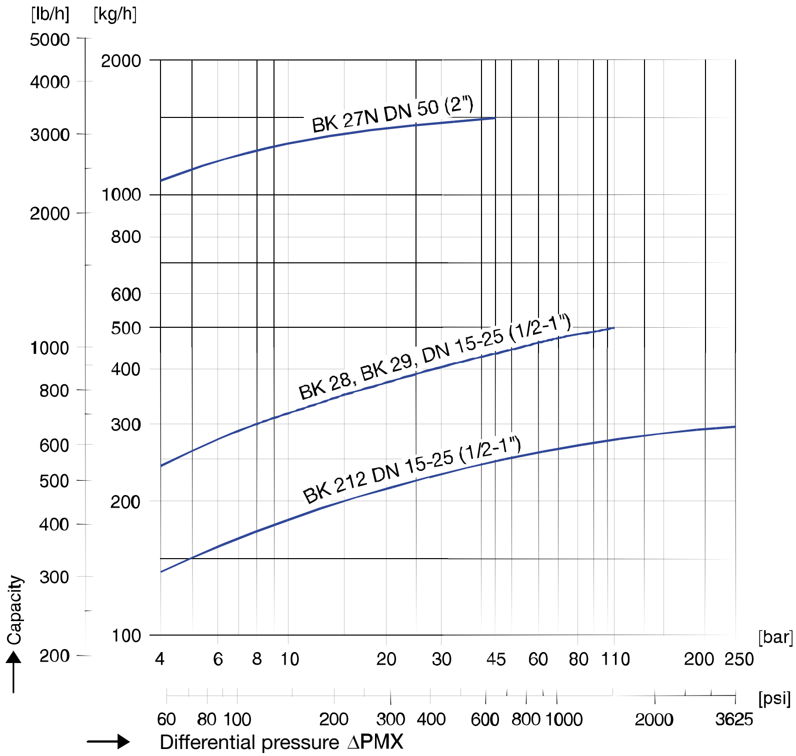


16.2 Thermostatic/Thermodynamic Steam Traps, PN 63-630, BK Range

The capacities given in the chart are those obtained with approximately 10 K undercooling below saturation temperature.

Traps with larger capacities have more undercooling. The capacities of cold condensate (during start-up of the plant) are several times the capacities indicated in the chart. See the individual data sheets.

BK 27N PN 63 DN 50
BK 28 PN 100 DN 15, 20, 25
BK 29 PN 160 DN 15, 20, 25
BK 212 PN 630 DN 15, 20, 25



16.3 Thermostatic Traps with Pilot Control by Membrane Regulators, up to PN 40, MK Range

The capacities given in the chart are those obtained with approximately 10 K under-cooling below saturation temperature. The capacities of cold condensate (during start-up) are several times the capacities indicated in the chart.

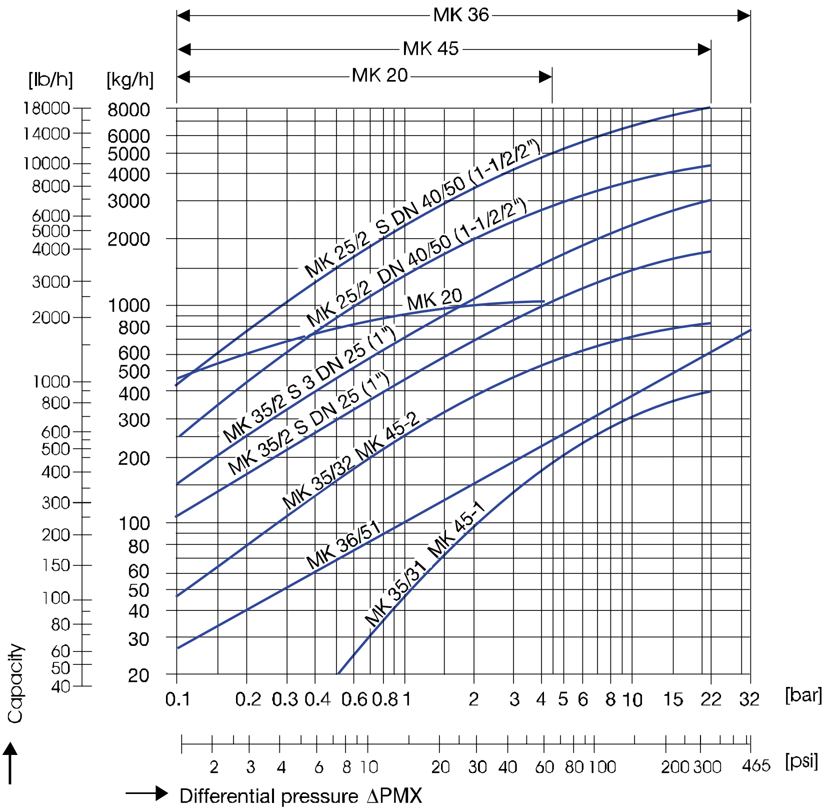
See the individual data sheets, especially for application of the U capsule ("under-cooling" capsule).

MK 45-1, MK 45-2, MK 35/2S, MK 35/2S3, PN 40 DN 15, 20, 25

MK 35/31; MK35/32 PN 25 DN 3/8", 1/2"; MK 36/51; PN 40 DN 1/4", 3/8", 1/2", 3/4";

MK 25/2; PN 40 DN 40, 50

MK 25/2S; PN 40 DN 40, 50

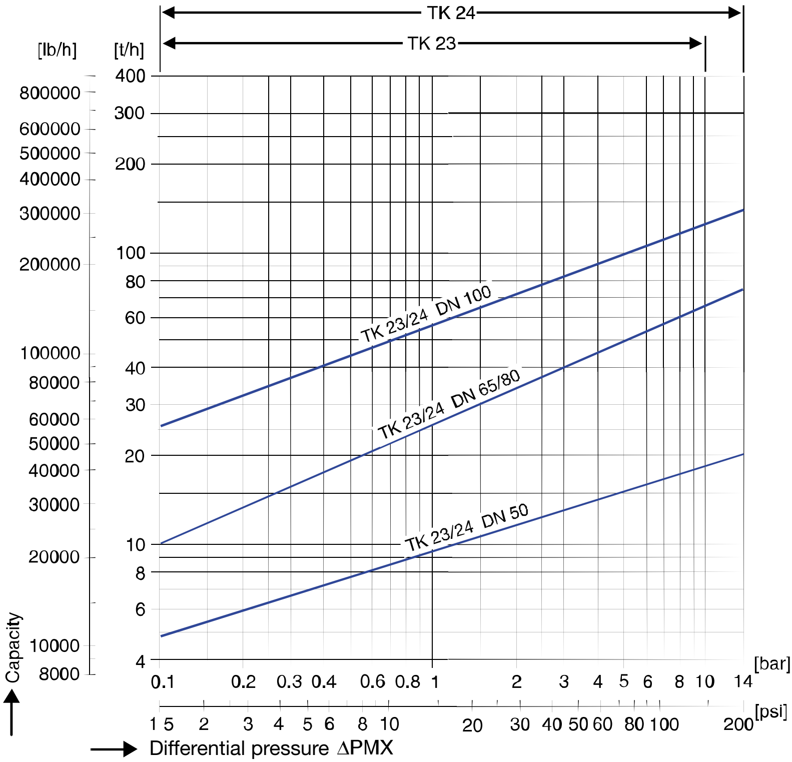


16.4 Thermostatic Traps with Pilot Control by Membrane Regulators, up to PN 25, TK Range

The capacities given in the chart are those obtained with approximately 5 K undercooling below saturation temperature. The capacities of cold condensate (during start-up of the plant) are several times the capacities indicated in the chart (see the corresponding data sheet).

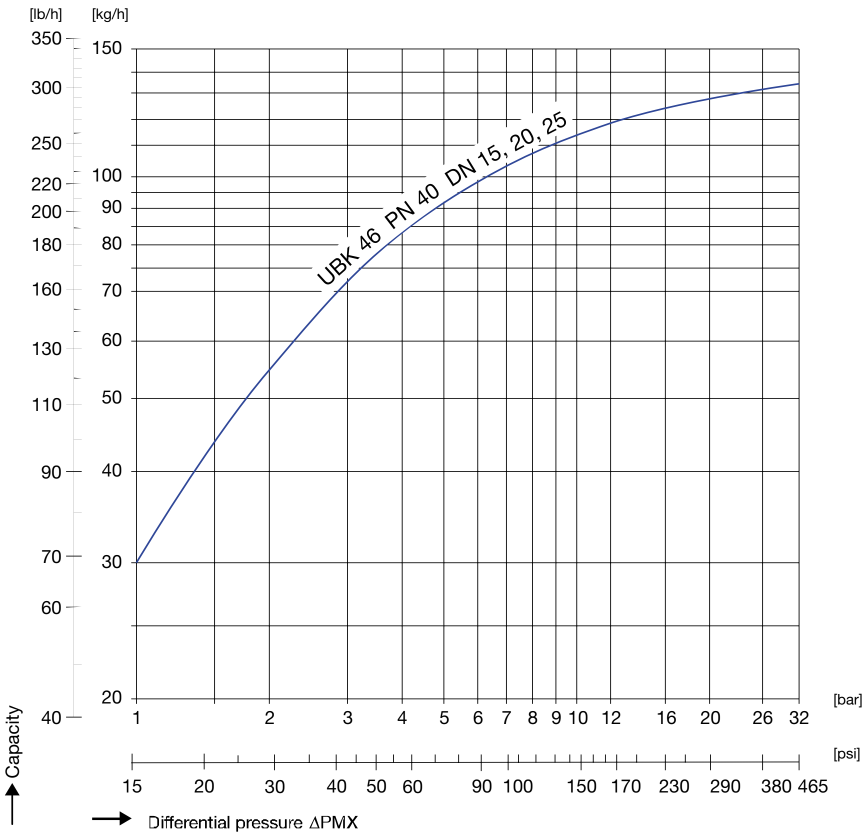
TK 23 PN16 DN 50, 65, 80, 100

TK 24 PN25 DN 50, 65, 80, 100



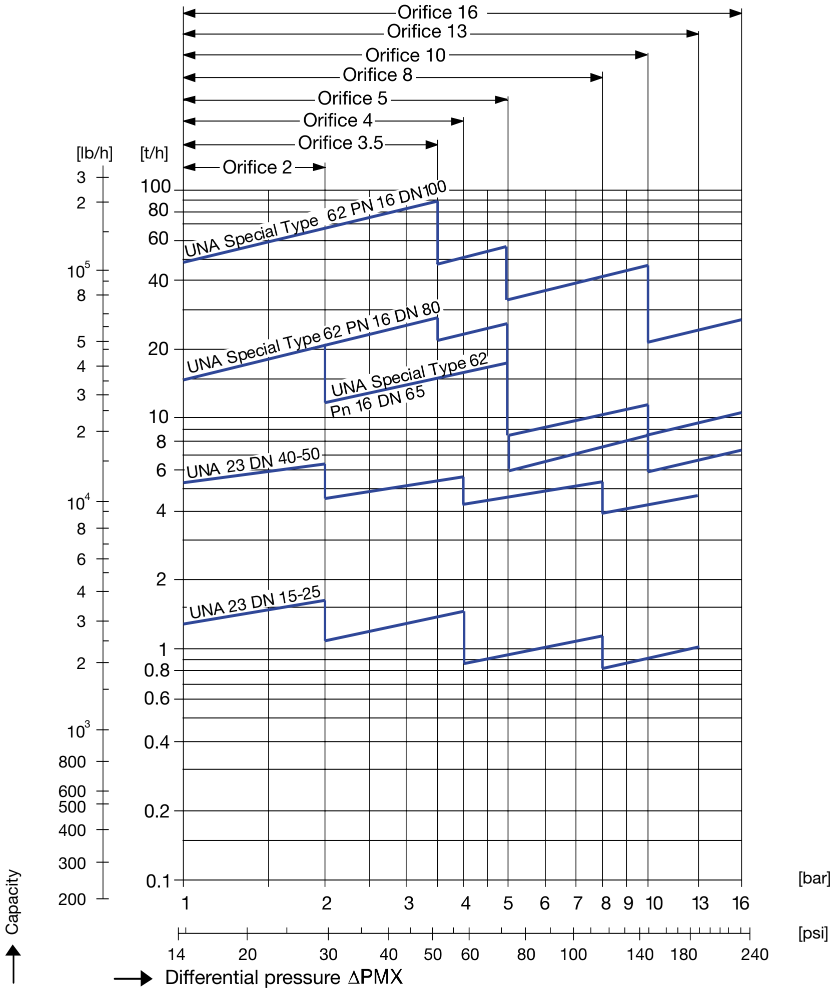
16.5 Thermostatic Traps for Constant Discharge Temperatures, up to PN 40, Type UBK 46

With the factory setting, this trap opens at condensate temperatures <100 °C for pressures up to 19 barg (e.g. 80 °C at 4 barg, 85 °C at 8 barg), and at condensate temperatures ≥ 100 °C for pressures > 20 barg (e.g. 116 °C at 32 barg).
The capacity given in the chart is obtained at a condensate temperature that is slightly below the corresponding opening temperature.
The capacities of cold condensate (during start-up of the plant) are several times the capacities indicated in the chart (see individual data sheets).
UBK 46 PN 40 DN 15, 20, 25



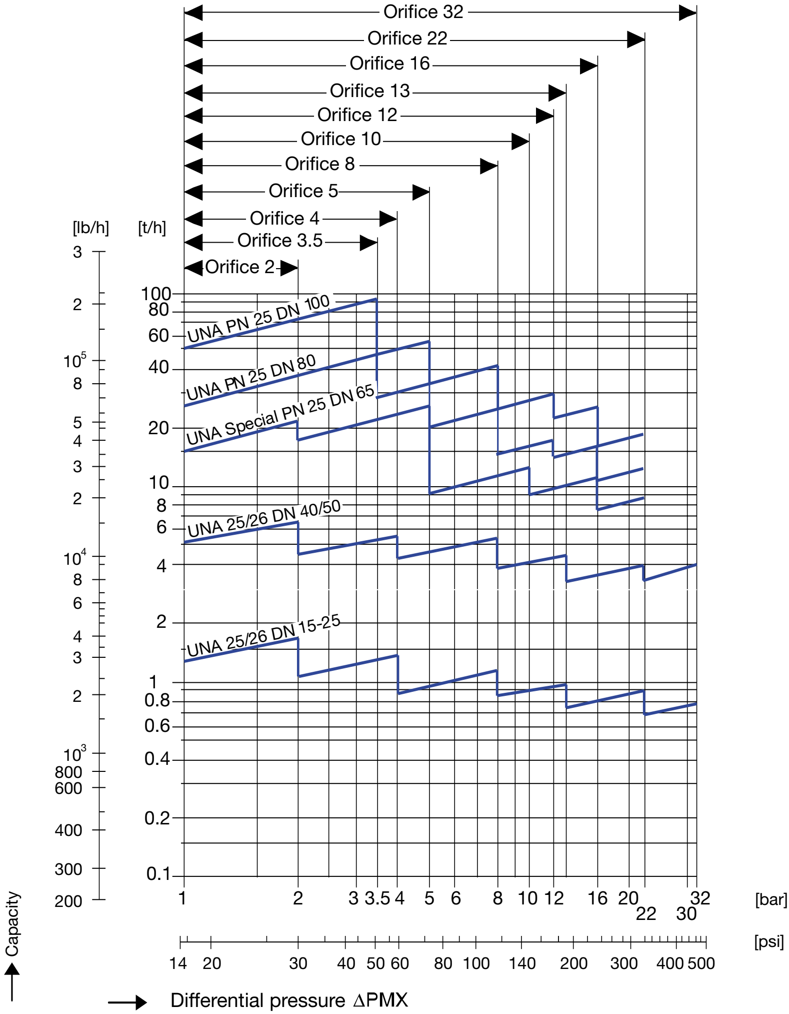
16.6 Float Traps up to PN 16, UNA 23 DN 15–50; UNA Special Type 62 DN 65–100

Maximum capacity of boiling hot condensate for the different sizes and orifices that are available. The maximum allowable differential pressure (working pressure) depends on the cross-sectional areas of the orifice.



16.7 Float Traps, PN 25 and PN 40, UNA 25/26 DN 15–50; UNA Special DN 65–100

Maximum capacity of boiling hot condensate for the different sizes and orifices that are available. The maximum allowable differential pressure (working pressure) depends on the cross-sectional areas of the orifice.

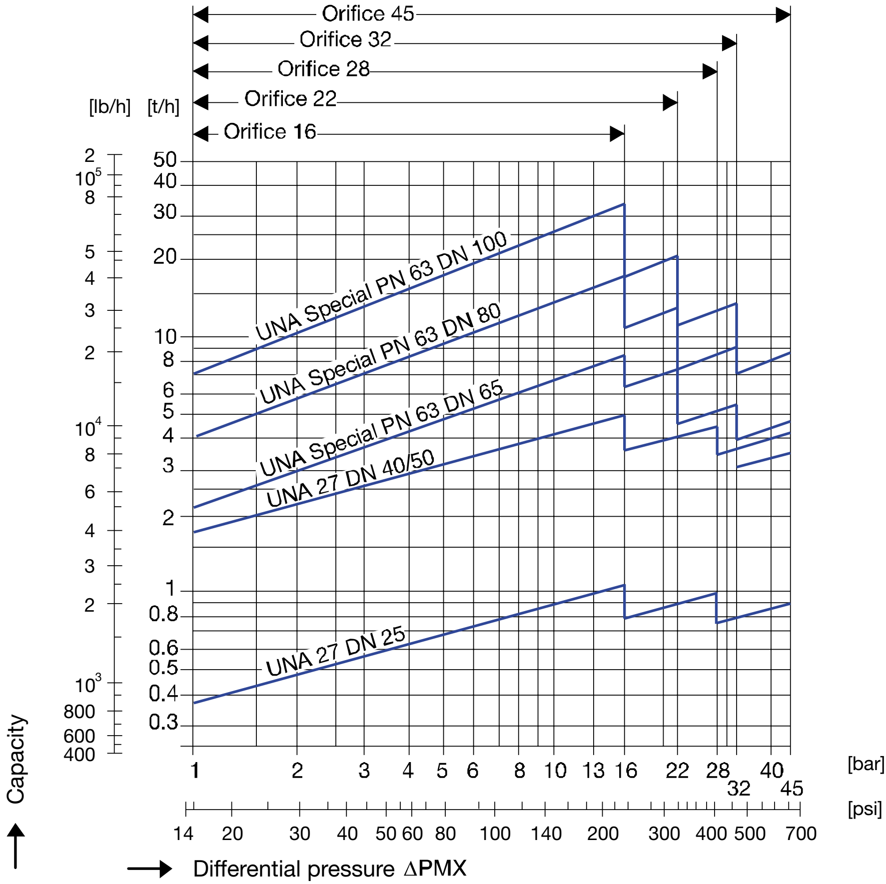


16.8 Float Traps, PN 63

Maximum capacity of boiling hot condensate for the different sizes and orifices that are available. The maximum allowable differential pressure (working pressure) depends on the cross-sectional areas of the orifice.

UNA 27 DN 25, 40, 50

UNA Special DN 65, 80, 100

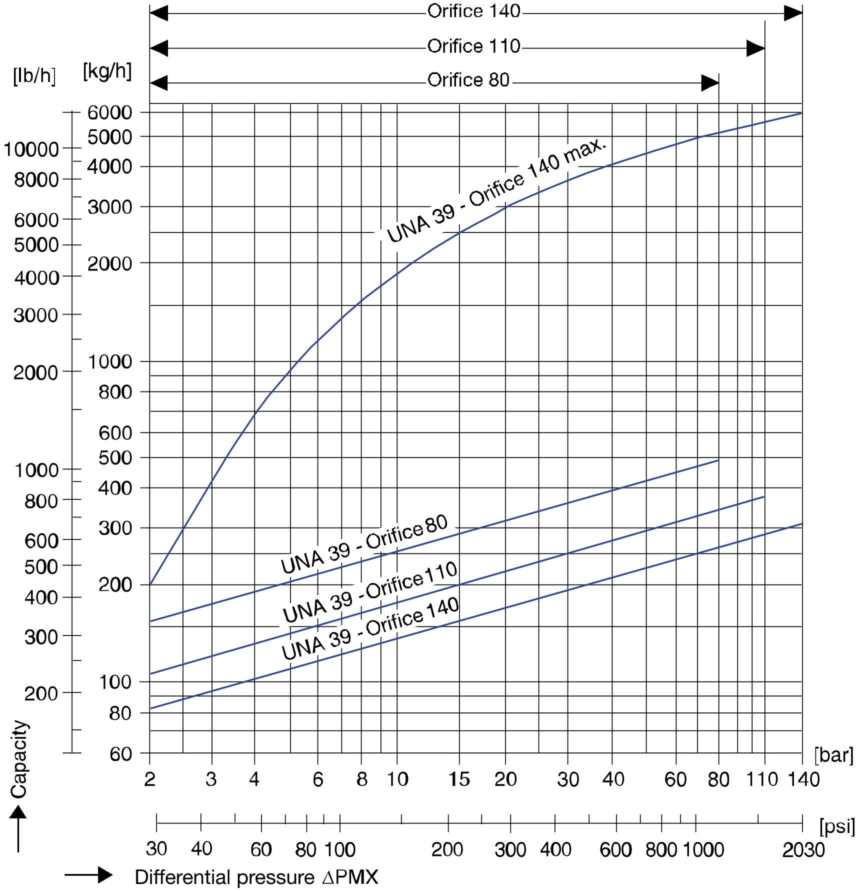


16.9 Float Traps, PN 160, UNA 39

Maximum capacity of boiling hot condensate.

The maximum allowable differential pressure (working pressure) depends on the cross-sectional areas of the orifice.

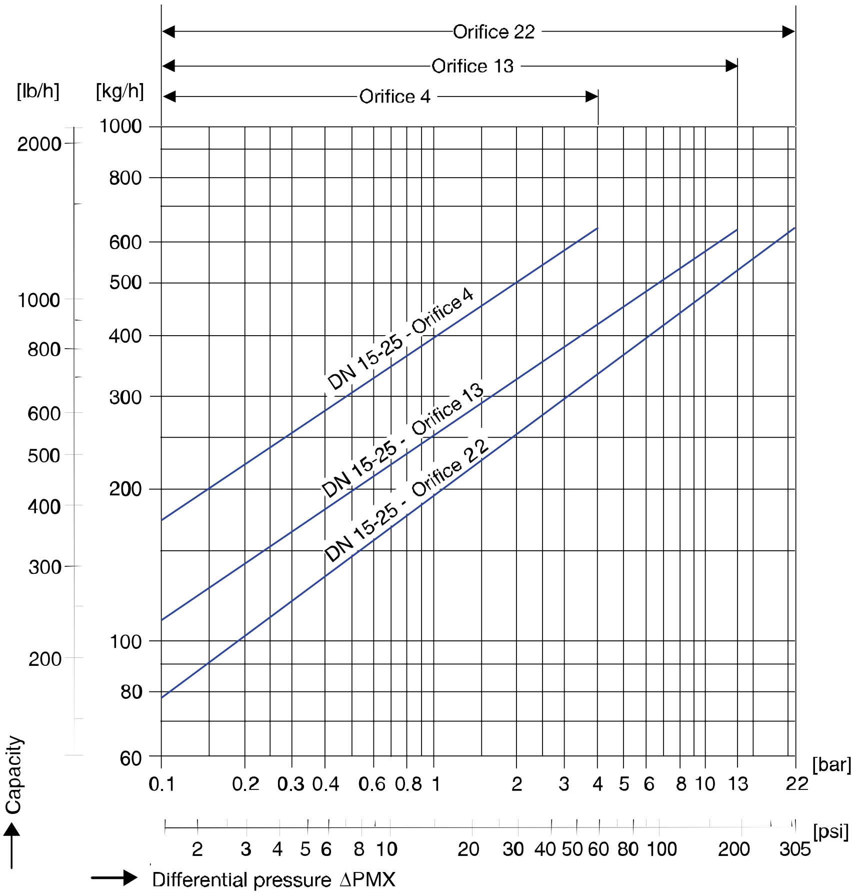
UNA 39 PN 160 DN 15, 25, 50



16.10 Float Traps, PN 25/40 DN 15, 20, 25
UNA 14/16

Maximum capacity of boiling hot condensate.

The maximum allowable differential pressure (working pressure) depends on the cross-sectional areas of the orifice.

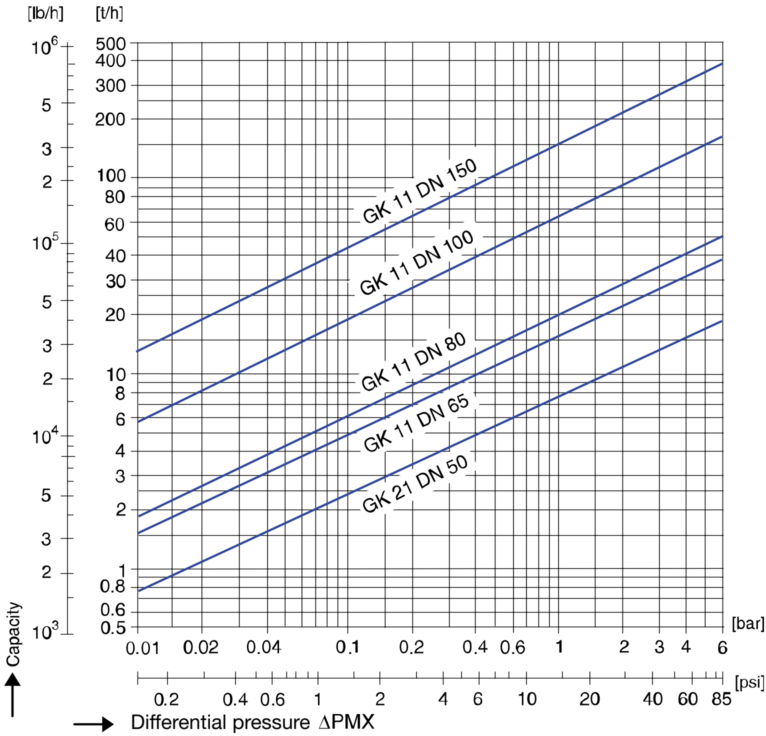


16.11 Thermodynamic Traps with Stage Nozzle, PN 16, DN 50–150

Maximum capacity of hot condensate at continuous load with 3/4 valve lift; the cold water capacity is approximately 70 % higher.

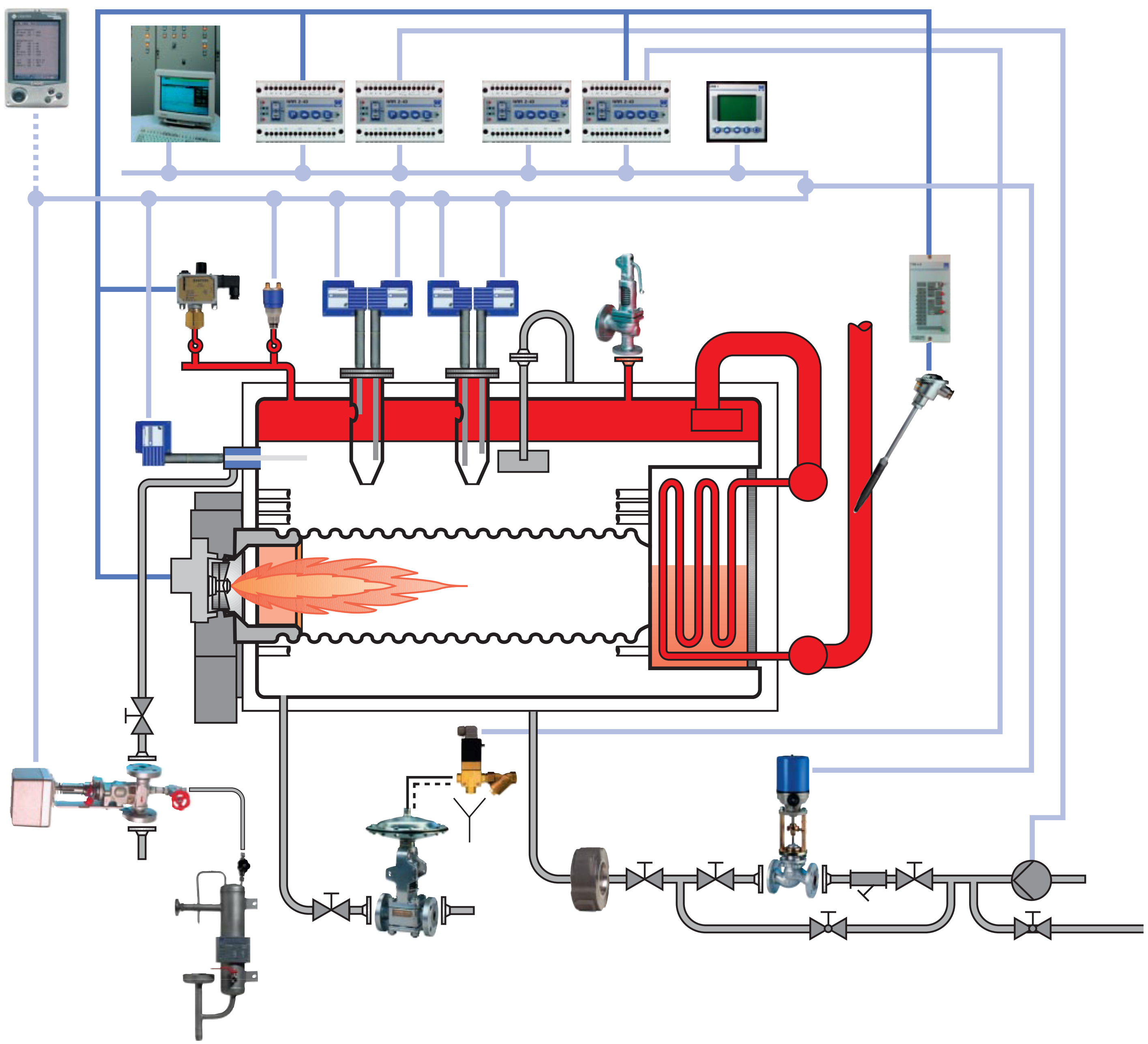
GK 21 DN 50

GK 11 DN 65, 80, 100, 150



Information:
GESTRA Steam Boiler Equipment with Bus Technology

For operation e.g. according to TRD 604 (72 h) or EN 12953 (24 h)



Cost savings through intelligent bus technology

a Low-level limiter of "high-integrity design": level electrode NRG 16-40, level switch NRS 1-40

bt Modulating level controller with integrated 2nd water level and conductivity indicator: level probe NRG 26-40, level controller NRR 2-40, control terminal and display unit URB 1

c High-level alarm of "high-integrity design": level electrode NRG 16-41, level switch NRS 1-41 *)

de Conductivity measurement and continuous/intermittent blowdown: conductivity electrode LRG 16-40, continuous blowdown controller LRR 1-40, continuous blowdown valve BAE 36-1, intermittent blowdown valve MPA, 3/2-way pilot valve, strainer

f Sample cooler

g Blowdown flash vessel

h Residual blowdown cooler

j Blowdown receiver

k Safety temperature limiter: resistance thermometer TRG 5-55, temperature switch TRS 5-6

m Safety valve GSV

n Pressure limiter DSF

o Pressure controller/transmitter

p DISCO non-return valve RK 86

q Strainer GSF

r Stop valve GAV

s Electrical/pneumatic control valve V 725

t Control terminal and display unit URB 1

u Process data acquisition

v Process data query / commissioning support via modem/cellphone/Palm

w Monitoring of the fresh water: ✎Demineralization equipment: using conductivity monitoring

*) not required by EN

The Benefits in Detail

1. No risk of overheating
- *¥ Patented thermal barrier in cylindrical body above electrode flange*
- *¥ Electronic temperature protection in the terminal box*
- *¥ Minimization of thermal effects*

2. Easy installation and maintenance
- *¥ Freely accessible connecting terminals at the control units*
- *¥ Large terminal box for easy installation*

3. Reduced cost
- *¥ Minimized inventory and spares levels*
- *¥ Only a single cable needed between boiler and control cabinet*
- *¥ Only one cable in the control cabinet for all sensing units*
- *¥ Optimum system integration without additional cable installations*

4. Increased safety
- *¥ Active cable monitoring*
- *¥ Easy integration into visual display and automation systems*

Get a technical lead with the first and only control package for energy supply centres using an open CAN-bus system. Only GESTRA permits easy interfacing to other open bus systems.

Page

17. Valves for Special Purposes

FLOWSERVE® GESTRA

Proven Technology.
New Ideas. Modern Production.

GESTRA, always one step ahead.

STERI*line*®

Once again GESTRA is at the forefront of steam trap technology with the new SMK 22 STERI*line* trap. This compact lightweight steam trap for pharmaceutical production plants is setting new standards in pure-steam sterilization. It is the perfect solution for all sterile and aseptic applications, superseding expensive and complex systems for condensate discharge control.

“Our installations require fast and reliable sterilizing.”

“The immediate removal of pure-steam condensate even in the event of sudden and extreme pressure and load fluctuations is critical for efficient and reliable operation.”

“We are looking for a trap that can also be used for air-venting in vessels.”

These are just some examples of customer requirements which are met by our new SMK 22 STERI*line* steam traps.

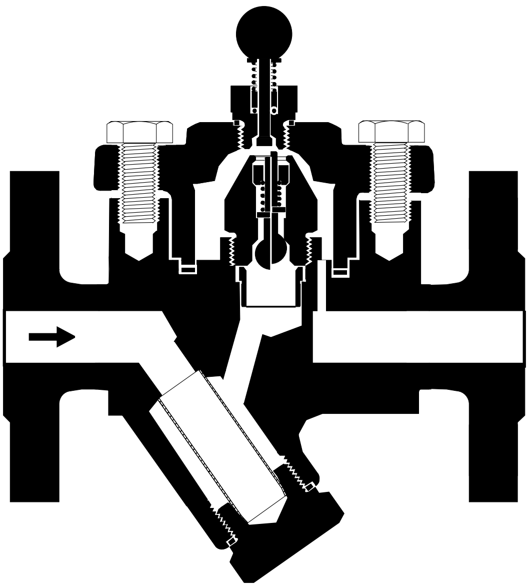
17. Valves for Special Purposes

17.1 Condensate Drain Valve AK 45

When steam-heated plants are taken into operation, the incoming steam condenses very quickly but the pressure only builds up slowly. In the process, a relatively large quality of condensate is produced but the existing steam trap is not yet able to discharge this start-up condensate without banking up. This prolongs the start-up time. Dangerous thermal waterhammer can occur.
When a plant is shut down, the residual steam condenses. The pressure drops and a vacuum may result. There may be negative consequences:

- Deformation of the heating surfaces by vacuum
- Increased corrosion due to shut-down, and danger of freezing through residual condensate
- Waterhammer on start-up

Remedy:
Start-up drainage, evacuation and ventilation should be provided in addition to the steam trap. This can be done with manually operated valves, but is better effected automatically with the GESTRA drain valve AK 45 (see Fig. 97).



RHOMBUSline®

Fig. 97 AK 45, DN 15, 20, 25

Automatic drainage offers the following benefits in relation to manual draining:
- Labour-saving
- Excludes human error or negligence
- Prevents steam losses by open valves
- Prevents waterhammer and frost damage
- Reduces the risk of accidents at poorly accessible points
- Averts the need for an air-inlet valve

The functional principle of the GESTRA AK 45 is based on a pressure-controlled seal plug. When there is no pressure, the AK 45 is held in the open position by a spring. When the plant is taken into operation, the condensate can drain freely out of the plant. Only when a certain steam pressure is reached (the closing pressure) does the valve close automatically. If the plant is shut down, causing the pressure to drop, the AK 45 opens at about the same pressure as the closing pressure in the start-up phase (i.e. opening pressure = closing pressure).
A hand purging knob is provided, so that the AK 45 can be opened manually with the system under pressure to clear any deposits from the valve seat area.

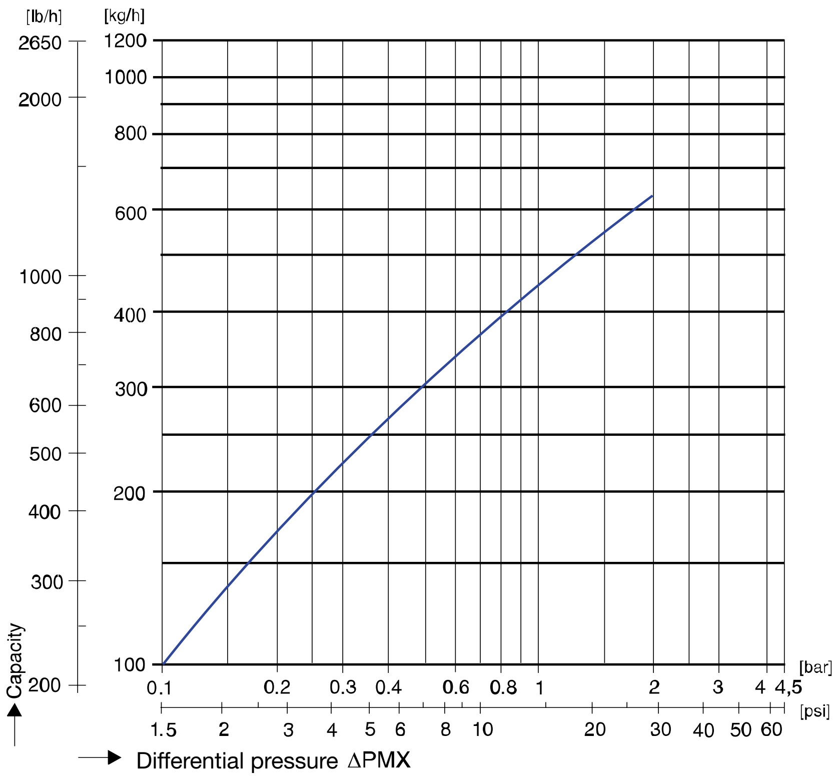


Fig. 98 AK 45 capacities for cold condensate

When taking a steam line which has risers into service (e.g. a remote steam line), the steam trap is not able to discharge the condensate which is generated on start-up. Through friction between the two phases, the steam entrains the cold condensate and transports it into the rising part of the line. Pulsation and thermal waterhammer can result. Here too, the GESTRA AK 45 can provide the solution (Fig. 99).

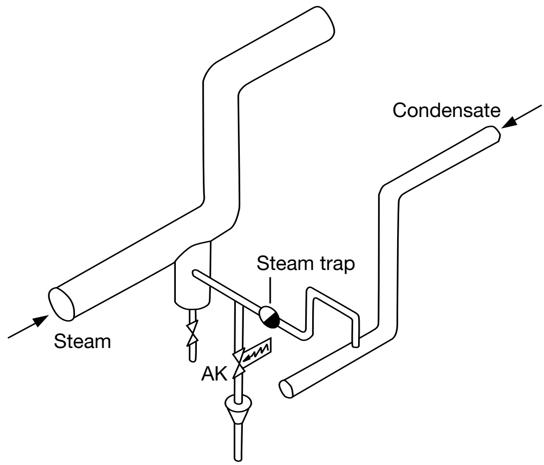


Fig. 99

For heat exchangers operating in batch mode (e.g. boiling apparatus, autoclaves or evaporators), fast start-up and shut-down with frequent batch changes is required. The GESTRA AK 45 permits rapid start-up, because the condensate produced at start-up can be discharged freely. Waterhammer can no longer occur. When the plant has been shut down, the GESTRA AK 45 allows the residual condensate to drain, thereby preventing frost damage and distortion through the formation of vacuum and also reducing the downtime corrosion (see Fig. 100).

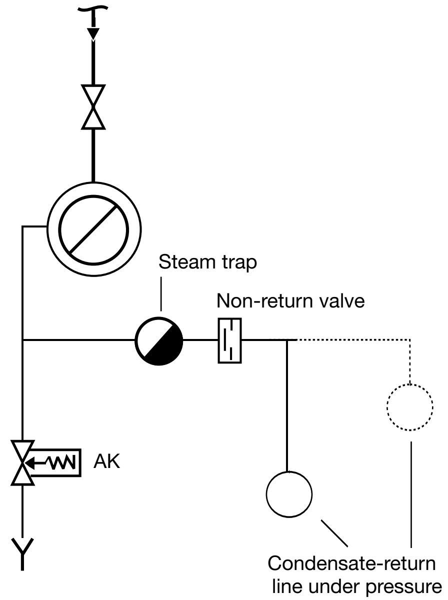


Fig. 100

17.2 Steam Traps for Sterile Applications, SMK 22 for the Pharmaceutical Industry (Fig. 101)

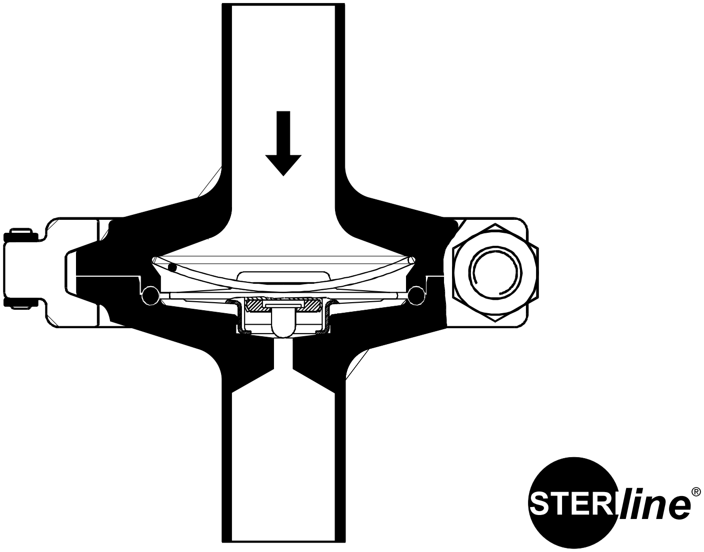


Fig. 101

This thermostatic steam trap features a minimum of stagnant area and a corrosion-resistant membrane regulator unaffected by waterhammer, and is used for the discharging of condensate and the venting of steam in sterile and aseptic applications (SIP).
Reliable sterilization is safeguarded through rapid heating and drainage with absolutely no banking up during the sterilization process. The try-clamp (a jointed clamp) permits easy maintenance of the SMK.
The membrane regulator has a self-centering valve cone that can move freely, thereby ensuring steam-tight shut-off unimpaired by particulate matter.
High sensitivity, thanks to reduced dimensions of the regulator (evaporation thermostat). Automatic air-venting and discharge of condensate without any banking-up within the rated pressure/temperature range. The opening temperature is approximately 5 K below the boiling point.
Maximum differential pressure $\Delta p = 6$ barg.
All parts in contact with the fluid are of stainless steel. The body gasket is of EPDM (O-ring) in accordance with the regulations specified by the Food and Drug Administration (FDA).
The surface roughness Ra of the wetted surfaces is ≤ 0.8 µm.

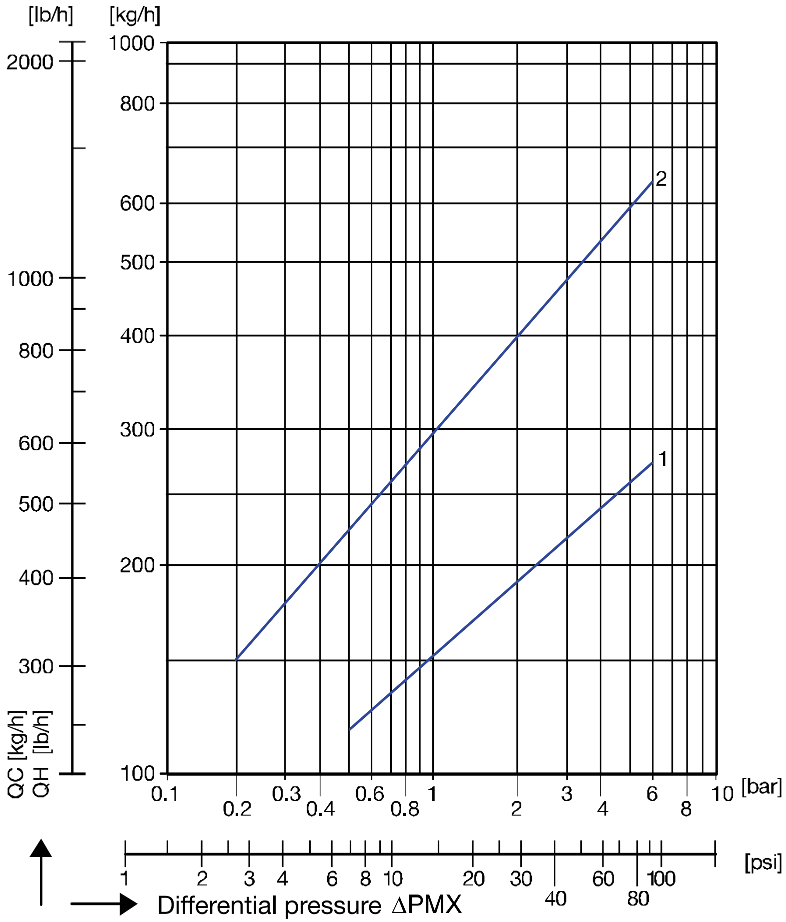
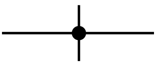
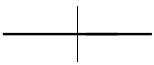


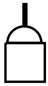
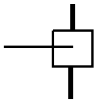
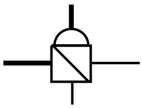
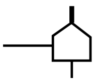
Fig. 102 Capacity chart for SMK 22
1 Max. capacity of hot condensate
2 Max. capacity of cold condensate

Symbols according to DIN 2481

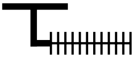
Media and Lines

	Steam
	Condensate, feedwater
	Sensing line
	Air
	Flexible line
	Line with heating or cooling
	Intersection of two lines with junction
	Branch point
	Intersection of two lines without junction
	Tundish
	Discharge vent (canopy)

Boilers, Heat Exchangers and Equipment

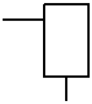
	Steam boiler
	Steam boiler with superheater
	Desuperheater with water injection
	Steam converter
	Surface heat exchanger
	Separator
	Flash vessel
	Steam user without heating surface
	Steam user with heating surface

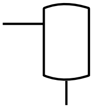
Boilers, Heat Exchangers and Equipment

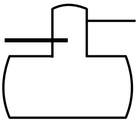

Space heating

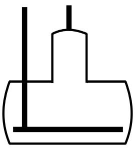

Exhaust, or vent to atmosphere

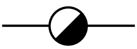

Open tank

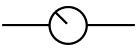

Vessel, general


Vessel with dished end

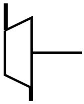

Vessel with deaeration


Steam accumulator


Steam trap


Vaposcope

Machines


Steam turbine

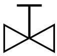
Electric motor, general

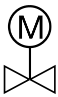

Liquid pump, general


Compressor, general (vacuum pump)

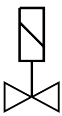
Valves

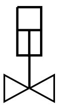

Shut-off valve, general

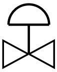

Shut-off valve, manually operated

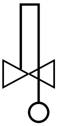


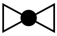
Shut-off valve, motorized


Shut-off valve, solenoid-operated

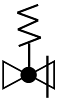

Shut-off valve, piston-operated

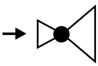

Shut-off valve, diaphragm-operated

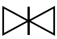

Shut-off valve, float-operated

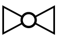

Valve

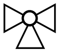

Angle valve

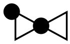

Spring-loaded safety valve

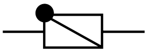

Pressure-reducing valve


Gate valve

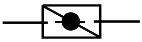

Cock


Three-way cock


Check valve

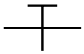

Swing check valve

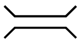

DISCO non-return valve RK

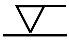

Butterfly valve

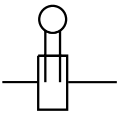
Instruments

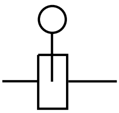

Pressure gauge, general


Thermometer, general

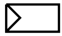

Flowmeter, general

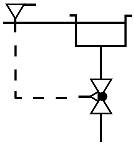

Liquid level

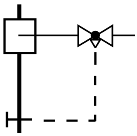

Conductivity

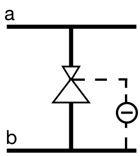

pH meter

Control Equipment

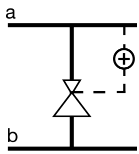

Controller, general


Drain controller


Desuperheater with water injection and temperature controller



Pressure-reducing valve opens with decreasing pressure in line b



Pressure-reducing valve opens with decreasing pressure in line a

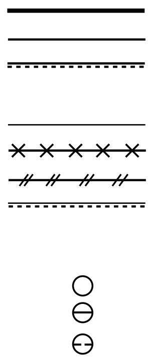
International Symbols and Abbreviations

Symbols

Process lines
Steam
Water
Air

Instrument lines
Lines, general
Capillary systems
Pneumatic signalling lines
Electrical signalling lines

Circular symbols for equipment
Locally fitted
Panel mounting
Rack mounting



Letters used in multi-letter symbols

as first letter		as successive letters	
C	Conductivity	A	Alarm
D	Density	C	Control
F	Flowrate, quantity	D	Difference[1]
H	Hand (manual operation)	G	Gauge (sightGlass)
L	Level	I	Indicating
M	Moisture	R	Recording
P	Pressure	S	Switching[2]
S	Speed, velocity, frequency	T	Transmitter
T	Temperature	V	Valve

[1] PD= pressure difference; TD = temperature difference etc.
[2] S = Switch (switching) can also mean Safety.

Example for the composition and meaning of a multi-letter symbol:
The quantity to be measured, e.g. pressure (P), is to be indicated (I) and controlled (C).
Then PIC 110 means: Pressure Indicating Controller for control circuit 110.

Material Designations

Old material designation (DIN)		EN designation	EN designation	ASTM	
Brief name	Number	Brief name	Number	Equivalent material[1]	Category
GG-25	0.6025	EN-GJL-250	EN-JL 1040	A 126-B	Grey cast iron
GGG-40	0.7043	EN-GJS-400-15	EN-JS 1030	A 536 60-40-18	S.G. (ductile) iron
GGG-40.3	0.7043	EN-GJS-400-18-LT	EN-JS 1025	–	S.G. (ductile) iron
GTW-40	0.8040	EN-GJMW-400-5	EN-JM 1030	–	Malleable cast iron, white
RSt 37-2	1.0038	S235JRG2	1.0038	A 283-C	Structural steel
C22.8	1.0460	P250GH	1.0460	A 105	Forged steel, unalloyed (carbon steel)
GS-C 25	1.0619	GP240GH	1.0619	A 216-WCB	Cast steel (carbon steel)
15 Mo 3	1.5415	16Mo3	1.5415	A 182-F1	Forged steel, heat resistant
GS-22 Mo 4	1.5419	G20Mo5	1.5419	A 217-WC1	Cast steel, heat resistant
13 CrMo 4 4	1.7335	13CrMo4-5	1.7335	A 182-F12-2	Forged steel, heat resistant
GS-17 CrMo 5 5	1.7357	G17CrMo5-5	1.7357	A 217-WC6	Cast steel, heat resistant
G-X 8 CrNi 13	1.4008	GX7CrNiMo12-1	1.4008	–	Cast steel, stainless
G-X 6CrNi 18 9	1.4308	GX5CrNi19-10	1.4308	A 351-CF8	Stainless steel (casting), austenitic
G-X 6CrNiMo 18 10	1.4408	GX5CrNiMo19-11-2	1.4408	A 351-CF8M	Stainless steel (casting), austenitic
X 6 CrNiTi 18 10	1.4541	X6CrNiTi18-10	1.4541	–	Stainless steel (forged), austenitic
X 6 CrNiNb 18 10	1.4550	X6CrNiNb18-10	1.4550	A 182-F347	Stainless steel (forged), austenitic
G-X 5 CrNiNb 18 9	1.4552	GX5CrNiNb19-11	1.4552	A 351-CF8C	Stainless steel (casting), austenitic
X 6 CrNiMoTi 17 12 2	1.4571	X6CrNiMoTi17-12-2	1.4571	–	Stainless steel (forged), austenitic
G-X 5 CrNiMoNb 18 10	1.4581	GX5CrNiMoNb19-11-2	1.4581	–	Stainless steel (casting), austenitic
CuZn 39 Pb 3	2.0401	CuZn38Pb2	CW608N	–	Hot-pressed brass
CuZn 35 Ni 2	2.0540	CuZn35Ni3Mn2AlPb	CW710R	–	Brass
G-CuAl 9 Ni	2.0970.01	CuAl10Ni3Fe2-C	CC332G	–	Bronze
G-CuSn 10	2.1050.01	CuSn10-Cu	CC480K	–	Bronze
GC-CuSn 12	2.1052.04	CuSn12-C	CC483K	–	Bronze

[1] Note the differences in chemical and physical properties!

Index

GESTRA Product Overview

Steam Traps

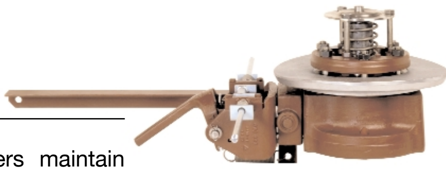
- Thermostatic Steam Traps with Duo S.S. (Bimetallic) Regulator or Membrane Regulator
- Ball Float Traps
- Thermodynamic Steam Traps
- Steam Trap Units for Universal Connectors
- Steam Trap Monitoring Equipment

Non-Return Valves

Gravity Circulation Checks
- DISCO®-Non-Return Valves
- DISCO®-Check Valves
- DISCOCHECK®-Dual-Plate Check Valves

Tank-Car and Tank-Container Valves

GESTRA special equipment for the transport and storage of hazardous gases and liquids meets the most stringent safety requirements.



Cooling-Water Control Valves

Direct-acting proportional controllers maintain the cooling water outlet temperature at a preset value as a function of the discharge temperature.

Return-Temperature Control Valves

These directly controlled return-temperature control valves maintain constant return temperatures within their proportional range.

GESTRA Product Overview

Pressure Control Valves

Direct-acting pressure-reducing valve with large set-point ranges for steam, neutral gases and liquids.

Temperature Control Valves

Self-acting temperature control valves operate as normal- and reverse-acting valves with external feeler. Suitable for applications in heating and cooling processes with steam, gas and liquids.

Control Valves

- Control valves with electric and pneumatic actuators
- Control valves with radial stage nozzle

Ball Valves

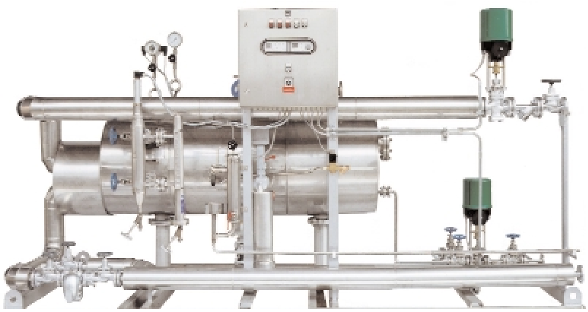
Safety Valves

Strainers

Stop Valves

Special Equipment and Vessels for Heat Recovery

- Condensate Recovery and Return System
- Desuperheaters
- Steam Regenerators
- Feedwater Deaerating Plants
- Blowdown Receiver (Mixing Cooler)
- Condensate Dampening Pots
- Air/Steam Driers and Purifiers

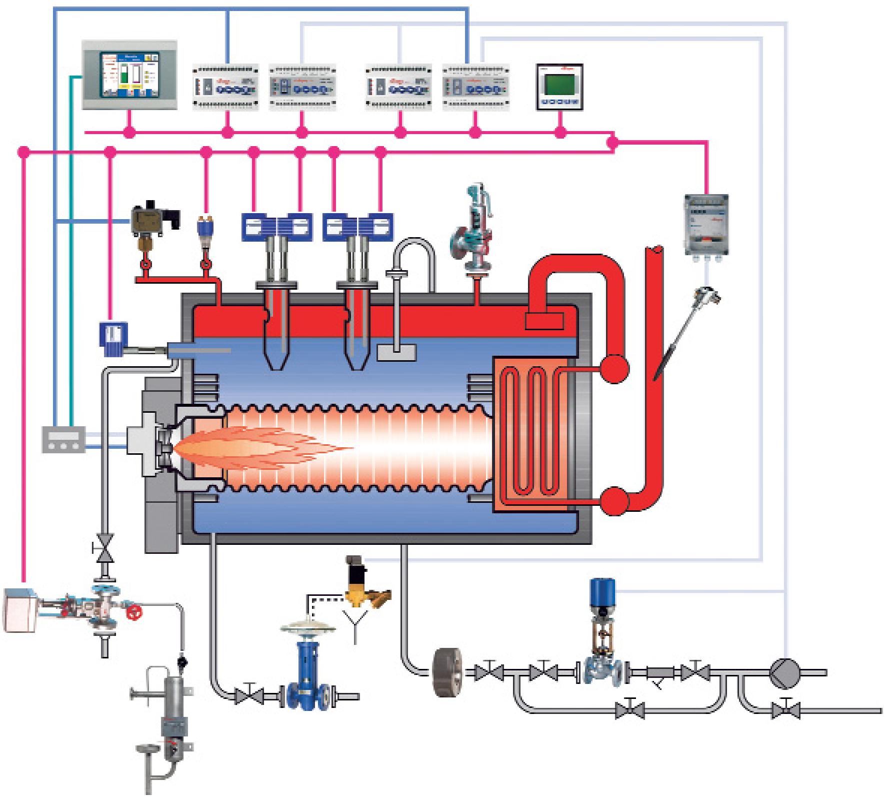


GESTRA Product Overview

Equipment for Energy Supply Centres

All components for improving operational safety and monitoring steam and pressurized hot water plants in accordance with TRD 701 / 601 / 602 / 604 24h / 604 72h

- Level Control, Monitoring and Alarm
- Temperature Control and Alarm
- Conductivity Monitoring
- Continuous and Intermittent Blowdown Valves
- Programme-Controlled Blowdown Systems
- Liquid Monitoring
- Flowmeters for Steam, Gases and Liquids
- Bus Technology



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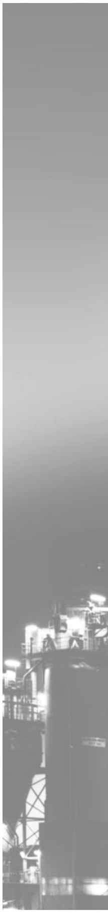

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With Energy into the Future