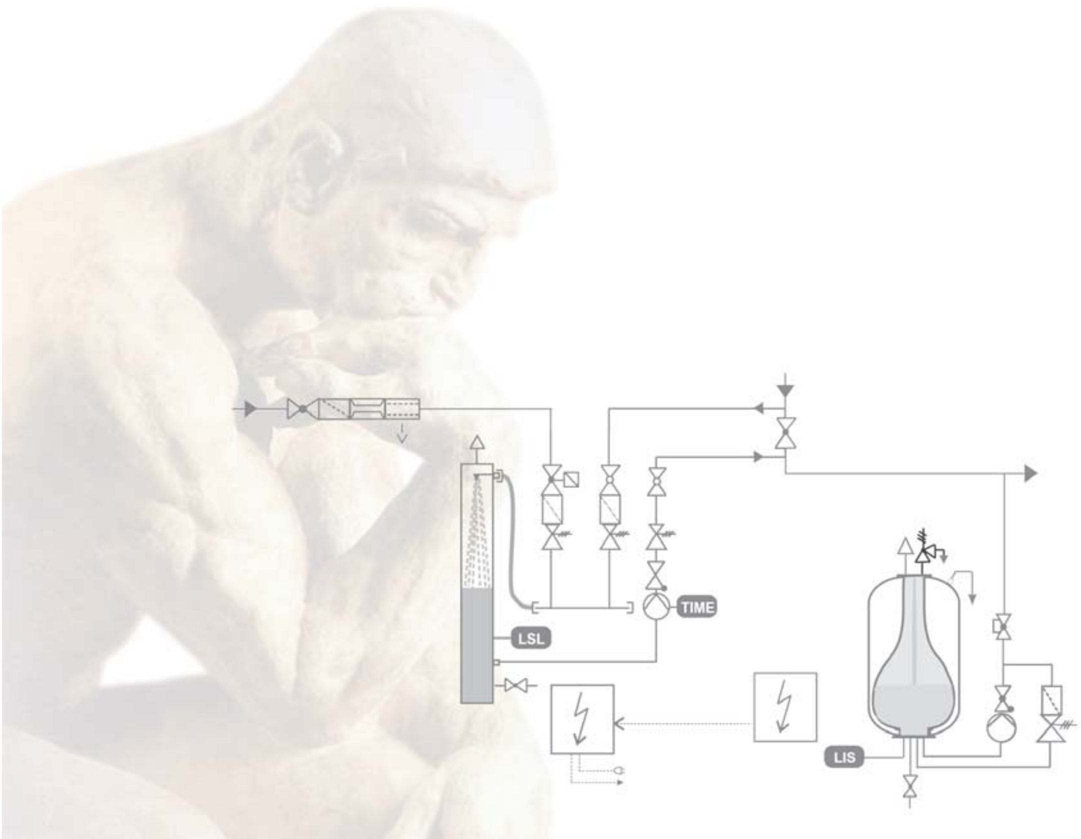
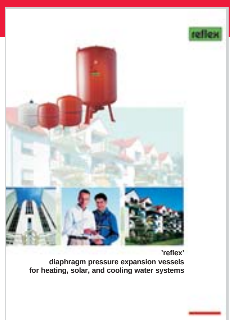
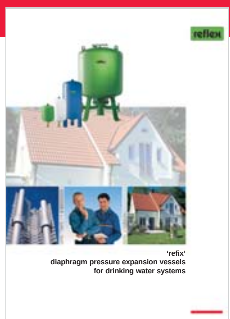



# Pressure-Maintaining, Deaeration, Water Make-up, and Heat Transfer Systems

**Planning, Calculation, Equipment**

# Technical planning documents

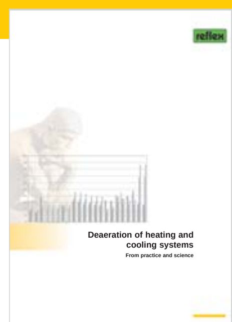


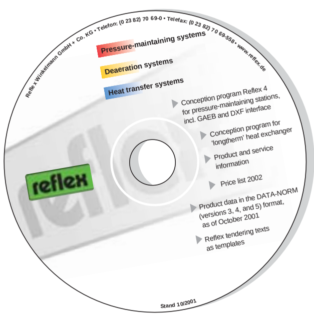








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## Calculation procedures

This guide is intended to provide you with the key notes and recommendations regarding the planning, calculation, and equipment of Reflex pressure-maintaining, deaeration, and heat transfer systems. Calculation forms have been prepared for selected systems. You find the most important auxiliary values and physical characteristics for the calculation and the requirements regarding the safety-related equipment in overviews.

- Calculation forms
- Auxiliary values

Do not hesitate to contact us if you miss anything.
Your professional consultant is ready to assist you.

- Your professional consultant
→ page 51

**Standards, guidelines** Key fundamentals for the planning, calculation, equipment and the operation are contained in the standards and guidelines

| | |
|---|---|
| DIN 4751 T2* | Water heating systems, safety-related equipment ... |
| DIN 4747 T1 | District heating systems, safety-related equipment ... |
| DIN 4753 T1 | Water heating devices and water heating systems ... |
| DIN 4757 T1 | Solar heating systems ... |
| DIN 4807 | Expansion vessels |
| T1 | Terms ... |
| T2* | Calculation |
| DIN 4807 T5 | Expansion vessels for drinking water installations ... |
| DIN 1988 T5 | Technical rules for drinking water installations, pressure intensification and pressure reduction ... |
| DGRL | Pressure Equipment Directive 97/23/EC |
| BetrSichV | Operational Safety Regulation (from 1 January 2003) |
| HeizAnlV | Heating Systems Regulation |

* DINEN12828 Heating systems in buildings – Planning of warm water heating systems, replaces the marked DIN standards with a transitional period until 03/2004

**Planning documents** You find the product-specific specifications required for the calculation in the corresponding product documents and, of course, at 'www.reflex.de'.

**Systems** Not all systems are and can be covered by the standards. Based on new findings and research results, we therefore also provide you with recommendations for the calculation of special systems, such as solar systems, cooling water circuits, and district heating systems.

The automation of the system operation gains more and more importance. Thus, pressure monitoring and water make-up systems are treated in the same manner as central bleeding and deaeration systems.


**Calculation program** You can use our **Reflex calculation program** available on CD-ROM for the automated calculation of pressure-maintaining systems and heat exchangers.

Use this opportunity to find your optimum solution quickly and easily.

**Special systems** Please contact our special department with respect to special systems, e.g. pressure-maintaining stations in district heating systems with a heating capacity of more than 14 MW or flow temperatures of more than 120°C.

- Special pressure maintenance
+49 (0) 2382/7069-536

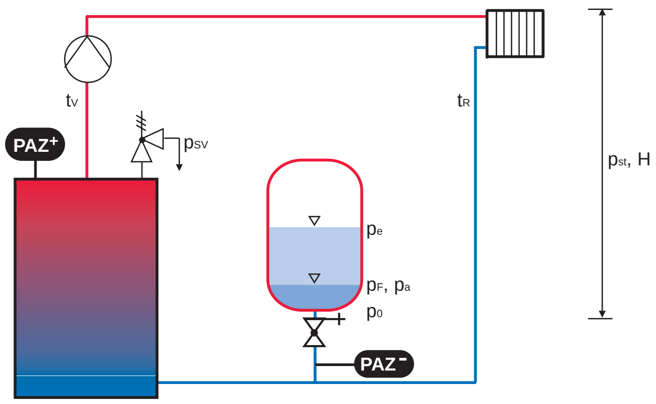
## Tasks of pressure-maintaining systems

Pressure-maintaining systems play a central role in heating and cooling circuits and have to perform three basic tasks:

1. Maintaining the pressure at each point of the system within the admissible limits, i.e. the admissible operating excess pressure must not be exceeded, but also ensuring a minimum pressure to avoid low pressure cavitation, and evaporation.
2. Compensation of volume variations of the heating or cooling water due to temperature variations.
3. Correcting water losses caused by the system by means of a hydraulic back pressure.

A proper calculation, operation and maintenance is a basic requirement for the correct functioning of the overall system.

## Calculation values



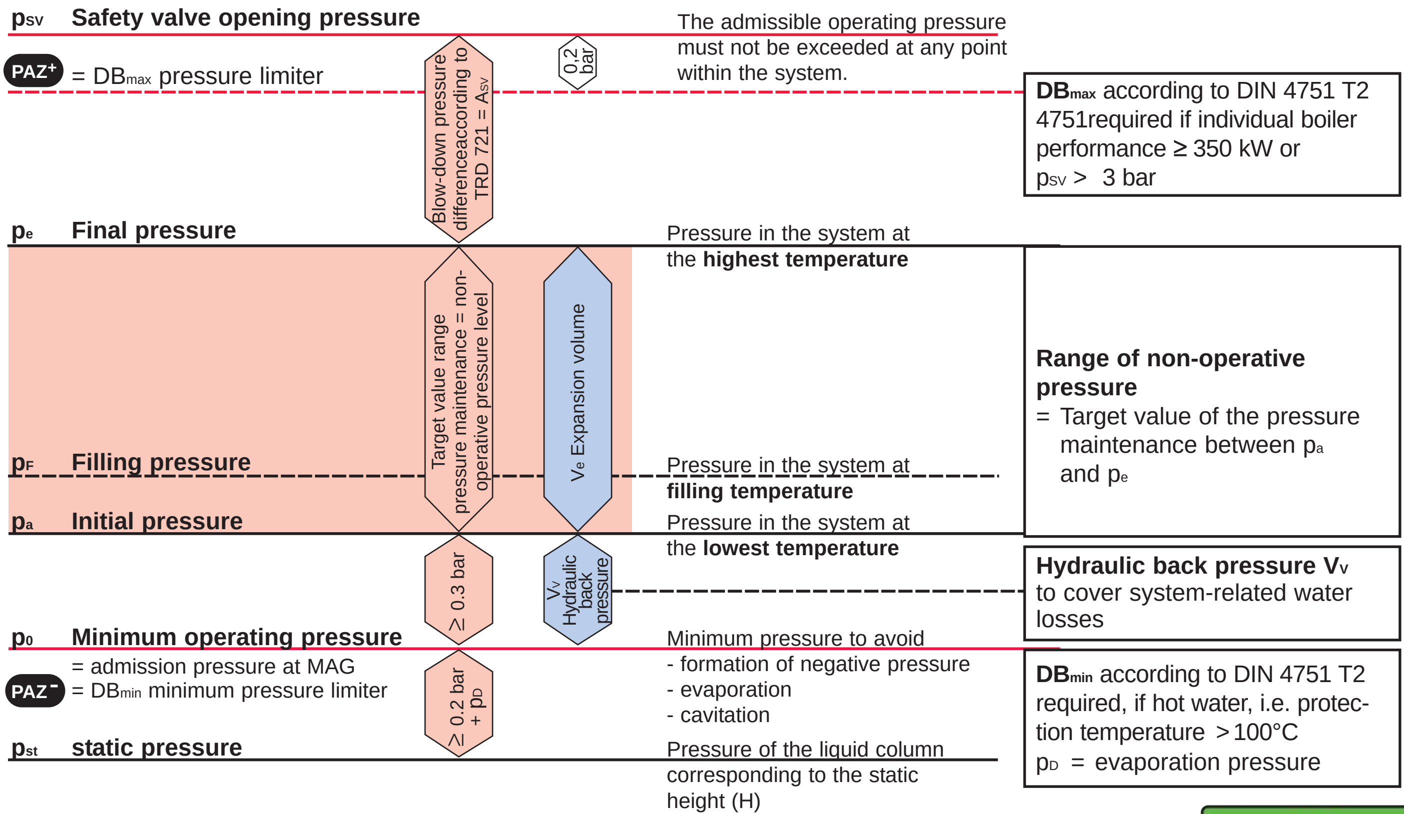

**Most popular connection:**
- circulating pump in the flow pipe
- expansion vessel in the return pipe

=

suspension pressure maintenance

**Definitions according to DIN 4807 T1/T2 and DIN 4751 T2 on the example of a heating system with a diaphragm pressure expansion vessel (MAG)**

Pressures are specified as excess pressures and refer to the connecting branch of the MAG or the pressure measuring sensor in case of pressure-maintaining stations. The connection corresponds to the above diagram.






reflex

## Physical characteristics and auxiliary values

### Physical characteristics of water and water compounds

pure water without the addition of antifreeze agents

| t / °C | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 105 | 110 | 120 | 130 | 140 | 150 | 160 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| n / % (+ 10°C on t) | | 0 | 0,13 | 0,37 | 0,72 | 1,15 | 1,66 | 2,24 | 2,88 | 3,58 | 4,34 | 4,74 | 5,15 | 6,03 | 6,96 | 7,96 | 9,03 | 10,20 |
| $p_D$ / bar | | -0,99 | -0,98 | -0,96 | -0,93 | -0,88 | -0,80 | -0,69 | -0,53 | -0,30 | 0,01 | 0,21 | 0,43 | 0,98 | 1,70 | 2,61 | 3,76 | 5,18 |
| Δn ($t_R$) | | | | | | | | 0 | 0,64 | 1,34 | 2,10 | 2,50 | 2,91 | 3,79 | | | | |
| ρ / kg/m³ | 1000 | 1000 | 998 | 996 | 992 | 988 | 983 | 978 | 972 | 965 | 958 | 955 | 951 | 943 | 935 | 926 | 917 | 907 |

Water with the addition of antifreeze agent*, 20% (vol.)
lowest admissible system temperature -10°C

| t / °C | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 105 | 110 | 120 | 130 | 140 | 150 | 160 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| n* / % (-10°C on t) | 0,07 | 0,26 | 0,54 | 0,90 | 1,33 | 1,83 | 2,37 | 2,95 | 3,57 | 4,23 | 4,92 | — | 5,64 | 6,40 | 7,19 | 8,02 | 8,89 | 9,79 |
| $p_D$* / bar | | | | | | -0,9 | -0,8 | -0,7 | -0,6 | -0,4 | -0,1 | — | 0,33 | 0,85 | 1,52 | 2,38 | 3,47 | 4,38 |
| ρ / kg/m³ | 1039 | 1037 | 1035 | 1031 | 1026 | 1022 | 1016 | 1010 | 1004 | 998 | 991 | — | 985 | 978 | 970 | 963 | 955 | 947 |

Water with the addition of antifreeze agent*, 34% (vol.)
lowest admissible system temperature -20°C

| t / °C | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 105 | 110 | 120 | 130 | 140 | 150 | 160 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| n* / % (-20°C on t) | 0,35 | 0,66 | 1,04 | 1,49 | 1,99 | 2,53 | 3,11 | 3,71 | 4,35 | 5,01 | 5,68 | — | 6,39 | 7,11 | 7,85 | 8,62 | 9,41 | 10,2 |
| $p_D$* / bar | | | | | | -0,9 | -0,8 | -0,7 | -0,6 | -0,4 | -0,1 | — | 0,23 | 0,70 | 1,33 | 2,13 | 3,15 | 4,41 |
| ρ / kg/m³ | 1066 | 1063 | 1059 | 1054 | 1049 | 1043 | 1037 | 1031 | 1025 | 1019 | 1012 | — | 1005 | 999 | 992 | 985 | 978 | 970 |

n - percentage expansion for water referred to a lowest admissible system temperature of +10°C (in general, filling water)
n* - percentage expansion for water with the addition of antifreeze agent referred to a lowest admissible system temperature of -10°C or -20°C
Δn - percentage expansion for water for the calculation of temperature layer containers between 70°C and max. return temperature
$p_D$ - evaporation pressure for water referred to the atmosphere
$p_D$* - evaporation pressure for water with the addition of an antifreeze agent
ρ - density
* - antifreeze agent Antifrogen N, if you use different antifreeze agents, please contact the manufacturer for the physical characteristics



### Determination of the water content $V_A$ of heating systems by approximation

- $V_A = \dot{Q}_{tot}$ x $v_A$ + pipelines + others → for systems with natural rotating boilers
- $V_A = \dot{Q}_{tot}$ ($v_A$ - 1.4 l) + pipelines + others → for systems with heat exchangers
- $V_A = \dot{Q}_{tot}$ ($v_A$ - 2.0 l) + pipelines + others → for systems without heat generators

($\dot{Q}_{tot}$: installed heating capacity)

$V_A$ = ..................... + ..................... + ..................... = ..................... litres

- specific water content $v_A$ in litre/kW of heating systems (heat generator, distribution, heating surfaces)

| $t_V/t_R$ °C | radiators | | Flat | Convectors | Ven-tilation | Floor heating |
|---|---|---|---|---|---|---|
| | Cast iron radiators | Tube and steel radiators | | | | |
| 60/40 | 27,4 | 36,2 | 14,6 | 9,1 | 9,0 | $V_A$ = 20 l/kW<br>$V_A$** = 20 l/kW $\frac{n_{FB}}{n}$ |
| 70/50 | 20,1 | 26,1 | 11,4 | 7,4 | 8,5 | |
| 70/55 | 19,6 | 25,2 | 11,6 | 7,9 | 10,1 | |
| 80/60 | 16,0 | 20,5 | 9,6 | 6,5 | 8,2 | |
| 90/70 | 13,5 | 17,0 | 8,5 | 6,0 | 8,0 | |
| 105/70 | 11,2 | 14,2 | 6,9 | 4,7 | 5,7 | |
| 110/70 | 10,6 | 13,5 | 6,6 | 4,5 | 5,4 | |
| 100/60 | 12,4 | 15,9 | 7,4 | 4,9 | 5,5 | |

Attention: by approximation, in the individual case substantial deviations possible

** If the floor heating is operated and protected as a part of the entire system with lower flow temperatures , $v_A$** is to be used for the calculation of the entire water quantity
$n_{FB}$ = percentage expansion referred to the maximum flow temperature of the floor heating

- approximate water contents of heating tubes

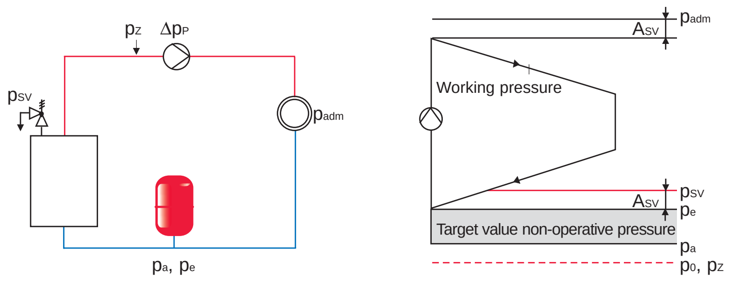
| DN | 10 | 15 | 20 | 25 | 32 | 40 | 50 | 60 | 65 | 80 | 100 | 125 | 150 | 200 | 250 | 300 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| litres/m | 0,13 | 0,21 | 0,38 | 0,58 | 1,01 | 1,34 | 2,1 | 3,2 | 3,9 | 5,3 | 7,9 | 12,3 | 17,1 | 34,2 | 54,3 | 77,9 |

## Hydraulic integration

The hydraulic integration of the pressure maintenance into the system has a substantial influence on the working pressure course. This consists of the non-operative pressure level of the pressure maintenance and the difference pressure that is generated if the circulating pump is running. Three main types are distinguished. In the practice, there are additional, different variants.

**Admission pressure maintenance**

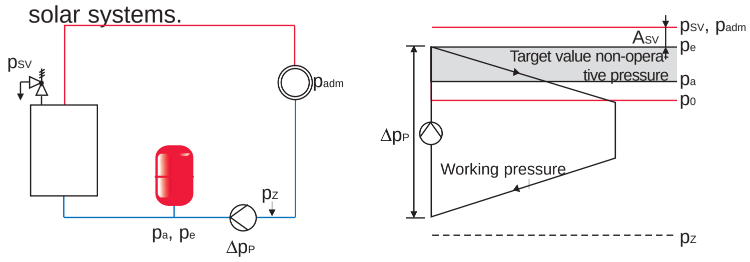
(suction pressure maintenance)
The pressure maintenance is integrated **before** the circulating pump, i.e. on the suction side. This method is used almost exclusively as its handling is the easiest.




- Advantage:
  - low non-operating pressure level
  - working pressure > non-operating pressure to avoid the risk of low pressures
- Disadvantage:
  - high working pressure in case of a high circulating pump pressure (large-scale systems), consider network load $p_{adm}$

**Follow-up pressure maintenance**

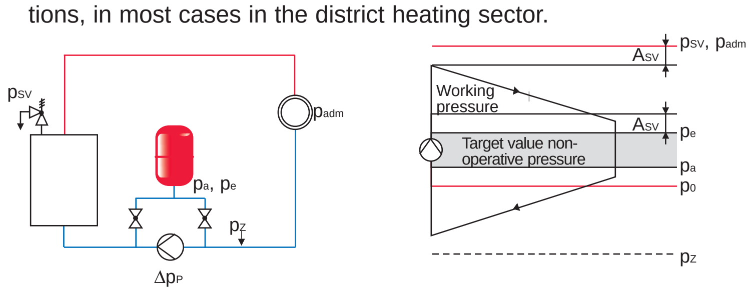
The pressure maintenance is integrated **after** the circulati pump, i.e. on the pressure side. With respect to the calculation of the non-operative pressure, a system-specific difference pressure of the circulating pump (50 ... 100%) must be considered. The application is restricted to few individual cases → solar systems.




- Advantage:
  - low non-operative pressure level unless the entire pump pressure must be load
- Disadvantage:
  - high non-operative pressure level
  - make sure in any case that the required flow pressure $p_z$ according to the manufacturer's speci fications for the circulating pump is met

**Medium pressure maintenance**

The measurement point for the non-operative pressure level is "placed" into the system by means of an analogy measurement section. The non-operative and working pressure levels can be ideally adjusted to each other and designed variably (symmetric, asymmetric medium pressure maintenance). Due to the relatively high expenditure with respect to the devices, the application is restricted to systems with complicated pressure conditions, in most cases in the district heating sector.




- Advantage:
  - optimum, variable adjustment of working and non-operative pressure
- Disadvantage:
  - high expenditure with respect to the devices

**Reflex recommendation** Use the suction pressure maintenance! Only use a different pressure maintenance in justified exceptions. Please do not hesitate to contact us!

# Pressure-maintaining systems

## heating and cooling circuits

### Special pressure-maintaining systems - overview

Reflex produces two different types of pressure-maintaining systems.

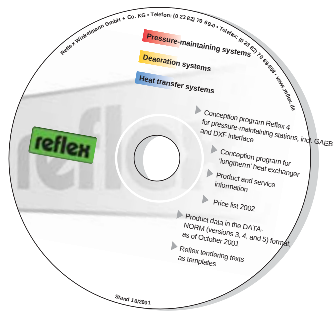
- **Reflex diaphragm pressure expansion vessels (MAG) with gas cushion** can be operated without auxiliary energy and are, thus, allocated to the static pressure-maintaining systems. The pressure is generated by a gas cushion in the vessel. To achieve an automated operation, the combination with reflex 'magcontrol' water make-up stations as well as with reflex 'servitec magcontrol' water make-up and deaeration stations is recommended.

- **Reflex pressure-maintaining systems with external pressure generation** work with auxiliary energy and are, thus, allocated to the dynamic pressure-maintaining systems. It is distinguished between pump-controlled and compressor-controlled systems. As the reflex 'variomat' and reflex 'gigamat' control the pressure in the system by means of pumps and overflow valves directly on the water side, the pressure in the reflex 'reflexomat' is adjusted on the air side by means of a compressor and a solenoid valve.

Both systems have their justification. Water-controlled systems work very silently and are able to quickly respond to pressure changes. By means of the **unpressurized** storage of the expansion water, they can be simultaneously used as central bleeding and deaeration system ('variomat'). Compressor-controlled systems, such as the 'reflexomat', allow a very elastic operation within extremely tight pressure limits with approximately ± 0.1 bar (pump-controlled approximately ± 0.2 bar) around the target value. In combination with the reflex 'servitec', a deaeration function is possible also here.

Our Reflex calculation program selects the ideal solution for you.

- **'Deaeration of heating and cooling systems'**
  This brochure explains when and why the deployment of deaeration systems is also and in particular required in closed systems.



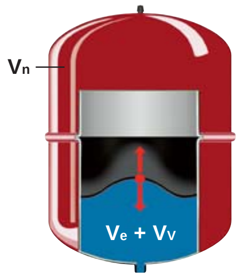



- **Preferred fields of application** are listed in the following table. Experience shows that it is recommended to **automate** the operation of the pressure maintenance, i.e. to monitor the pressure and perform a water make-up in time and to automatically and **centrally bleed** systems. Traditional air holes are not required, the cumbersome subsequent bleeding is a thing of the past, the operation becomes safer, the costs are reduced.

| **default pressure maintenance flow temperature up to 120°C** | | **pressure maintenance** | **autom. Operation with water make-up** | **central Bleeding and Deaeration** | **preferred Performance range** | |
|---|---|---|---|---|---|---|
| **'reflex' MAG** | - without additional equipment<br>- with 'control' water make-up<br>- with 'servitec magcontrol' | X<br>X<br>X | —-<br>X<br>X | —-<br>—-<br>X | up to 1000 kW |  |
| **'variomat'** | **1** Single-pump system<br>**2-1** single-pump system<br>**2-2** Double-pump system | X<br>X<br>X | X<br>X<br>X | X<br>X<br>X | 150-2000 kW<br>150-4000 kW<br>500-8000 kW |  |
| **'gigamat'** | - without additional equipment<br>- with 'servitec levelcontrol' | X<br>X | X<br>X | —-<br>X | 5000-60000 kW |  |
| | - Special systems | corresponding to the type of task | | | | |
| **'reflexomat'** | - without additional equipment<br>- with 'control' water make-up<br>- with 'servitec levelcontrol' | X<br>X<br>X | —-<br>X<br>X | —-<br>—-<br>X | 150-24000 kW |  |

## Reflex diaphragm pressure expansion vessels
## Types: ‘reflex N, F, S, A, E, G’

**Nominal volume $V_n$**




The pressure in the expansion vessel is generated by means of a gas cushion. Water level and the pressure in the gas room are linked with each other (p x V = constant). Therefore, it is not possible to use the entire nominal volume for the water absorption. The nominal volume is by the factor $\frac{p_e + 1}{p_e - p_0}$ larger than the required water absorption volume $V_e + V_V$.

This is one reason why dynamic pressure-maintaining systems are to be preferred in case of larger systems and tight pressure conditions ($p_e$ - $p_0$). If reflex ‘servitec magcontrol’ deaeration systems are used, the volume of the deaeration tube (5 litres) is to be considered during the determination of the size.

without deaeration

$V_n = (V_e + V_V)\,\frac{p_e + 1}{p_e - p_0}$

with reflex ‘servitec magcontrol’

$V_n = (V_e + V_V + 5\,l)\,\frac{p_e + 1}{p_e - p_0}$

**Pressure monitoring**
**Admission pressure $p_0$**

The gas admission pressure is to be checked manually prior to the commissioning Minimum operating pressure and during the annual maintenance work and must be set to the minimum operating pressure of the system. The pressure is to be recorded on the typeplate. The planner must specify the gas admission pressure on the drawings. To avoid the cavitation at the circulating pumps, we recommend to choose a minimum operating pressure of at least 1 bar also for roof and central heating systems and for heating systems in low buildings. Typically, the expansion vessel is integrated on the suction side of the circulating pump (admission pressure maintenance). In case of the integration on the pressure side (follow-up pressure maintenance) the difference pressure of the circulating pumps $\Delta p_P$ is to be considered to avoid the formation of negative pressures. With respect to the calculation of $p_0$, an increased factor of safety of 0.2 bar is recommended. You should only do without this increased factor in case of extremely tight pressure conditions.

Admission pressure maintenance

$p_0 \geq p_{st} + p_D + 0.2$ bar

$p_0 \geq 1$ bar Reflex recommendation

Follow-up pressure maintenance

$p_0 \geq p_{st} + p_D + \Delta p_P$

**Initial pressure $p_a$**
**water make-up**

One of the most important pressures! It limits the lower target value range of the pressure maintenance and simultaneously protects the hydrauli back pressure $V_V$, i.e. the minimum water level in the expansion vessel. A reliable control and check of the initial pressure is only ensured if the Reflex formula for the initial pressure is complied with. Our calculation program takes this into consideration. With the higher initial pressures compared to traditional conceptions (higher hydraulic back pressure), a stable operation is ensured. The known functional failures of expansion vessels due to an insufficient or even missing hydraulic back pressure are avoided. In particular in case of small differences between final pressure and admission pressure, slightly larger vessels may result using the new calculation method. This should, however, be of no importance with respect to a higher operational safety.

reflex ‘control’ water make-up stations automatically monitor and protect the initial or filling pressure. → reflex ‘control’ water make-up stations

Reflex formula for the initial pressure

$p_a \geq p_0 + 0.3$ bar

**Filling pressure $p_F$**

The filling pressure $p_F$ is the pressure that must be present during the filling of a system, referred to the temperature of the filling water, to ensure that the hydraulic back pressure $V_V$ is ensured at the lowest system temperature. With respect to heating systems, the following applies in general: filling pressure = initial pressure (lowest system temperature = filling temperature = 10°C). The filling pressure of cooling circuits with temperatures below 10°C is, for example, larger than the initial pressure.

**Final pressure $p_e$**

It limits the upper target value range of the pressure maintenance. It must be set such that the pressure at the system safety valve is lower at least by the blow-down pressure difference $A_{SV}$ according to TRD 721. The blow-down pressure difference depends on the type of the safety valve.

Reflex recommendation

$p_e = p_{SV} - A_{SV}$

$p_{SV} \geq p_0 + 1.5$ bar for $p_{SV} \leq 5$ bar

$p_{SV} \geq p_0 + 2.0$ bar for $p_{SV} > 5$ bar

Blow-down pressure difference according to TRD 721 $A_{SV}$

| | |
|---|---|
| SV-H | 0,5 bar |
| SV-D/G/H | 0.1 $p_{SV}$<br>0.3 bar for $p_{SV} < 3$ bar |

**Deaeration**
**Deaeration**

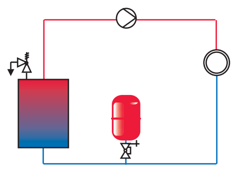
Especially closed systems must be deaerated purposefully, in particular nitrogen concentrations will otherwise result in unpleasant operation failures and in the dissatisfaction of the customers. reflex ‘servitec magcontrol’ automatically deaerates and makes up water. → page 28

reflex

## Heating systems

**Calculation** according to DIN 4807 T2 and DIN 4751 T2

**Connection** in most cases as suction pressure maintenance according to the diagram with a circulating pump in the flow pipe and an expansion vessel in the return, i.e. on the suction side of the circulating pump


'reflex'
'variomat'
'gigamat'
'reflexomat'

**Physical characteristics n, $p_D$** typically physical characteristics for pure water without antifreeze agents → page 6

**Expansion volume $V_e$ highest temperature $t_{TR}$** Determination of the percentage expansion normally between lowest temperature = filling temperature = 10°C and highest target value setting of the temperature controller $t_{TR}$

**Minimum operating pressure $p_0$** In particular with respect to low buildings and central roof units, the minimum admission pressure for the circulating pump according to the manufacturer's specifications must be proven due to the low static pressure $p_{st}$. Thus, we recommend to choose a minimum operating pressure $p_0$ of at least 1 bar also in case of lower static heights.

▶ **Be careful** in case of central roof units and low buildings

Reflex recommendation:
$p_0 \geq 1$ bar

**Filling pressure $p_F$ Initial pressure $p_a$** As the filling temperature with 10°C is, in general, equal to the lowest system temperature, the MAG filling pressure = initial pressure. With respect to pressure-maintaining stations it must be considered that filling and water make-up devices must possibly run against the final pressure. This only applies to the 'reflexomat'.



**Pressure maintenance** In form of a static pressure maintenance with 'reflex N, F, A, E, S, G', also in combination with the water make-up and deaeration stations 'control' and 'servitec magcontrol', or from approximately 150 kW in form of 'variomat' pressure-maintaining station for the pressure maintenance, deaeration and water make-up, or as compressor-controlled pressure-maintaining station 'reflexomat'. → page 18

For systems with oxygen-rich water (e.g. floor heating with non diffusion-proof tubes) 'refix D', 'refix DE', or 'refix DE junior' is used up to 70°C (all water carrying parts are corrosion-proof).

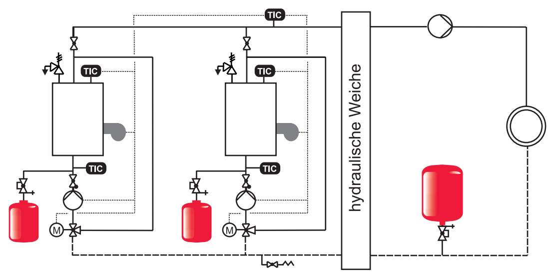
▶ Use 'refix' if there is a risk of corrosion

**Deaeration, bleeding, water make-up** To achieve a permanently safe, automatic operation of the heating system, it is recommended to equip the pressure-maintaining devices with water make-up systems and to complete them with 'servitec' deaeration systems. Please refer to page 28 for detailed information.

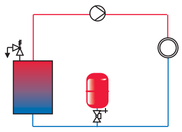
**Auxiliary vessels** If a temperature of 70°C is permanently exceeded in the pressure maintenance, an auxiliary vessel must be installed to protect the diaphragms in the expansion vessel. → page 39

**Single fuse protection** According to DIN 4751 T2, each heat generator must be connected with at least one expansion vessel. Only fuse-protected shut-offs are admissible. If a heat generator is shut-off hydraulically (e.g. sequential boiler switching), the connection to an expansion vessel must be ensured nevertheless. Therefore, in multi-boiler systems typically each boiler is protected with a separate expansion vessel. This is only calculated for the corresponding boiler water content.

Due to the good deaeration performance of the 'variomat', it is recommended to install a diaphragm expansion vessel (e.g. 'reflex N') at the heat generator also in single-boiler systems to minimize the number of switching actuations.

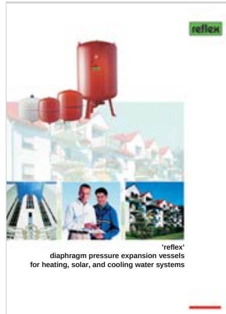


## 'reflex N, F, A, E, G' in heating systems



**Connection:** admission pressure maintenance, MAG in the return, circulating pump in the flow pipe, in case of follow-up pressure maintenance observe notes on page 9

**Object:**




### Initial data

| Heat generator | 1 | 2 | 3 | 4 | |
|---|---|---|---|---|---|
| Heating capacity $\dot{Q}_W$ : | .......... kW | ........... kW | .......... kW | .......... kW | **$\dot{Q}_{tot}$ = .......... kW** |
| Water content $V_W$ : | .......... litres | .......... litres | .......... litres | .......... litres | |

Design flow temperature $t_V$ : .......... °C
Design return temperature $t_R$ : .......... °C → p. 6 Water content by approximation $V_A = f(t_V, t_R, \dot{Q})$ — **$V_A$ = .......... litres**
Water content known $V_A$ : .......... litres — percentage expansion with $t_R$ — **$n_R$ = .......... %**

▶ at $t_R$ > 70°C 'V auxiliary vessel' to be provided

highest target value setting
Temperature controller $t_{TR}$ : .......... °C → p. 6 percentage expansion n
antifreeze addition : .......... % (with antifreeze agents n*) — **n = .......... %**

Safety temperature limiter $t_{STB}$: ........... °C → p. 6 Evaporation pressure $p_D$ at > 100°C (with antifreeze agents $p_D$*) — **$p_D$ = .......... bar**

static pressure $p_{st}$ : .......... bar — **$p_{st}$ = .......... bar**

### Pressure calculation

**Pre-pressure** $p_0$ = static pressure $p_{st}$ + evaporation pressure $p_D$ + (0.2 bar)[1)]
$p_0$ = ............................. +................................... + (0.2 bar)[1)] = .......... bar — **$p_0$ = .......... bar**
Reflex recommendation $p_0 \geq$ 1.0 bar

[1)] Recommended

▶ Check the required admission pressure of the circulating pump according to the manufacturer's specifications

**safety valve response pressure** $p_{SV}$ → Reflex recommendation
$p_{SV} \geq$ Pre-pressure $p_0$ + 1,5 bar for $p_{SV} \leq$ 5 bar
$p_{SV} \geq$ Pre-pressure $p_0$ + 2,0 bar for $p_{SV}$ > 5 bar
$p_{SV} \geq$ .............................. + .................................................... = ........... bar — **$p_{SV}$ = .......... bar**

▶ Check whether the admissible operating pressure is complied with

**End pressure** $p_e \leq$ Safety valve $p_{SV}$ – Blow-down pressure difference according to TRD 721
$p_e \leq p_{SV}$ – 0.5 bar for $p_{SV} \leq$ 5 bar
$p_e \leq p_{SV}$ – 0.1 x $p_{SV}$ for $p_{SV}$ > 5 bar
$p_e \leq$ ..............................– .................................................... = ........... bar — **$p_e$ = .......... bar**

### Vessel

**Expansion volume** $V_e = x\, V_A \frac{n}{100}$ = .......................... x ...................... = ........... litres — **$V_e$ = .......... litres**

**Hydraulic back pressure** $V_V$ = 0,005 x $V_A$ for $V_n$ > 15 litres with $V_V \geq$ 3 litres
$V_V \geq$ 0.2 x $V_n$ for $V_n \leq$ 15 litres
$V_V \geq$ ......... x ............. =......................... x ...................... = ........... litres — **$V_V$ = .......... litres**

**Nominal volume**
without 'servitec' $V_n = (V_e + V_V) \times \frac{p_e + 1}{p_e - p_0}$

with 'servitec' $V_n = (V_e + V_V + 5\ \text{litres}) \times \frac{p_e + 1}{p_e - p_0}$

$V_n$ = .......................... x .................................................... = ........... litres
selected $V_n$ 'reflex' = ........... litres — **$V_n$ = .......... litres**

**Initial pressure control**
without 'servitec' $p_a = \dfrac{p_e + 1}{1 + \dfrac{V_e (p_e + 1)(n + n_R)}{V_n (p_0 + 1)\, 2n}} - 1\ \text{bar}$

with 'servitec' $p_a = \dfrac{p_e + 1}{1 + \dfrac{(V_e + 5\ \text{litres})(p_e + 1)}{(n + n_R)\ V_n (p_0 + 1)\, 2n}} - 1\ \text{bar}$

$p_a = \dfrac{\text{........................................}}{1 + \dfrac{\text{...................................}}{\text{...................................}}} - 1\ \text{bar}$ = ........... bar — **$p_a$ = .......... bar**

▶ Filling pressure = initial pressure at a filling temperature of 10°C

Condition: $p_a \geq p_0$ + 0.25...0.3 bar, otherwise calculation for larger nominal volume

### Result summary

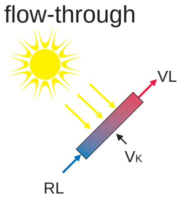
| | | | | |
|---|---|---|---|---|
| 'reflex' ..... / ..... bar | ........... litres | Admission pressure | $p_0$ ............. bar | → check before initial operation |
| 'refix' ..... / ..... bar | ........... litres | Initial pressure | $p_a$ ............. bar | → water make-up setting |
| 'refix' only in case of oxygen-rich water (e.g. floor heating) | | Final pressure | $p_e$ ............. bar | |

## Solar heating systems

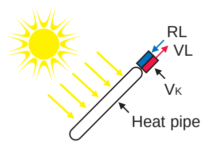
**Calculation** following DIN 4807 T2 and DIN 4757 T1 (solar heating systems)

Solar heating systems provide the special characteristic that the highest temperature cannot be defined through the controller at the heat generator, but is determined by the standstill temperature of the collector. This results in two possible calculation methods.

**direct** heating-up in a flat collector or a tube collector with direct flow-through




**indirect** heating-up in a tube collector according to the heat pipe principle




▶ Please observe the manufacturer's specification regarding the standstill temperatures!



**Nominal volume** **Calculation without evaporation in the collector**

The percentage expansion n* and the evaporation pressure $p_D$* are referred to the standstill temperature. As up to more than 200°C can be achieved by certain collectors, this calculation method has to be ruled out in this case. In case of indirectly heated tube collectors (system heat pipe), systems with a limitation of the standstill temperature are known. If a minimum operating pressure of $p_0 \leq 4$ bar is sufficient to avoid an evaporation, the calculation can in most cases be performed without the evaporation.

With respect to this variant it must be considered that an increased temperature load permanently reduces the antifreeze effect of the heat transfer medium.

Nominal volume without evaporation

$$V_n = (V_e + V_V)\,\frac{p_e + 1}{p_e - p_0}$$

▶ I solar systems, in particular in case of a calculation with evaporation, we recommend the installation of auxiliary vessels.
→ page 39

**Nominal volume** **Calculation with evaporation in the collector**

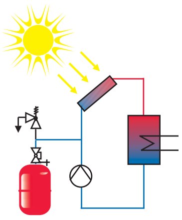
For collectors with a standstill temperature of up to more than 200°C, an evaporation in the collector cannot be excluded. In this case, the evaporation pressure is only considered up to the desired evaporation point (110-120°C). To make up, the entire collector volume $V_K$ is considered for the determination of the nominal volume of the MAG in addition to the expansion volume $V_e$ and the hydraulic back pressure $V_V$.

This variant is to be preferred as it leads to a reduced load of the heat transfer medium due to the lower temperature, and the antifreeze effect is maintained for a longer period of time.

Nominal volume with evaporation

$$V_n = (V_e + V_V + V_K)\,\frac{p_e + 1}{p_e - p_0}$$

**Connection** As the expansion vessel with safety valve in the return must be positioned without a shut-off possibility towards the collector, a follow-up pressure maintenance is forced, i.e. the integration of the expansion vessel on the pressure side of the circulating pump.



'reflex S'

**Physical characteristics $n^*$, $p_D^*$** Antifreeze additions of up to 40% must be considered with respect to the determination of the percentage expansion $n^*$ and the evaporation pressure $p_D^*$ according to the manufacturer's specification.
→ P. 6, physical characteristics for water compounds with Antifrogen N

If an evaporation is expected, the evaporation pressure $p_D^*$ is alternatively considered up to the boiling temperature 110°C or 120°C. Then, the percentage expansion $n^*$ is determined between the lowest outside temperature (e.g. -20°C) and the boiling temperature.

**with evaporation**
$p_D^* = 0$
$n^* = f$ (boiling temp.)

If the calculation is performed without evaporation, the evaporation pressure $p_D^*$ and the percentage expansion $n^*$ are to be referred to the standstill temperature of the collector.

**without evaporation**
$p_D^* = f$ (standstill temp.)
$n^* = f$ (standstill temp.)

**Admission pressure $p_0$**
Minimum operating pressure

Depending on the calculation procedure, the minimum operating pressure (= admission pressure) is adjusted to the standstill temperature in the collector (= without evaporation) or the boiling temperature (= with evaporation). In both cases, the circulating pump pressure $\Delta p_P$ is to be considered for the above mentioned typical connection as the expansion vessel is integrated on the pressure side of the circulating pump (follow-up pressure maintenance).

**without evaporation**
$p_0 = p_{st} + p_D^*(\text{standstill}) + \Delta p_P$

**with evaporation**
$p_0 = p_{st} + p_D^*(\text{boiling}) + \Delta p_P$

▶ record the set admission pressure on the typeplate

**Filling pressure $p_F$**
**Initial pressure $p_a$**

As a rule, the filling temperature (10°C) is substantially higher than the lowest system temperature, i.e. the filling pressure is higher than the initial pressure.

**Pressure maintenance** In general, in form of a static pressure maintenance with 'reflex S', also in combination with 'magcontrol' water make-up stations.

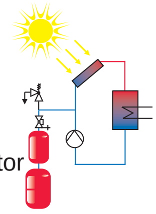
**Auxiliary vessels** If a stable return temperature ≤ 70°C cannot be ensured on the consumer side, an auxiliary vessel is to be installed at the expansion vessel. → p. 39

### 'reflex S' in solar systems with evaporation

**Calculation method** : The minimum operating pressure $p_0$ is calculated such that no evaporation occurs up to flow temperatures of 110°C or 120°C, i.e. an **evaporation in the collector is admissible at stands till temperatures**.

**Connection** : follow-up pressure maintenance, MAG in the return to the collector

**Object** :




#### Initial data

| | | | | |
|---|---|---|---|---|
| Number of collectors | z : .......... units | | | |
| Collector surface | $A_K$ : .......... m² | $A_{Ktot}$ = z x $A_K$ | $A_{Ktot}$ = ............ m² | **$A_{Ktot}$ = ......... kW** |
| Water content per collector | $V_K$ : .......... litres | $V_{Ktot}$ = z x $V_K$ | $V_{Ktot}$ = ............ litres | **$V_{Ktot}$ = ......... litres** |
| highest flow temperature | $t_V$ : 110°C or 120°C | → p. 6 percentage expansion n* | | **n* = ......... %** |
| lowest outside temperature | $t_A$ : -20°C | and evaporation pressure $p_D$* | | **$p_D$* = ......... bar** |
| Antifreeze addition | : .......... % | | | |
| static pressure | $p_{st}$ : .......... bar | | | **$p_{st}$ = ......... bar** |
| Difference pressure at the circulating pump | $\Delta p_P$ : .......... bar | | | **$\Delta p_P$ = ......... bar** |

▶ We recommend the installation of a 'V auxiliary vessel' (→ p. 39).

▶ Check the compliance of the minimum flow pressure $p_Z$ for the circulating pumps according to the manufacturer's specifications $p_Z = p_0 - \Delta p_P$

▶ Check whether the admissible operating pressure is complied with

#### Pressure calculation

**Pre-pressure** $p_0$ = static pressure $p_{st}$ + pump pressure $\Delta p_P$ + evaporation pressure $p_D$*
$p_0$ = .............................. + ............................ + ....................................
= ............ bar — **$p_0$ = ......... bar**

**safety valve response pressure** $p_{SV}$ → Reflex recommendation
$p_{SV}$ ≥ Pre-pressure $p_0$ + 1,5 bar for $p_{SV}$ ≤ 5 bar
$p_{SV}$ ≥ Pre-pressure $p_0$ + 2,0 bar for $p_{SV}$ > 5 bar
$p_{SV}$ ≥ .............................. + .................................................... = ............ bar — **$p_{SV}$ = ......... bar**

**End pressure** $p_e$ ≤ Safety valve $p_{SV}$ – Blow-down pressure difference according to TRD 721
$p_e$ ≤ $p_{SV}$ – 0.5 bar for $p_{SV}$ ≤ 5 bar
$p_e$ ≤ $p_{SV}$ – 0.1 x $p_{SV}$ for $p_{SV}$ > 5 bar
$p_e$ ≤ .............................. – .................................................... = ........... bar — **$p_e$ = ......... bar**



#### Vessel

**System volume** $V_A$ = collector vol. $V_{Ktot}$ + tubes + buffer storage + other
$V_A$ = ............................ + ..................... + ...................... + ...............
= ........... litres — **$V_A$ = ......... litres**

**Expansion volume** $V_e = \frac{n^*}{100} \times V_A$ = ...................... + ...................... = ........... litres — **$V_e$ = ......... litres**

**Hydraulic back pressure** $V_V$ = 0,005 x $V_A$ for $V_n$ > 15 litres with $V_V$ ≥ 3 litres
$V_V$ ≥ 0.2 x $V_n$ for $V_n$ ≤ 15 litres
$V_V$ ≥ ......... x ............. = ..................... x ...................... = ........... litres — **$V_V$ = ......... litres**

**Nominal volume** $V_n = (V_e + V_V + V_{Ktot}) \times \frac{p_e + 1}{p_e - p_0}$
$V_n$ = ............................ x .................................................. = ........... litres — **$V_n$ = ......... litres**
selected $V_n$ 'reflex S' = ........... litres

**Control initial pressure** $p_a = \frac{p_e + 1}{1 + \frac{(V_e + V_{Ktot})(p_e + 1)}{V_n (p_0 + 1)}} - 1$ bar

$p_a = \frac{..............................}{1 + \frac{..........................}{..........................}} - 1$ bar = ........... bar — **$p_a$ = ......... bar**

Condition: $p_a \geq p_0$ + 0.25...0.3 bar, otherwise calculation for larger nominal volume

**percentage expansion** between lowest temperature (-20°C) and filling temperature (in most cases 10°C) → p. 6 $n^*_F$ = ........... % — **$n^*_F$ = ......... %**

**Filling pressure** $p_F = V_n \times \frac{p_0 + 1}{V_n - V_A \times n_F^* - V_V} - 1$
$p_F$ = ............................ x ........................................... – 1 = ........... litres — **$p_F$ = ......... bar**

#### Result summary

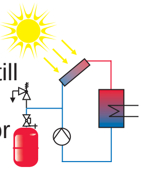
| | | | | |
|---|---|---|---|---|
| 'reflex S' / 10 bar | ........... litres | Admission pressure | $p_0$ ............ bar | → check before commissioning |
| | | initial pressure | $p_a$ ............ bar | → water make-up setting |
| | | filling pressure | $p_F$ ............ bar | → refilling of the system |
| | | final pressure | $p_e$ ............ bar | |

## 'reflex S' in solar systems without evaporation

**Calculation method** : The minimum operating pressure $p_0$ is chosen such that **no evaporation** occurs in the collector, in general possible at standstill temperatures ≤ 150°C.

**Connection** : follow-up pressure maintenance, MAG in the return to the collector

**Object** :




### Initial data

Number of collectors z : .......... units

Collector surface $A_K$ : .......... m² | $A_{Ktot}$ = z x $A_K$ | $A_{Ktot}$ = ............ m² | $A_{Ktot}$ = ......... kW

Water content per collector $V_K$ : .......... litres | $V_{Ktot}$ = z x $V_K$ | $V_{Ktot}$ = ............ litres | $V_{Ktot}$ = ......... litres

highest flow temperature $t_V$ :

lowest outside temperature $t_A$ : -20°C

Antifreeze addition : .......... %

→ p. 6 percentage expansion n* and evaporation pressure $p_D$* | n* = ......... % | $p_D$* = ......... bar

static pressure $p_{st}$ : .......... bar | $p_{st}$ = ......... bar

Difference pressure at the circulating pump $\Delta p_P$ : .......... bar | $\Delta p_P$ = ......... bar

▸ Check the compliance of the minimum flow pressure $p_Z$ for the circulating pumps according to the manufacturer's specifica-

### Pressure calculation

**Pre-pressure** $p_0$ = static pressure $p_{st}$ + evaporation pressure $p_D$* + pump pressure $\Delta p$ P

$p_0$ = ............................. + .................................... + ..........................

= ............ bar | $p_0$ = ......... bar

**safety valve response pressure** $p_{SV}$ → Reflex recommendation

$p_{SV}$ ≥ Pre-pressure $p_0$ + 1,5 bar for $p_{SV}$ ≤ 5 bar

$p_{SV}$ ≥ Pre-pressure $p_0$ + 2,0 bar for $p_{SV}$ > 5 bar

$p_{SV}$ ≥ .............................. + .................................................... = ............ bar | $p_{SV}$ = ......... bar

▸ Check whether the admissible operating pressure is complied with

**End pressure** $p_e$ ≤ Safety valve $p_{SV}$ – Blow-down pressure difference according to TRD 721

$p_e$ ≤ $p_{SV}$ – 0.5 bar for $p_{SV}$ ≤ 5 bar

$p_e$ ≤ $p_{SV}$ – 0.1 x $p_{SV}$ for $p_{SV}$ > 5 bar

$p_e$ ≤ .............................. – .................................................... = ............ bar | $p_e$ = ......... bar

### Vessel

**System volume** $V_A$ = collector vol. $V_{Ktot}$ + tubes + buffer storage + other

$V_A$ = ............................. + ...................... + ....................... + ................

= ............litres | $V_A$ = ......... litres

**Expansion volume** $V_e = \frac{n^*}{100}$ x $V_A$ = ...................... + ....................... = ............litres | $V_e$ = ......... litres

**Hydraulic back pressure** $V_V$ = 0,005 x $V_A$ for $V_n$ > 15 litres with $V_V$ ≥ 3 litres

$V_V$ ≥ 0.2 x $V_n$ for $V_n$ ≤ 15 litres

$V_V$ ≥ ......... x ............. = ..................... x ....................... = ............ litres | $V_V$ = ......... litres

**Nominal volume** $V_n = (V_e + V_V) \times \frac{p_e + 1}{p_e - p_0}$

$V_n$ = ............................ x .................................................... = ............ litres | $V_n$ = ......... litres

selected $V_n$ 'reflex S' = ............ litres

**Control initial pressure**

$$p_a = \frac{p_e + 1}{1 + \frac{V_e\,(p_e + 1)}{V_n\,(p_0 + 1)}} - 1\text{ bar}$$

$$p_a = \frac{\ldots\ldots\ldots\ldots}{1 + \frac{\ldots\ldots\ldots}{\ldots\ldots\ldots}} - 1\text{ bar}$$

= ............ bar | $p_a$ = ......... bar

Condition: $p_a \geq p_0$ + 0.25...0.3 bar, otherwise calculation for larger nominal volume

**percentage expansion** between lowest temperature (-20°C) and filling temperature (in most cases 10°C)

→ p. 6 $n^*_F$ = ............ % | $n^*_F$ = ......... %

**Filling pressure**

$$p_F = V_n \times \frac{p_0 + 1}{V_n - V_A \times n_F^* - V_V} - 1$$

$p_F$ = ............................ x ........................................... – 1 = ............ litres | $p_F$ = ......... bar

### Result summary

| | | | |
|---|---|---|---|
| 'reflex S' / 10 bar | ........... litres | Admission pressure | $p_0$ ............ bar → check before commissioning |
| | | initial pressure | $p_a$ ............ bar → water make-up setting |
| | | filling pressure | $p_F$ ............ bar → refilling of the system |
| | | final pressure | $p_e$ ............ bar |



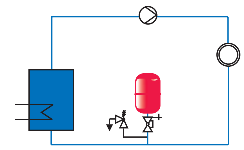
reflex

# Pressure-maintaining systems

## heating and cooling circuits

### Cooling water systems

**Calculation** according to DIN 4807 T2


'reflex'

**Connection** as admission pressure maintenance according to the diagram opposite with expansion vessel on the suction side of the circulating pump or also as follow-up pressure maintenance.

**Physical characteristics n*** Antifreeze additions according to the lowest system temperature are to be considered during the determination of the percentage expansion n* according to the manufacturer's specifications.
for Antifrogen N → p. 6

**Expansion volume $V_e$** Determination of the percentage expansion n* typically between the lowest system temperature (e.g. standstill during the winter -20°C) and the highest system temperature (e.g. standstill during the summer +40°C).

**Minimum operating pressure $p_0$** As no temperatures > 100°C are used, special increase factors are unnecessary.

▸ record the set admission pressure on the typeplate

**Filling pressure $p_F$**
**Initial pressure $p_a$** Often, the lowest system temperature is below the filling temperature, i.e. the filling pressure is above the initial pressure.



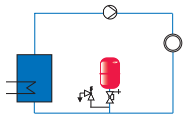
**Pressure maintenance** In general, in form of a static pressure maintenance with 'reflex', also in combination with 'control' and 'servitec magcontrol' water make-up and deaeration stations.

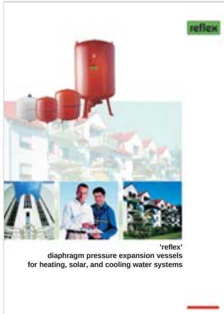
**Deaeration, bleeding, water make-up** To achieve a permanently safe, automatic operation in cooling water systems, it is recommended to equip the pressure-maintaining devices with water make-up systems and to complete them with 'servitec' deaeration systems. This is of particular importance with respect to cooling water systems, as you must completely do without thermal bleeding effects.
Please refer to page 28 for detailed information.

**Auxiliary vessels** The 'reflex' diaphragms are suited up to approximately -20°C and the vessels up to -10°C, it can, however, not be excluded that the diaphragms freeze solid on the container. Thus, we recommend the installation of a 'V auxiliaryvessel' into the return pipe to the refrigerating machine at temperatures ≤ 0°C. → page 39

**Single fuse protection** Analogously to heating systems, we recommend a single fuse protection for multiple refrigerating machines.
→ heating system, , p. 10

## 'reflex N, F, S, A, E, G' in cooling water systems






**Connection:** admission pressure maintenance, MAG on the circulation pump, in case of follow-up pressure maintenance observe notes on page 9

**Object:**

### Initial data

| | | | |
|---|---|---|---|
| Return temperature to the refrigerating machine | $t_R$ | : ............°C | |
| Flow temperature from the refrigerating machine | $t_V$ | : ............°C | |
| lowest system temperature | $t_{Smin}$ | : ............°C (e.g. standstill during the winter) | |
| highest system temperature | $t_{Smax}$ | : ............°C (e.g. standstill during the summer) | |
| Antifreeze addition | | : ............% | |
| percentage expansion n* → p. 6 | | n* = n* at the highest temp. ($t_{Smax}$ o. $t_R$) - n* at the lowest temp. ($t_{Smin}$ o. $t_V$)<br>n* = ................................. - ................................. = ............ °C | **n* = .......... %** |
| percentage expansion between the lowest temperature and the filling temperature | | = ............ °C | **$n_F$* = .......... %** |
| static pressure | $p_{st}$ | : ............ bar | **$p_{st}$ = .......... bar** |

▶ at $t_R \leq 0$°C 'V auxiliary vessel to be provided

### Pressure calculation

**Pre-pressure** $p_0$ = static pressure $p_{st}$ + (0.2 bar)[1]
$p_0$ = ............................. + (0.2 bar)[1] = ............ bar — **$p_0$ = .......... bar**

**safety valve response pressure**
$p_{SV}$ → Reflex recommendation
$p_{SV} \geq$ Pre-pressure $p_0$ + 1,5 bar for $p_{SV} \leq 5$ bar
$p_{SV} \geq$ Pre-pressure $p_0$ + 2,0 bar for $p_{SV} > 5$ bar
$p_{SV} \geq$ ............................... + ...................................................... = ............ bar — **$p_{SV}$ = .......... bar**

**End pressure**
$p_e \leq$ Safety valve $p_{SV}$ – Blow-down pressure difference according to TRD 721
$p_e \leq p_{SV}$ – 0.5 bar for $p_{SV} \leq 5$ bar
$p_e \leq p_{SV}$ – 0,1$p_{SV}$ for $p_{SV} > 5$ bar
$p_e \leq$ ............................... – ...................................................... = ............ bar — **$p_e$ = .......... bar**

[1] Recommended

▶ Check the required admission pressure of the circulating pump according to the manufacturer's specifications

▶ Check whether the admissible operating pressure is complied with

### Vessel

**system volume** $V_A$

| | | |
|---|---|---|
| refrigerating machines | : .................................... | litres |
| cooling register | : .................................... | litres |
| buffer storage | : .................................... | litres |
| tubes | : .................................... | litres |
| other | : .................................... | litres |
| System volume $V_A$ | : .................................... | litres |

**$V_A$ = .......... litres**

**Expansion volume** $V_e = \frac{n^*}{100} \times V_A$ =.......................... x ...................... = ............ litres — **$V_e$ = .......... litres**

**Hydraulic back pressure**
$V_V = 0{,}005 \times V_A$ for $V_n > 15$ litres with $V_V \geq 3$ litres
$V_V \geq 0.2 \times V_n$ for $V_n \leq 15$ litres
$V_V \geq$ .......... x .............. =.......................... x ...................... = ............ litres — **$V_V$ = .......... litres**

**Nominal volume**
without 'servitec' $V_n = (V_e + V_V) \times \frac{p_e + 1}{p_e - p_0}$
with 'servitec' $V_n = (V_e + V_V + 5 \text{ litres}) \times \frac{p_e + 1}{p_e - p_0}$
$V_n$ = .......................... x .................................................... = ............ litres
selected $V_n$ 'reflex' = ............ litres — **$V_n$ = .......... litres**

**Initial pressure control**
without 'servitec' $p_a = \frac{p_e + 1}{1 + \frac{V_e (p_e + 1)}{V_n (p_0 + 1)}} - 1 \text{ bar}$
with 'servitec' $p_a = \frac{p_e + 1}{1 + \frac{(V_e + 5 \text{ litres})}{(p_e + 1)\, V_n (p_0 + 1)}} - 1 \text{ bar}$
$p_a = \frac{\text{..................................}}{1 + \frac{\text{.............................}}{\text{.............................}}} - 1 \text{ bar}$ = ............ bar — **$p_a$ = .......... bar**

Condition: $p_a \geq p_0$ + 0.25...0.3 bar, otherwise calculation for larger nominal volume

**Filling pressure** $p_F = V_n \times \frac{p_0 + 1}{V_n - V_A \times n_F^* - V_V} - 1 \text{ bar}$
$p_F$ = ............................ x ...................................... – 1 bar = ............ litres — **$p_F$ = .......... bar**

### Result summary

'reflex' ..... / ..... bar ........... litres

| | | |
|---|---|---|
| Admission pressure | $p_0$ ............ bar | → check before commissioning |
| initial pressure | $p_a$ ............ bar | → water make-up setting |
| filling pressure | $p_F$ ............ bar | → refilling of the system |
| final pressure | $p_e$ ............ bar | |

## Reflex pressure-maintaining systems with external pressure generation
## Types: ’variomat’, ’gigamat’, ’reflexomat’

**Application** In general, the aspects valid for Reflex diaphragm pressure expansion vessels apply to the selection and calculation.


→ Heating systems Page 10
→ Solar systems Page 12
→ Cooling water systems Page 16


The systems are, however, usually only operated in a higher performance range. → page 8


**Nominal volume $V_n$** Pressure-maintaining systems with an external pressure generation distiguish themselves by the fact that the pressure is controlled independently of the water level in the expansion vessel by means of a control unit. Thus, it is possible to utilize almost the complete nominal volume $V_n$ for the water absorption ($V_e + V_V$). This is a substantial advantage compared with the pressure maintenance with diaphragm pressure expansion vessels.

$V_n = 1.1\ (V_e + V_V)$

Suction pressure maintenance

$p_0 \geq p_{st} + p_D + 0.2$ bar

Final pressure maintenance

$p_0 \geq p_{st} + p_D + \Delta p_P$

**Pressure monitoring Minimum operating pressure $p_0$** To ensure a sufficient pressure at the high points, an increased factor of safety of 0.2 bar is recommended for the calculation of the minimum operating pressure. You should only do without this factor in exceptional cases as the risk of a gas exhalation at the high points increases otherwise.



**Initial pressure $p_a$** It limits the lower target value range of the pressure maintenance. If the initial pressure is fallen short of, the pressure-maintaining pump or the compressor are turned on and turned off with a hysteresis of 0.2 ... 0.1 bar. The Reflex formula for the initial pressure ensures the required safety of at least 0.5 bar above the saturation pressure at the high point of a system.

$p_a \geq p_0 + 0.3$ bar

**Final pressure $p_e$** It limits the upper target value range of the pressure maintenance. It must be set such that the pressure at the system safety valve is lower at least by the blow-down pressure difference $A_{SV}$ according to TRD 721. If the final pressure is exceeded, the overflow device must open at the latest.

$p_e \geq p_a + A_D$

Condition: $p_e \leq p_{SV} - A_{SV}$

Blow-down pressure difference according to TRD 721 $A_{SV}$

| | |
|---|---|
| SV-H | 0,5 bar |
| SV-D/G/H | 0.1 $p_{SV}$<br>0.3 bar for<br>$p_{SV}$ < 3 bar |

**Operating range $A_D$ of the pressure maintenance.** It depends on the type and is limited by the initial and final pressures The values opposite are to be respected at least.

| | $A_D = p_e - p_a$ |
|---|---|
| ’variomat’ | ≥ 0.4 bar |
| ’gigamat’ | ≥ 0.4 bar |
| ’reflexomat’ | ≥ 0.2 bar |

**Deaeration Bleeding** Especially closed systems must be deaerated purposefully, in particular nitrogen concentrations will otherwise result in unpleasant operation failures and in the dissatisfaction of the customers. reflex ‘variomat’ are equipped with a built-in water make-up and deaeration. It is recommended to complete reflex ‘gigamat’ and reflex ‘reflexomat’ pressure-maintaining systems by reflex ‘servitec levelcontrol’ water make-up and deaeration stations.

Partial flow deaerations are only operative if they are integrated into the representative main flow of the system.

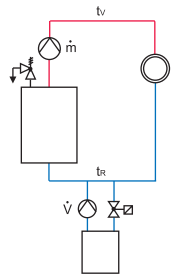
→ p. 28

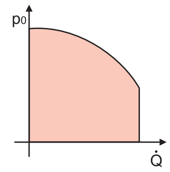
**Compensating volume flow $\dot{V}$**

According to DIN 4751 T2, the pressure-maintaining systems of heating systems are to be dimensioned for 0.85 litres/(hkW), referred to the nominal heating capacity. This compensating volume flow would be given with a homogenous boiler temperature of 140°C. Upon a corresponding proof, variations of the values are admissible.

Cooling circuits are typically operated in a temperature range < 30°C. Compared to heating systems, the compensating volume flow is approximately divided in half. Thus, only half of the nominal heating capacity $\dot{Q}$ must be considered with respect to the selection with the diagram for heating systems.

To make the selection easier for you, we have prepared diagrams which you can use to determine the achievable minimum operating pressure $p_0$ directly in dependence of the nominal heating capacity $\dot{Q}$.




**Redundancy due to partial load behaviour**

To improve the partial load behaviour, in particular with respect to pump-controlled systems, it is recommended to use double-pump systems at least from a heating capacity of 2 MW. A redundancy is often required by the operator in areas with especially high requirements regarding the operational safety. It is useful to halve the performance per pump unit. A full redundancy is, in general, not required if you consider that less than 10% of the pump and overflow capacity are needed during the normal operation.

‘variomat 2-2’ and ‘gigamat’ systems distinguish themselves by the fact that they are not only equipped with two pumps, but also with two type-checked overflow valves. The change-over is performed in dependence of the load and in case of failures.

▶ Reflex recommendation: from 2 MW double-pump systems with a dimensioning of 50% + 50% = 100% → ‘variomat 2-2’



‘variomat’ ≤ 8 MW
pump-controlled

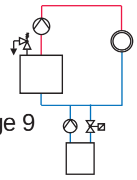
‘gigamat’ ≤ 60 MW
pump-controlled

‘reflexomat’ ≤ 24 MW
compressor-controlled

# Pressure-maintaining systems

## heating and cooling circuits

### reflex ‘variomat’ in heating and cooling systems




**Connection:** admission pressure maintenance, ‘variomat’ in the return, circulating pump in the flow pipe, in case of follow-up pressure maintenance observe notes on page 9

**Object:**

## Initial data

Heat generator — 1 — 2 — 3 — 4

Heating capacity $\dot{Q}_W$ : .......... kW .......... kW .......... kW .......... kW — $\dot{Q}_{tot}$ = .......... kW

Water content $V_W$ : .......... litres .......... litres .......... litres .......... litres

Design flow temperature $t_V$ : .......... °C
Design return temperature $t_R$ : .......... °C — → p. 6 Water content by approximation $v_A = f(t_V, t_R, \dot{Q})$ — $V_A$ = .......... litres
Water content known $V_A$ : .......... litres

▶ at $t_R$ > 70°C ‘V auxiliary vessel’ to be provided

highest target value setting
Temperature controller $t_{TR}$ : .......... °C — → p. 6 percentage expansion n (with antifreeze agents n*) — n = .......... %
antifreeze addition : .......... %

Safety temperature limiter $t_{STB}$ : .......... °C — → p. 6 Evaporation pressure $p_D$ at > 100°C (with antifreeze agents $p_D$*) — $p_D$ = .......... bar

▶ STB
‘variomat 1’ max. 100°C
‘variomat 2’ max. 120°C

static pressure $p_{st}$ : .......... bar — $p_{st}$ = .......... bar

## Pressure calculation

**Minimum operating pressure** $p_0$ = static pressure $p_{st}$ + Evaporation pressure $p_D$ + (0.2 bar)[1)]
$p_0$ = ............................ + ................................. + (0.2 bar)[1)] = ........... bar — $p_0$ = .......... bar
Condition $p_0$ ≥ 1.3 bar

[1)] the more $p_0$ exceeds $p_{st}$, the better the deaeration function; 0.2 bar are the required minimum

**Final pressure** $p_e$ ≥ Minimum operating pressure $p_0$ + 0,3 bar + Operating range ‘variomat’ $A_D$
$p_e$ ≥ ..................................... + 0,3 bar + 0,4 bar = ........... bar — $p_e$ = .......... bar

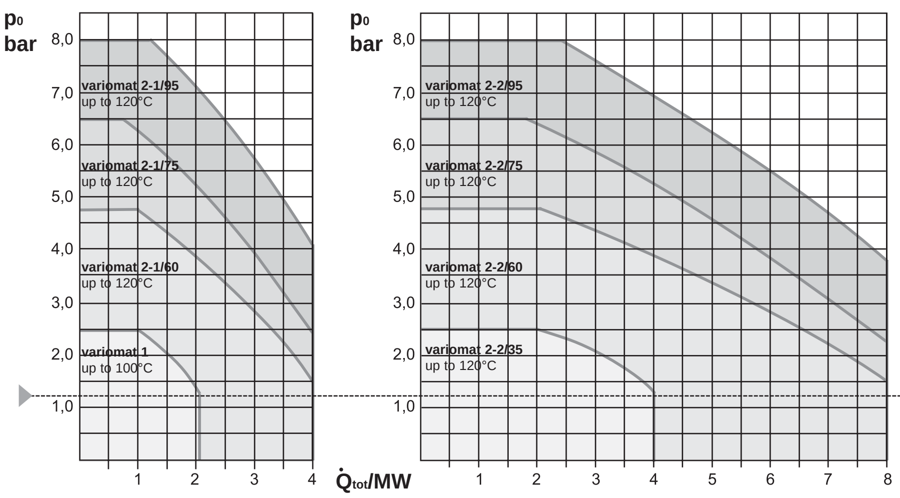
**Safety valve opening pressure**
$p_{SV}$ ≥ final pressure $p_e$ + blow-down pressure difference $A_{SV}$
$p_{SV}$ ≥ $p_e$ + 0,5 bar for $p_{SV}$ ≤ 5 bar
$p_{SV}$ ≥ $p_e$ + 0.1 x $p_{SV}$ for $p_{SV}$ > 5 bar
$p_{SV}$ ≥ ..................................... + ............................................ = ........... bar — $p_{SV}$ = .......... bar

▶ Check whether the admissible operating pressure is complied with

## Selection control unit



Diagram valid for **heating systems**
for **cooling systems** $t_{max}$ ≤ 30°C only 50% of $\dot{Q}_{tot}$ are to be considered




**Overall heating capacity of the heat-generating system**

‘variomat 2-2’ recommended for
▶ special requirements with respect to the supply
▶ safety Capacities ≥ 2 MW

$p_0$ = 1.3 bar min. setting for permanent deaeration

▶ automatic, load-dependent connection and failure change-over of pumps and overflow devices for ‘variomat 2-2’

| | variomat 1 | variomat 2-1 | variomat 2-2/35 | variomat 2-2/60 - 95 |
|---|---|---|---|---|
| $\dot{V}$ | 2 m³/h | 4 m³/h | 2 m³/h | 4 m³/h |

◀ Minimum volume flow $\dot{V}$ in the system circuit at the point of integration of the ‘variomat’

## Vessel

**Nominal volume** $V_n$ taking into account the hydraulic back pressure

$V_n = 1.1 \times V_A \frac{n + 0.5}{100}$ = 1.1 x .................. x ........................ = ........... litres — $V_n$ = .......... litres

▶ The nominal volume can be allocated to multiple vessels.

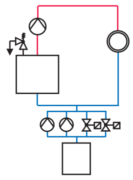
## Result summary

‘variomat’ .................. Type
VG primary vessel .................. litres
VF secondary vessel .................. litres
VW heat insulation .................. litres
(only for heating systems)

Minimum operating pressure $p_0$ .................. bar
Final pressure $p_e$ .................. bar

**Note:** Due to the good deaeration performance of ‘variomat’, the single fuse protection of the heat generator with ‘reflex’ diaphragm pressure expansion vessels is, in general, recommended.

## reflex 'gigamat' in heating and cooling systems




**Connection:** admission pressure maintenance, 'gigamat' in the return, circulating pump in the flow pipe, in case of follow-up pressure maintenance observe notes on page 9

**Object:**

### Initial data

| Heat generator | 1 | 2 | 3 | 4 | |
|---|---|---|---|---|---|
| Heating capacity $\dot{Q}_W$: | .......... kW | .......... kW | .......... kW | .......... kW | $\dot{Q}_{tot}$ = .......... kW |
| Water content $V_W$: | .......... litres | .......... litres | .......... litres | .......... litres | |

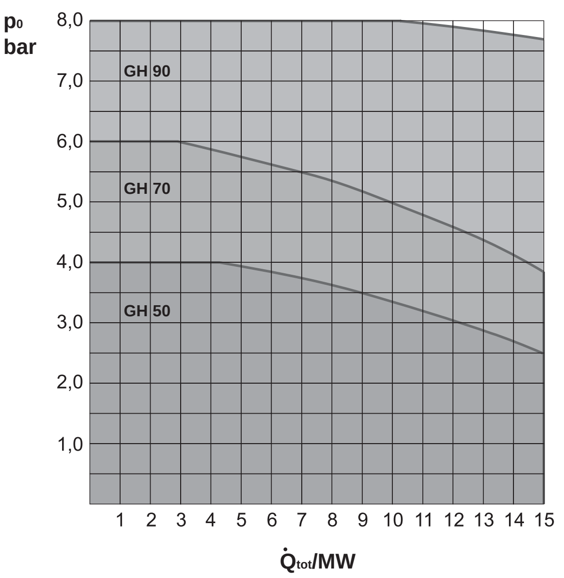
| | | | | | |
|---|---|---|---|---|---|
| Design flow temperature<br>Design return temperature<br>Water content known | $t_V$ : .......... °C<br>$t_R$ : .......... °C<br>$V_A$ : .......... litres | → p. 6 | Water content by approximation<br>$V_A = f(t_V, t_R, \dot{Q})$ | $V_A$ = .......... litres | ▶ at $t_R$ > 70°C 'V auxiliary vessel' to be provided |
| highest target value setting<br>Temperature controller<br>antifreeze addition | $t_{TR}$ : .......... °C<br>: .......... % | → p. 6 | percentage expansion n<br>(with antifreeze agents n*) | n = .......... % | |
| Safety temperature limiter | $t_{STB}$ : .......... °C | → p. 6 | Evaporation pressure $p_D$ at > 100°C<br>(with antifreeze agents $p_D$*) | $p_D$ = .......... bar | ▶ STB max. 120°C |
| static pressure | $p_{st}$ : .......... bar | | | $p_{st}$ = .......... bar | |

### Pressure calculation

| | | | |
|---|---|---|---|
| **Minimum operating pressure**<br>Condition | $p_0$ = static pressure $p_{st}$ + evaporation pressure $p_D$ + (0.2 bar)[1)]<br>$p_0$ = .......................... + ................................ + (0.2 bar)[1)] = ........... bar<br>$p_0 \geq$ 1.0 bar | $p_0$ = .......... bar | [1)] Recommended |
| **Final pressure** | $p_e \geq$ Minimum operating pressure $p_0$ + 0,3 bar + Operating range 'gigamat' $A_D$<br>$p_e \geq$ ....................................+ 0,3 bar + 0,4 bar = ........... bar | $p_e$ = .......... bar | |
| **Safety valve opening pressure** | $p_{SV} \geq$ final pressure $p_e$ + blow-down pressure difference $A_{SV}$<br>$p_{SV} \geq$ $p_e$ + 0,5 bar for $p_{SV} \leq$ 5 bar<br>$p_{SV} \geq$ $p_e$ + 0.1 x $p_{SV}$ for $p_{SV}$ > 5 bar<br>$p_{SV} \geq$ .............................. + ............................................ = ........... bar | $p_{SV}$ = .......... bar | ▶ Check whether the admissible operating pressure is complied with |

### Selection control unit

Diagram valid for **heating systems** **STB ≤ 120°C**
for **cooling systems** $t_{max}$ ≤ 30°C only 50% of $\dot{Q}_{tot}$ are to be considered




**Overall heating capacity of the heat-generating system**

Systems in performance ranges not illustrated upon request

++49 (0) 2382/7069-536



### Vessel

**Nominal volume** $V_n$ taking into account the hydraulic back pressure

$V_n = 1.1 \times V_A \frac{n + 0.5}{100}$ = 1.1 x .................. x ........................ = ........... litres

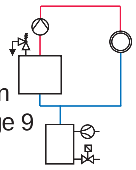
$V_n$ = .......... litres

▶ The nominal volume can be allocated to multiple vessels.

### Result summary

| | | | |
|---|---|---|---|
| GH hydraulic unit | .................. | Minimum operating pressure | $p_0$ .................. bar |
| GG primary vessel | .................. litres | Final pressure | $p_e$ .................. bar |
| GF secondary vessel | .................. litres | | |

### reflex 'reflexomat' in heating and cooling systems




**Connection:** admission pressure maintenance, 'reflexomat' in the return, circulating pump in the flow pipe, in case of follow-up pressure maintenance observe notes on page 9

**Object:**

### Initial data

| | | 1 | 2 | 3 | 4 | |
|---|---|---|---|---|---|---|
| Heat generator | | | | | | |
| Heating capacity | $\dot{Q}_W$ : | .......... kW | .......... kW | .......... kW | .......... kW | $\dot{Q}_{tot}$ = .......... kW |
| Water content | $V_W$ : | .......... litres | .......... litres | .......... litres | .......... litres | |

| | | | | |
|---|---|---|---|---|
| Design flow temperature | $t_V$ : .......... °C | → p. 6 | Water content by approximation $V_A = f(t_V, t_R, \dot{Q})$ | $V_A$ = .......... litres |
| Design return temperature | $t_R$ : .......... °C | | | |
| Water content known | $V_A$ : .......... litres | | | |
| highest target value setting Temperature controller | $t_{TR}$ : .......... °C | → p. 6 | percentage expansion n (with antifreeze agents n*) | n = .......... % |
| antifreeze addition | : .......... % | | | |
| Safety temperature limiter | $t_{STB}$ : .......... °C | → p. 6 | Evaporation pressure $p_D$ at > 100°C (with antifreeze agents $p_D$*) | $p_D$ = .......... bar |
| static pressure | $p_{st}$ : .......... bar | | | $p_{st}$ = .......... bar |

▶ at $t_R$ > 70°C 'V auxiliary vessel' to be provided

▶ STB max. 120°C

### Pressure calculation

**Minimum operating pressure** $p_0$ = static pressure $p_{st}$ + evaporation pressure $p_D$ + (0.2 bar)[1)]
$p_0$ = ............................ + ................................ + (0.2 bar)[1)] = ........... bar  $p_0$ = .......... bar
Recommendation $p_0 \geq$ 1.0 bar

**Final pressure** $p_e \geq$ Minimum operating pressure $p_0$ + 0,3 bar + Operating range 'reflexomat' $A_D$
$p_e \geq$ ..................................... + 0,3 bar + 0,2 bar = ........... bar  $p_e$ = .......... bar

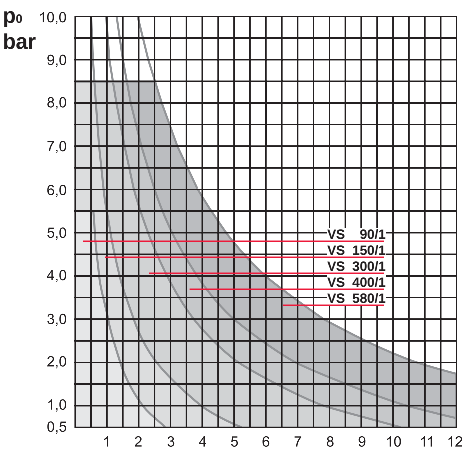
**Safety valve opening pressure** $p_{SV} \geq$ final pressure $p_e$ + blow-down pressure difference $A_{SV}$
$p_{SV} \geq p_e$ + 0,5 bar for $p_{SV} \leq$ 5 bar
$p_{SV} \geq p_e$ + 0.1 x $p_{SV}$ for $p_{SV}$ > 5 bar
$p_{SV} \geq$ ..................................... + ........................................... = ........... bar  $p_{SV}$ = .......... bar

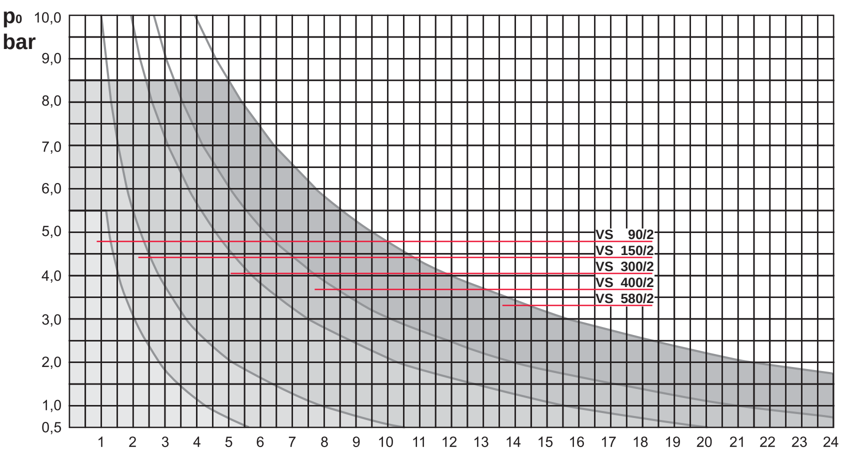
1) Recommended

▶ Check whether the admissible operating pressure is complied with

### Selection control unit

Diagram valid for **heating systems**
for **cooling systems** $t_{max} \leq$ 30°C only 50% of $\dot{Q}_{tot}$ are to be considered




$\dot{Q}_{tot}$/MW
**Overall heating capacity of the heat-generating system**

▶ automatic, load-dependent connection and failure change-over of compressors for VS .../2-control units

### Vessel

**Nominal volume** $V_n$ taking into account the hydraulic back pressure

$V_n = 1.1 \times V_A \frac{n + 0.5}{100}$ = 1.1 x .................. x ........................ = ........... litres  $V_n$ = .......... litres

▶ The nominal volume can be allocated to multiple vessels.

### Result summary

| | | | | |
|---|---|---|---|---|
| 'reflexomat' with control unit VS | ............/..... | Minimum operating pressure | $p_0$ | .................. bar |
| RG primary vessel | .................. litres | Final pressure | $p_e$ | .................. bar |
| RF secondary vessel | .................. litres | | | |

# District heating systems, large-scale and special systems

**Calculation** DIN 4807 T2 does, for example, not apply to district heating systems. Here, a co-ordination with the network operator and the expert with respect to systems for which an inspection is required is recommended.

Please do not hesitate to contact us!

**Connection** With respect to district heating systems, often connections deviating from the standard heating construction are preferred. Thus, systems with follow-up and medium pressure maintenance are used in addition to the classical admission pressure maintenance. This, in turn, influences the calculation.

**Physical characteristics n, $p_D$** typically physical characteristics for pure water without antifreeze additions

**Expansion volume $V_e$** Due to the system volumes which are often very large and the low daily and weekly temperature variations compared to heating systems, calculation approaches deviating from DIN 4870 T2 are used that often result in smaller expansion volumes. With respect to the determination of the expansion coefficients, for example, the temperatures in the network flow as well as those in the network return are considered. In the extreme case, the calculation is only based on the temperature variations between flow and return.

**Minimum operating pressure $p_0$** It is to be adjusted to the protection temperature of the heat generator and must be determined such that the admissible non-operative and working pressures are neither exceeded nor fallen short of at any point within the network and that no cavitation occurs at pumps and control fittings.

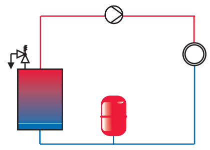
**Initial pressure $p_a$** With respect to pressure-maintaining stations the pressure-maintaining pump is connected if the initial pressure is fallen short of. In particular for networks with large circulating pumps, dynamic starting and stopping operations are to be considered. Then, the difference between $p_a$ and $p_0$ (= $DB_{min}$) should be at least 0.5 ... 1 bar.

**Pressure maintenance** In large networks almost exclusively as pressure maintenance with external pressure generation, such as 'variomat', 'gigamat', or 'reflexomat' . Above 120°C with special consideration of the provisions of the TRD 604 Bl. 2 regarding the unattended operation (BoB).

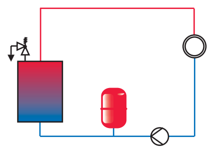
**Deaeration** It is recommended to equip heat generating systems that do not provide of a thermal deaeration system with a 'servitec' vacuum spray tube deaeration.

Special pressure maintenance
+49 (0) 2382/7069-536

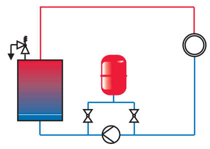
**Admission pressure maintenance**



**Follow-up pressure maintenance**



**Medium pressure maintenance**



'reflex'
'variomat'
'gigamat'
'reflexomat'
special stations

# Pressure-maintaining systems

## Drinking water systems

Drinking water belongs to the foodstuffs! Thus, expansion vessels in drinking water installations must meet the special requirements of the DIN 4807 T5. Only flowed through vessels are admissible.

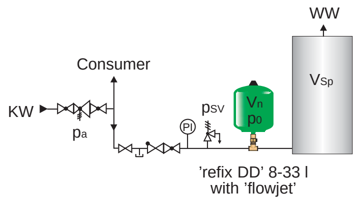
### Water heating systems

**Calculation** according to DIN 4807 T5 → see form on p. 25

**Connection** according to the diagram opposite.
In general, the safety valve is to be installed directly at the cold water inlet of the water heating device. With respect to 'refix DD' and 'DT5 junior', the safety valve can also be installed directly before the flow-through fitting in the flow direction if the following conditions are met:

'refix DD' with T-piece:
Rp ¾ max. 200 l water heating device
Rp 1 max. 1000 l water heating device
Rp 1¼ max. 5000 l water heating device

'refix DT5 junior' flow-through fitting Rp 1¼:
max. 5000 l water heating device




**Physical characteristics n, $p_D$** in general, determination between cold water temperature 10°C and max. warm water temperature 60°C.

**Admission pressure $p_0$**
Minimum operating pressure
The minimum operating pressure or admission pressure $p_0$ in the expansion vessel must be at least 0.2 below the minimum flow pressure. According to the distance between the pressure reducer and the 'refix', admission pressure settings of 0.2...1.0 bar below the set pressure of the pressure reducer are required.

▸ record the set admission pressure on the typeplate

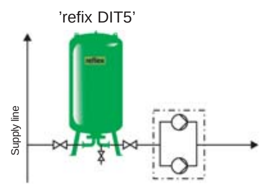


**Initial pressure $p_e$** It is identical with the set pressure of the pressure reducer.
Pressure reducers are prescribed according to DIN 4807 T5 to achieve a stable initial pressure and, thus, the full absorption capacity of the 'refix'.

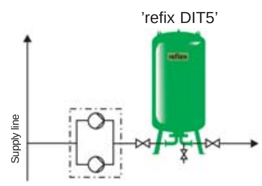
**Expansion vessel** In systems with drinking water utilization according to DIN 1988, only flowed through 'refix' vessels according to DIN 4807 T5 may be deployed. For non-drinking water applications, 'refix' with a connection are sufficient.

### Pressure-intensifying systems

**Calculation** according to DIN 1988 T5, Technical Rules for Drinking Water Installations, Pressure Intensification, and Pressure Reduction
→see form on p. 26

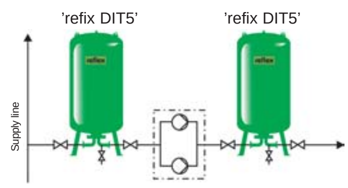



**Connection** **On the admission pressure side of a DEA**, 'refix' expansion vessels discharge the connection line and the supply network. The deployment must be coordinated with the water supply company.




**On the follow-up pressure side of a DEA,** the switching frequency is reduced by the installation of 'refix', in particular for cascade-controlled systems.

In some cases, the installation on **both sides** can be required for a DEA.




**Admission pressure $p_0$**
**Initial pressure $p_a$**
The minimum operating pressure or admission pressure $p_0$ in the 'refix' must be set to approximately 0.5...1 bar below the min. supply pressure in the event of an installation on the suction side and 0.5...1 bar below the working pressure for an installation on the pressure side of a DEA.

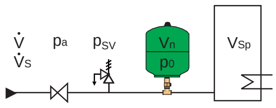
As the initial pressure $p_a$ is at least 0.5 bar higher than the admission pressure, a sufficient hydraulic back pressure is always present which is an important prerequisite for a low-wear operation.

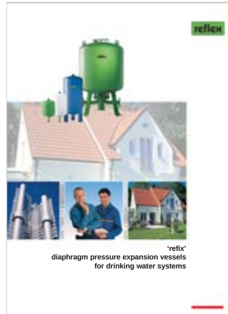
▸ record the set admission pressure on the typeplate

**Expansion vessel** In systems with drinking water utilization according to DIN 1988, only flowed through 'refix' vessels according to DIN 4807 T5 may be deployed. For non-drinking water applications, 'refix' with a connection are sufficient.

## ‘refix’ in water heating systems

**Object:**




### Initial data

| | | | | |
|---|---|---|---|---|
| Storage volume | $V_{Sp}$ | : .......... litres | | |
| Heating capacity | $\dot{Q}$ | : .......... kW | | |
| Water temperature in the storage | $t_{ww}$ | : .......... °C | according to the controller setting 50...60°C<br>→ p. 6 percentage expansion n | **n = .......... %** |
| Set pressure of the pressure reducer | $p_a$ | : .......... bar | | |
| Safety valve setting | $p_{SV}$ | : .......... bar | Reflex recommendation: $p_{SV}$ = 10 bar | |
| Peak flow | $\dot{V}_S$ | : .......... m³/h | | |

### Selection according to the nominal volume $V_n$

**admission pressure** $p_0$ = Set pressure of the pressure reducer $p_a$ – (0.2...1.0 bar)

$p_0$ = ................................................ – ................ = ............ bar

**$p_0$ = .......... bar**

▶ Set the admission pressure to 0.2...1 bar below pressure reducer (depending on the distance between the pressure reducer and ‘refix’)

**Nominal volume** $V_n = V_{Sp} \dfrac{n \times (p_{SV} + 0.5)(p_0 + 1.2)}{100 \times (p_0 + 1)(p_{SV} - p_0 - 0.7)}$

$V_n$ = .................................. x .................................. = ............ litres

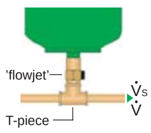
selected according to brochure = ............ litres

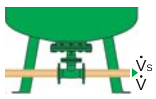
**$V_n$ = .......... litres**

### Selection according to the peak volume flow $\dot{V}_S$

If the nominal volume of the ‘refix’ has been selected, it must be checked for direct flow vessels whether the peak volume flow $\dot{V}_S$ resulting from the pipe system calculation according to DIN 1988 can be used for the ‘refix’.

In this case, a 60-litre ’refix DT5 junior’ for a higher flow is to be used for the ‘refix DD’ instead of a vessel with 8-33 litres. Alternatively, a ‘refix DD’ with a correspondingly larger T-piece can be used.




| | recommended max. peak volume flow $\dot{V}_S$* | actual pressure loss with volume flow $\dot{V}$ |
|---|---|---|
| **’refix DD’ 8 - 33 l**<br>with or without ’flowjet’<br>Passage Rp ¾ = standard | ≤ 2.5 m³/h | $\Delta p = 0{,}03\ \text{bar} \left(\dfrac{\dot{V}\ [m^3/h]}{2{,}5\ m^3/h}\right)^2$ |
| T-piece Rp 1 | ≤ 4,2 m³/h | negligible |
| Rp 1¼ | ≤ 7.2 m³/h | negligible |
| **’refix DT5 junior’ 60 - 500 l**<br>with ’flowjet’ Rp 1¼ | ≤ 7.2 m³/h | $\Delta p = 0.04\ \text{bar} \left(\dfrac{\dot{V}\ [m^3/h]}{7{,}2\ m^3/h}\right)^2$ |
| **’refix DT5 junior Duo’ 80 - 500 l**<br>litres with duo connection DN 50 | ≤ 15 m³/h | negligible |
| **’refix DIT5’ 80 - 1000 l**<br>duo connection DN 50 | ≤ 15 m³/h | $\Delta p = 0.14\ \text{bar} \left(\dfrac{\dot{V}\ [m^3/h]}{15\ m^3/h}\right)^2$ |
| **’refix DIT5’ 1000 - 3000 l**<br>duo connection DN 65 | ≤ 27 m³/h | $\Delta p = 0.11\ \text{bar} \left(\dfrac{\dot{V}\ [m^3/h]}{28\ m^3/h}\right)^2$ |
| **‘refix D, DE, DE junior’**<br>(no flow-through) | unlimited | Δp = 0 |

* determined for a speed of 2 m/s

**Δp = .......... bar**

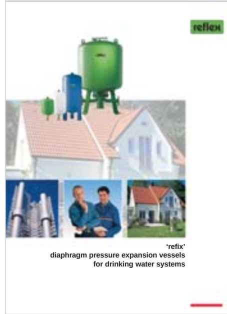
**G = ..........**



### Result summary

| | | | | | |
|---|---|---|---|---|---|
| ’refix DT5’ | ........... litres | | Nominal volume | $V_n$ | ............. litres |
| ‘refix DT5 junior’ | ........... litres | | Admission pressure | $p_0$ | ............. bar |
| ’refix DD’ | ........... litres, | G = .......... (standard Rp ¾ included) | | | |
| ‘refix DIT5’ | ........... litres | | | | |

### 'refix' in pressure-intensifying systems (DEA)

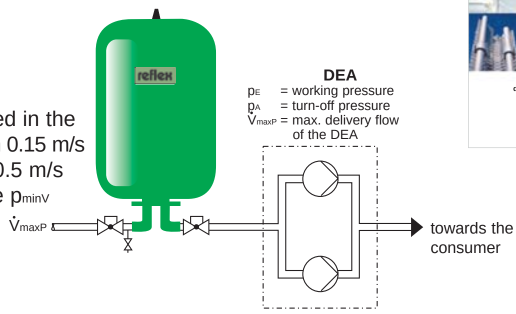



**Object:**

### Connection: 'refix' on the admission pressure side of the DEA

**Installation:** upon co-ordination with the competent water supply company (WVU)

**Necessity:** is given if the following criteria are not met
- in the case of a failure of the DEA pump, the flow speed in the connection line of the DEA must not change by more than 0.15 m/s
- in the case of a failure of all pumps not by more than 0.5 m/s
- during the pump runtime the minimum supply pressure $p_{minV}$ must not be fallen short of by more than 50% and must be at least 1 bar




**Initial data:**

min. supply pressure $p_{minV}$ = .......... bar
max. delivery flow $V_{maxP}$ = .......... m³/h

Selection according to DIN 1988 T5

| max. delivery flow $\dot{V}_{maxP}$ / m³/h | 'refix DT5 junior' with duo connection $V_n$ / litres | 'refix DIT5' $V_n$ / litre |
|---|---|---|
| ≤ 7 | 300 | 300 |
| > 7 ≤ 15 | 500 | 600 |
| > 15 | –- | 800 |

**$V_n$ = .......... litres**

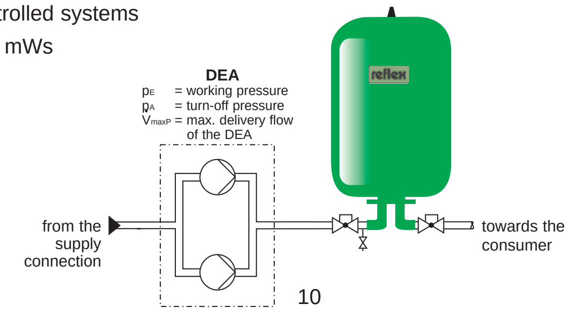
Admission pressure $p_0$ = min. supply pressure – 0.5 bar
$p_0$ = ..................................... – 0,5 bar = ........... bar

**$p_0$ = .......... bar**

### Connection: 'refix' on the follow-up pressure side of the DEA

- to limit the switching frequency of pressure-controlled systems

max. delivery head of the DEA $H_{max}$ = .......... mWs
max. supply pressure $p_{maxV}$ = .......... bar
working pressure $p_E$ = .......... bar
turn-off pressure $p_A$ = .......... bar
max. delivery flow $\dot{V}_{maxP}$ = .......... m³/h
switching frequency s = .......... 1/h
number of pumps n = ..........
electrical power $P_{el}$ = .......... kW
of the most powerful pump




10

| s - switching frequency | 1/h | 20 | 15 |
|---|---|---|---|
| Pump capacity | kW | ≤ 4,0 | ≤ 7,5 | ≤ 7,5 |

Nominal volume $V_n = 0.33 \times V_{maxP} \dfrac{p_A + 1}{(p_A - p_E) \times s \times n}$

$V_n$ = 0.33 x .......................... x .......................... = ........... litres

**$V_n$ = .......... litres**

- to store the minimum storage quantity $V_e$ between on and off of the DEA

Cut-in pressure $p_E$ = .......... bar
turn-off pressure $p_A$ = .......... bar
admission pressure 'refix' $p_0$ = .......... bar → Reflex-recommendation: $p_0 = p_E - 0.5$ bar
storage quantity $V_e$ = .......... m³

**$p_0$ = .......... bar**

Nominal volume $V_n = V_e \dfrac{(p_E + 1)(p_A + 1)}{(p_0 + 1)(p_A - p_E)}$

$V_n$ = ..................................... x .......................... = ........... litres

selected according to brochure = ........... litres

**$V_n$ = .......... litres**

Control of the adm. operating excess pressure

$p_{max} \leq 1.1\, p_{adm}$

$p_{max} = p_{maxV} + \dfrac{H_{max}\,[mWs]}{10}$ bar = ............................ = ........... bar

**$p_{max}$ = .......... bar**

### Result summary

'refix DT5 junior Duo' ........... litres 10 bar ☐
with duo connection DN 50 10 bar ☐
'refix DIT5' ........... litres 16 bar ☐

Nominal volume $V_n$ ............. litres
Useful volume $V_0$ ............. litres
Admission pressure $p_0$ ............. bar

# Water make-up and deaeration systems

Water make-up and deaeration systems can automate the system operation and make a substantial contribution to the operational safety.

As the water make-up and the deaeration are already integrated into 'variomat' pressure-maintaining stations, they have to be added to 'reflex' diaphragm pressure expansion vessels as well as to 'reflexomat' and 'gigamat' pressure-maintaining stations.

reflex 'control' water make-up stations always provide for a sufficient quantity of water in the expansion vessel. This is an elementary prerequisite for the function.

reflex 'servitec' deaeration stations cannot only make up water, but they can also centrally bleed and deaerate systems. Our common studies with the Technical University of Dresden have confirmed that this is in particular required for closed systems. Measurements have shown nitrogen concentrations between 25 and 35 mg/litre in the network content water. This is up to 2.5 times more than the natural load of drinking water. → p. 29

## Water make-up systems

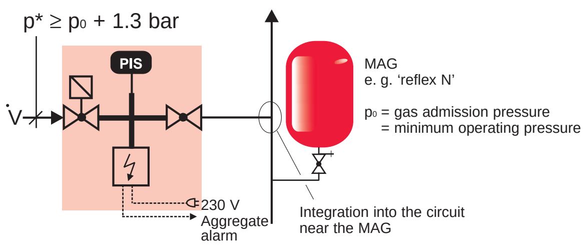
**reflex 'magcontrol'**
for 'reflex'
and other MAG

The pressure is indicated on the display and is monitored (alarms min, max). If the initial pressure is fallen short of ($p < p_0 + 0.3$ bar), a control is performed are made up with water. In case of a drinking water make up, the reflex 'fillset' is to be connected. The pressure directly before the water make-up must be at least 1.3 bar above the admission pressure of the MAG. The water make-up quantity $\dot{V}$ can be determined from the $k_{VS}$ value.

Water make-up quantity

$$\dot{V} \approx \sqrt{p^* - (p_0 + 0.3)} \times k_{VS}$$






Settings
$p_0$ = .......... bar
$p_{SV}$ = .......... bar

| | $k_{VS}$ value |
|---|---|
| 'magcontrol' | 1.4 m³/h |
| 'magcontrol' + 'fillset' | 0.7 m³/h |

* p = Excess pressure directly before the water make-up station in bar

**reflex 'control P'**

'control P' is a water make-up station with a pump and an open collection container (network separation container) as system separation towards the drinking water network according to DIN 1988.

'control P' is usually deployed if the fresh water supply pressure p for the direct water make-up without pump is too low or if an intermediate vessel is required for the network separation towards the drinking water network.

The flow rate is between 120-180 l/h with a maximum delivery head of 8.5 bar.

# Water make-up and deaeration systems

## Deaeration stations

In most cases, a simple sampling in a glass container is sufficient to detect excessive accumulations of gas in closed systems. The sample shows a milky appearance in the flow due to the formation of micro bubbles.

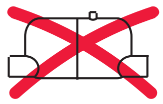
gassy, milky samp-ling

**'servitec magcontrol'** for 'reflex' and other MAG

The pressure is indicated on the display and is monitored by the control (alarm min, max) If the initial pressure is fallen short of ($p < p_0 + 0.3$ bar) a control is performed and water deaerated with a leakage quantity monitoring is made up. This allows the refilling of systems during manual operation. The oxygen admission into the system can be reduced.

Settings
$p_0$ = ........... bar
$p_{SV}$ = ........... bar

By means of the additional, cyclical deaeration of the circulation water accumulated, excessive gases are transferred out of the system. Circulation disorders due to free gases are - thanks to this central "bleeding" - a thing of the past.



Traditional air separators are not needed. You save installation and maintenance costs.

Tthe combination of 'servitec magcontrol' and 'reflex' expansion vessels is technically equivalent with 'variomat' pressure-maintaining stations and provides a real alternative in terms of prices, in particular in a capacity range below 500 kW.
→ Calculation 'reflex' page 9
→ 'servitec' according to the following table

**'servitec levelcontrol'** for 'reflexomat' and 'gigamat'
28 Pressure-maintaining stations

Function and design are similar to the 'servitec magcontrol'. The difference is that in this case the water make-up is performed in dependence of the water level in the expansion vessel. The pressure display and monitoring is not needed.

**Water make-up quantity System volume**

The throughput quantities of 'servitec' depend on the pumps used and the setting of the corresponding pressure reducing and overflow valves. For the standard systems with standard factory settings the values in the table result for the individual types. The recommended maximum system volumes apply if the network volume is deaerated at least once in two weeks in the partial flow. According to our experience, this is sufficient even for networks with extreme loads.

Please note that 'servitec' can only be operated in the specified working pressure range, i.e. the specified working pressure values may neither be fallen short of nor exceeded at the point of integration of 'servitec'. In case of deviating conditions we recommend special systems.

The deaeration of water/glycol mixtures is more complex. The special technical equipment of the servitec 60 g/l takes this fact into account.

| Type | System volumes $V_A$* | Water make-up rate | Working pressure |
|---|---|---|---|
| **for water up to 70°C** | | | |
| servitec magcontrol 15 | up to 1 m³ | to 0,02 m³/h | 1.0 to 2.5 bar |
| servitec ... / 35 | up to 60 m³ | to 0.35 m³/h | 1.3 to 2.5 bar |
| servitec ... / 60 | up to100 m³ | to 0,55 m³/h | 1.3 to 4.5 bar |
| servitec ... / 75 | up to100 m³ | to 0,55 m³/h | 1.3 to 5.4 bar |
| servitec ... / 95 | up to100 m³ | to 0,55 m³/h | 1.3 to 7,2 bar |
| servitec ... / 120 | up to100 m³ | to 0,55 m³/h | 1.3 to 9.0 bar |
| **for water/glycol mixtures up to 70°C** | | | |
| servitec ... / 60 / gl | up to20 m³ | to 0,55 m³/h | 1.3 to 4,5 bar |
| servitec ... / 75 / gl | up to20 m³ | to 0,55 m³/h | 1.3 to 5,4 bar |
| servitec ... / 95 / gl | up to20 m³ | to 0,55 m³/h | 1.3 to 7,2 bar |
| servitec ... / 120 / gl | up to20 m³ | to 0,55 m³/h | 1.3 to 9.0 bar |

▶ The working pressure must be within the working range of the pressure maintenance = $p_a$ to $p_e$.

* $V_A$ = max. system volume with a permanent deaeration of 2 weeks

'servitec' for higher system volumes and temperatures up to 90°C upon request.

▶ Water make-up and deaeration stations
+49 (0) 2382/7069-567

## From the joint research work with the Technical University of Dresden

Many heating systems have “air problems” to contend with. Intensive studies that were performed in collaboration with the Institute for Energy Technology of the Technical University of Dresden have shown that nitrogen is one of the main causes of circulation failures. Measurements performed on existing systems showed nitrogen concentrations between 25 and 50 mg/l which are substantially higher than the natural load of drinking water (18 mg/l). Our ‘servitec’ reduces the concentration within an extremely short period of time to almost 0 mg/l.

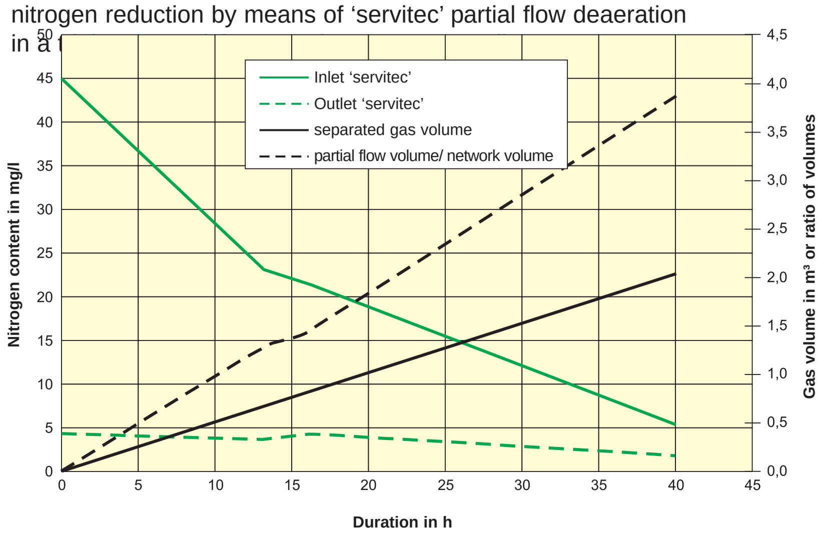
Figure 1:
‘servitec’ trial system in a heat transfer station of the Energieversorgung Halle

| | | |
|---|---|---|
| Heating capacity | : | 14,8 MW |
| water content | : | approx. 100 m³ |
| return temperature | : | ≤ 70 °C |
| return pressure | : | approx. 6 bar |



Figure 2:
nitrogen reduction by means of ‘servitec’ partial flow deaeration
in a t

natural load of drinking water = 18 mg/l $N_2$




nitrogen-rich, milky sampling

both samples are almost free of oxygen

clear, transparent sampling

‘servitec’ has reduced the $N_2$ content to almost 10% of the initial value within 40 hours and has segregated 4 m³ of nitrogen. The air problems in the high-rise buildings were solved.

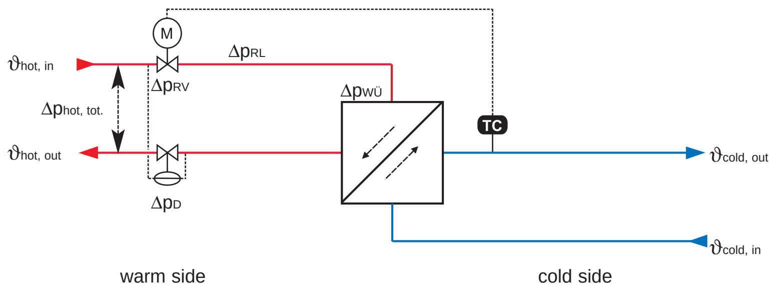
## Heat exchangers

The task of a heat exchanger is to transfer a specific quantity of heat from the hot side to the cold side. The transfer capacity is not only a device-specific value, but always depends on the requested temperatures. Thus, there is no ... kW heat exchanger. The device can rather transfer ... kw with specified temperature spreads.

**Fields of use**

– as system separation of media that must not be mixed, e.g.
  - heating and drinking water
  - heating and solar system water
  - water and oil circuits
– for the separation of circuits with different operating parameters, e.g.
  - excess operating pressure of side 1 is higher than the admissible excess operating pressure of side 2
  - the water content of side 1 is much higher than the one of side 2
– to minimize the mutual influence of the separated circuits

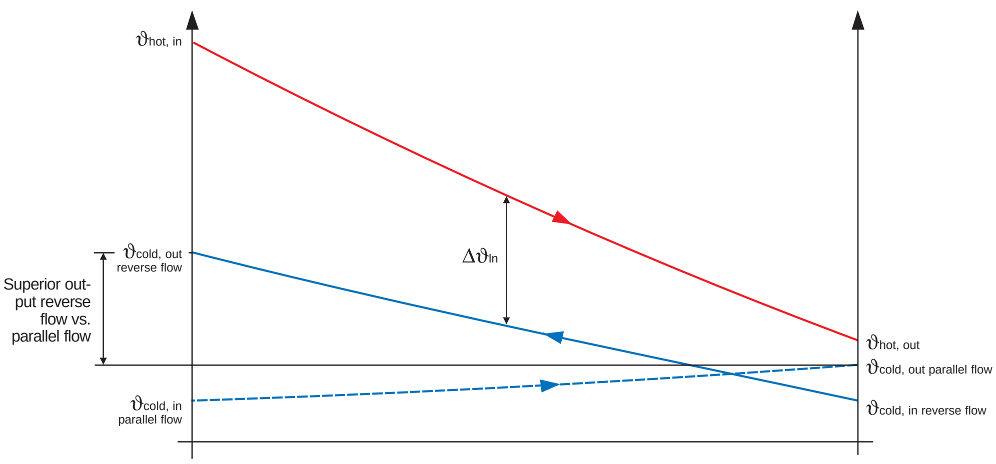
Deployment examples:
- indirect district heating connections
- floor heating systems
- drinking water heating
- solar systems
- machine refrigeration






**Reverse flow**

In general, heat exchangers should always be connected according to the reverse flow principle as this is the only way to utilize the full capacity. In case of the connection in the parallel flow, substantial capacity losses are to be expected.




**Hot and cold side**

Depending on the case of application, the allocation of the two system circuits as primary and secondary side varies. With respect to heating systems, the hot side is in most cases specified as primary side, with respect to cooling and refrigerating systems the cold side. The distinction between hot and cold side is clearer and independent of the case of application.

**Inlet / outlet**

The terms “flow” and “return” are problematic with respect to the dimensioning of heat exchangers as the calculation software does not forgive a mix-up of inlet and outlet. You have to clearly distinguish between the hot heating flow on the outlet side of the heat exchanger and the inlet into the plate heat exchanger that comes from the heating system in a cooled down state. In the Reflex calculation software, inlet always means the supply to the plate heat exchanger (the same applies analogously to the outlet).

**Thermal length**

The capacity or operational characteristic of a plate heat exchanger describes the ratio between the actual cooling of the hot side and the theoretical maximum cooling up to the inlet temperature of the cold side.

$$\text{Operational characteristic} = \Phi = \frac{\vartheta_{hot,\,in} - \vartheta_{hot,\,out}}{\vartheta_{hot,\,in} - \vartheta_{cold,\,in}} < 1$$

The term “thermal length” is often used for the qualitative description of the capacity. The thermal length is a device-specific property and depends on the structure of the heat exchanger plates. With a more distinct profiling and narrower channels the flow turbulence between the plates is increased. The device becomes “thermally longer” and can transfer more capacity or better adjust the temperatures of the two media.

**Medium, logarithmic temperature difference**

The temperature difference between hot and cold medium is a parameter for the driving force of the heat transfer. As this is a non-linear gradient, this driving force is linearized with the term “medium, logarithmic temperature difference $\Delta\vartheta_{ln}$“.

$$\Delta\vartheta_{ln} = \frac{(\vartheta_{hot,\,out} - \vartheta_{cold,\,in}) - (\vartheta_{hot,\,in} - \vartheta_{cold,\,out})}{\ln \frac{(\vartheta_{hot,\,out} - \vartheta_{cold,\,in})}{(\vartheta_{hot,\,in} - \vartheta_{cold,\,out})}}$$

The smaller this driving temperature difference, the more surface must be provided. This results in large devices, in particular in cold water networks.

**Terminal temperature difference**

The term “terminal temperature difference” is often used for the dimensioning of heat exchangers. It indicates to which extent the outlet temperature of side 2 is adjusted to the inlet temperature of side 1. The smaller this temperature difference is to be, the more transfer surface must be provided. This determines the price of the device. With respect to heating systems, you usually assume a terminal temperature difference of ≥ 5 K. For cooling systems, also terminal temperature differences of 2 K are required which can only be realized with very large devices. Thus, a critical consideration of the terminal temperature difference will quickly pay off!

$$\text{Terminal temperature difference} = \vartheta_{hot,\,out} - \vartheta_{cold,\,in}$$

**Pressure losses**

The admissible pressure loss is an important criterion for the dimensioning of a heat exchanger. Similar to the terminal temperature difference, a very small pressure loss can often only be realized with very large heat exchangers. In such a case, the volume flow to be circulated and, thus, also the pressure loss above the heat exchanger can be reduced by means of an increase of the temperature spread. If a higher pressure loss is provided in the system, e.g. in district heating networks, it is useful to allow a slightly higher pressure loss to be able to substantially reduce the system size.

**Flow properties**

The flow conditions in the media are of decisive importance for the size of a heat exchanger. The more turbulently the heat transfer media flow through the device, the higher the transferable capacity, but also the pressure losses. This interrelation between capacity, device size, and flow properties is described by the heat transition coefficient.

**Surface reserve**

To determine the device size of a heat exchanger, firstly the required exchanger surface is determined from the marginal conditions. Thereby, devices with a substantial surface excess may be calculated, e.g. by defaulting a maximum pressure loss. This surface reserve is a theoretical value. During the operation of the plate heat exchanger, the temperatures of the two heat exchanger media adjust to each other until the surface excess has been removed. In general, the target temperature for a heating circuit is specified at the controller. A theoretically determined surface reserve is removed by means of the reduction of the heating mass flow through the controller. Thus, the temperature on the outlet side of the hot medium decreases accordingly. The reduced mass flow must be considered in the dimensioning of the control fittings to avoid an overdimensioning.

# Heat transfer systems

## Physical fundamentals

**Thermal balances**

Heat emission and absorption of the heat transfer media

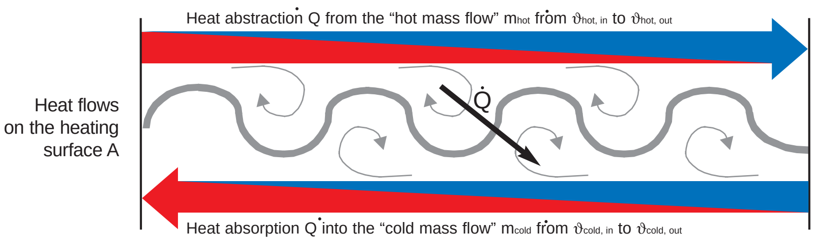
$$\dot{Q} = \dot{m} \text{ x } c \text{ x } (\vartheta_{in} - \vartheta_{out})$$

The capacity to be transferred can be determined from the defaulted temperature spread and the circulated mass flow using the above equation.

Heat transport through the heat transfer plates

$$\dot{Q} = k \text{ x } A \text{ x } \Delta\vartheta_{ln}$$

The heat transition coefficient k [W/m²K] is a medium- and device-specific value into which flow properties, nature of the exchanger surface, and type of the heat transfer media are included. The more turbulent the flow, the higher the pressure loss and, thus, the heat transition coefficient. The medium, logarithmic temperature difference $\Delta\vartheta_{ln}$ is a pure system value that results from the temperatures setting themselves.
Using a complicated calculation algorithm, the heat transition coefficient is determined by means of the specified marginal conditions. Then, the required device size is established based on the necessary exchanger surface.






**Initial data**

The following values must be known for the dimensioning of a heat exchanger:
- type of the media (e.g. water, water/glycol mixture, oil)
- physical characteristics for media other than water (e.g. concentrations, density, thermal conductivity and capacity, viscosity)
- inlet temperatures and required outlet temperatures
- capacity to be transferred
- admissible pressure losses

If the systems are, depending on the season, operated at extremely different conditions, such as in district heating networks, the heat exchangers must also be dimensioned for these marginal conditions.

**Calculation program**

You can use the Reflex calculation program which is available on our CD-ROM or as download at www.reflex.de for the optimum dimensioning of the reflex 'longtherm' heat exchangers. Your professional consultant is ready to assist you with the preparation of individual solutions.


Your professional consultant
→ page 51

## System equipment

**Safety technology**

Authoritative rules for the safety-related equipment of heat exchangers as indirect heat generators include:
- DIN 4747 for district heating domestic stations
- DIN 4751 T1, T2 for water heating systems ≤ 120°C, see chapter "Safety technology" on page 40
- DIN 1988 and DIN 4753 for drinking water heating systems

The following notes regarding the system equipment are intended to assist you with the dimensioning. You can use the notes already in the planning stage to avoid common problems in the system operation and problems related to system failures.

**Control valve**

The dimensioning of the control valve is of utmost importance for the stable operation of a heat exchanger. The valve should not be overdimensioned and should ensure a stable control behaviour also in the light load range.

The valve authority is one of the selection criteria. This describes the ratio of the pressure losses above the control valve with full opening to the available maximum pressure loss when the control valve is closed. If the valve authority is too small, the controlling effect of the valve is insufficient.

$$\text{Valve authority} = \frac{\Delta p_{RV}\,(100\,\%\text{ lift})}{\Delta p_{hot,\,tot.}} \geq 30...40\ \%$$ (see also page 30)

With the established decrease of pressure above the control valve, now the $k_{VS}$ value can be determined. This value is to be referred to the actual mass flow of the circuit to be controlled.

$$k_{VS} \geq k_V = \dot{V}_{hot}\sqrt{\frac{1\text{ bar}}{\Delta p_{RV}}} = \frac{\dot{m}_{hot}}{\rho_{hot}}\sqrt{\frac{1\text{ bar}}{\Delta p_{RV}}}$$

The $k_{VS}$ value of the selected control valve should not be substantially higher than the calculated value (do without increased factors of safety!). Otherwise, there is the risk that the system, in particular in the light and partial load range, runs instably and in phases which is one of the most common failure causes of plate heat exchangers.

▶ Do not overdimension the control valve

**Temperature sensor**
**Temperature controller**

The temperature sensors should be quick and almost inertia-free and should always be installed in the immediate vicinity of the plate heat exchanger outlet to allow an instantaneous reaction of the control to changing marginal conditions or control values. If sensors and controllers are slow and installed at a long distance from the plate heat exchanger, there is the risk of a periodic overshoot over the target temperatures and, thus, a phased operation of the control. Such an instable control behaviour may result in the failure of the plate heat exchanger. If additional control circuits, e.g. for the heating circuit control on the secondary side, are connected to the control circuit, these must communicate with each other.

Caution! Take utmost care over the selection of controllers and control valves. A wrong dimensioning can result in an instable operation and, thus, to an inadmissible dynamic material stressing.

# Equipment - Accessories - Safety Engineering - Inspection

In the sense of the guidelines and regulations all equipment parts required for the function and safety, such as connection lines, fittings, and control devices, belong to the equipment.

The safety-related equipment is set forth in standards. Main equipment parts are described in the following. For heat generating systems up to 120°C according to DIN 4751 T2 and water heating systems according to DIN 4751 T1, you find an extensive description on pages 40-43. The legend is given on page 47.

## Safety valves (SV)

Safety valves are not included in the delivery program of Reflex.

Safety valves protect heat (cold) generators, expansion vessel, and the entire system from an inadmissible pressure excess. They are to be dimensioned with consideration of possible load cases (e.g. heat supply for shut-off heat generators, pressure increase due to pumps).

**Warm and hot water generators**

**DIN 4751 T2:** “Each heat generator must be protected by means of safety valves according toTRD 721 from exceeding the admissible operating pressure.”

Safety valves on **directly** heated heat generators are to be dimensioned for saturated steam, referred to the nominal thermal output $\dot{Q}$. For a heat generator capacity of more than 350 kW, a blow tank is to be connected for the phase separation of steam and water. With respect to **indirectly** heated heat generators (heat exchangers) it can be calculated with 1 litre/(hkW) for the water discharge if the evaporation referred to the response pressure is excluded. According to DIN 4751 T2, up to three safety valves may be installed on a heat generator which is, however, not recommended.



SV letter code H

In the normal linguistic usage, these safety valves are known as “diaphragm safety valves” with response pressures of 2.5 and 3.0 bar. According to TRD 721, H valves may be used in Germany up to a response pressure of max. 3 bar. The capacity is established independently of the make. In simplified terms, the blowing-off capacity for steam and water is, independent of the response pressure (2.5 or 3.0 bar), equated.

SV letter code D/G/H

If the response pressures of 2.5 and 3.0 bar deviate or if a capacity of 900 kW is exceeded, D/G/H safety valves are used. The blowing-off capacities are specified make-specifically according to the allocated discharge figure.

**Water heating systems**

In water heating systems according to DIN 4753, only safety valves with the letter code W are allowed. In some cases, combined valves W/F (F - fluids) are offered. The capacity values are set forth in TRD 721.

**Solar systems**

Solar systems according to DIN 4757 T1 are to be equipped with H or D/G/H safety valves, intrinsically safe systems also with F safety valves (discharge for fluids). If solar systems are calculated according to the specifications in this document, they are deemed to be intrinsically safe.

**Cooling water systems**

For cooling water systems in which an evaporation can be excluded, F safety valves can be used according to the manufacturers. The load cases are to be determined in dependence on the connection and object-related.

**Expansion vessels**

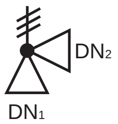
If the admissible operating excess pressure of expansion vessels is below the admissible operating pressure of the system, an intrinsic protection is required. The load cases are to be determined specifically. According to DIN 4751 T2, H, D/G/H and safety valves according to the AD form A2 (e.g. F) are allowed.
Reflex expansion vessels for pressure-maintaining stations are unpressurized in the normal operation. In case of operating errors, however, a pressurization is to be expected. Thus, they are protected with F valves through the control unit. The max. possible volume flow is to be discharged at blowing-off pressure (5 bar). This normally is 1 litre/(hkW), referred to the connected total thermal output.

**Safety valves on heat generators** according to DIN 4751 T2 and TRD 721, up to 120°C

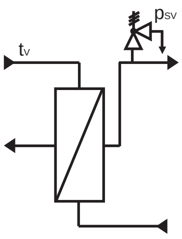
**Letter code H**, blowing-off pressure $p_{SV}$ 2.5 and 3.0 bar

| **Inlet connection [G] - outlet connection [G]** | ½ - ¾ | ¾ - 1 | 1 - 1¼ | 1¼ - 1½ | 1½ - 2 | 2 - 2½ |
|---|---|---|---|---|---|---|
| **Blowing-off capacity for steam and water / kW** | ≤ 50 | ≤ 100 | ≤ 200 | ≤ 350 | ≤ 600 | ≤ 900 |

**Letter code D/G/H**, e.g. model LESER, type 440*




| **$DN_1/DN_2$** | **20x32** | **25x40** | **32x50** | **40x65** | **50x80** | **65x100** | **80x125** | **100x150** | **125x200** | **150x250** | **20x32** | **25x40** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **$p_{SV}$ / bar** | **Steam discharge** ← | | | | **blowing-off capacity / kW** → | | | | | | **Water emission** | |
| **2,5** | 198 | 323 | 514 | 835 | 1291 | 2199 | 3342 | 5165 | 5861 | 9484 | 9200 | 15100 |
| **3,0** | 225 | 367 | 583 | 948 | 1466 | 2493 | 3793 | 5864 | 6654 | 10824 | 10200 | 16600 |
| **3,5** | 252 | 411 | 652 | 1061 | 1640 | 2790 | 4245 | 6662 | 7446 | 12112 | 11000 | 17900 |
| **4,0** | 276 | 451 | 717 | 1166 | 1803 | 3067 | 4667 | 7213 | 8185 | 13315 | 11800 | 19200 |
| **4,5** | 302 | 492 | 782 | 1272 | 1966 | 3344 | 5088 | 7865 | 8924 | 14518 | 12500 | 20200 |
| **5,0** | 326 | 533 | 847 | 1377 | 2129 | 3621 | 5510 | 8516 | 9663 | 15720 | 13200 | 21500 |
| **5,5** | 352 | 574 | 912 | 1482 | 2292 | 3898 | 5931 | 9168 | 10403 | 16923 | 13800 | 22500 |
| **6,0** | 375 | 612 | 972 | 1580 | 2443 | 4156 | 6322 | 9773 | 11089 | 18040 | 14400 | 23500 |
| **7,0** | 423 | 690 | 1097 | 1783 | 2757 | 4690 | 7135 | 11029 | 12514 | 20359 | 15800 | 25400 |
| **8,0** | 471 | 769 | 1222 | 1987 | 3071 | 5224 | 7948 | 12286 | 13941 | 22679 | 16700 | 27200 |
| **9,0** | 519 | 847 | 1346 | 2190 | 3385 | 5759 | 8761 | 13542 | 15366 | 24998 | 17700 | 28800 |
| **10,0** | 563 | 920 | 1462 | 2378 | 3676 | 6253 | 9514 | 14705 | 16686 | 27146 | 18600 | 30400 |




max. primary flow temperature $t_V$ to avoid an evaporation at $p_{SV}$

| **$p_{SV}$ / bar** | 2.5 | 3,0 | 3,5 | 4,0 | 4,5 | 5,0 | 5,5 | 6,0 | 7,0 | 8,0 | 9,0 | 10,0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **$t_V$ / °C** | ≤ 138 | ≤ 143 | ≤ 147 | ≤ 151 | ≤ 155 | ≤ 158 | ≤ 161 | ≤ 164 | ≤ 170 | ≤ 175 | ≤ 179 | ≤ 184 |

The table for the water discharge can be applied to **heat exchangers** if the conditions opposite are met.

**Safety valves on water heaters** according to DIN 4753 and TRD 721



**Letter code W**, blowing-off pressure $p_{SV}$ 6, 8, 10 bar, e.g. model SYR type 2115*

| **Inlet connection G** | **Storage volume litres** | **max. heating capacity kW** |
|---|---|---|
| ½ | ≤ 200 | 75 |
| ¾ | > 200 ≤ 1000 | 150 |
| 1 | > 1000 ≤ 5000 | 250 |
| 1¼ | > 5000 | 30000 |

**Safety valves in solar systems** according to DIN 4757 T1

**Letter code H, D/G/H, F** (intrinsically safe systems)

| **Inlet connector** | **DN** | 15 | 20 | 25 | 32 | 40 |
|---|---|---|---|---|---|---|
| **Collector inlet surface** | **m²** | ≤ 50 | ≤ 100 | ≤ 200 | ≤ 350 | ≤ 600 |

**Safety valves in refrigerating systems and at expansion vessels**

**Letter code F** (only with guaranteed fluid discharge), e.g. model SYR type 2115*

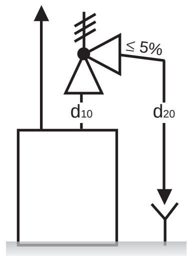
| **Connection inlet** | ½ | ¾ | 1 | 1¼ | 1½ | 2 |
|---|---|---|---|---|---|---|
| **$p_{SV}$ / bar** | **max. blowing-off capacity / m³/h** | | | | | |
| **4,0** | 2,8 | 3,0 | 9,5 | 14,3 | 19,2 | 27,7 |
| **4,5** | 3,0 | 3,2 | 10,1 | 15,1 | 20,4 | 29,3 |
| **5,0** | 3,1** | 3,4 | 10,6 ** | 16,0 | 21,5 | 30,9 |
| **5,5** | 3,3 | 3,6 | 11,1 | 16,1 | 22,5 | 32,4 |
| **6,0** | 3,4 | 3,7 | 11,6 | 17,5 | 41,2 | 50,9 |

* Please contact the manufacturer for current values
** Protection of Reflex expansion vessels in pressure-maintaining stations
Vessel up to 1000 litres, ∅ 740 mm, G ½ =3100 kW = 3.100 l/h
from 1000 litres, ∅ 1000 mm, G 1 =10600 kW = 10.600 l/h

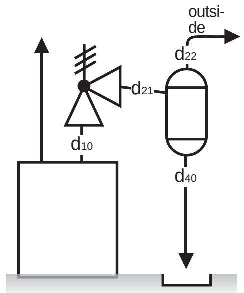
reflex

## Blow-off pipes of safety valves, blow tanks

**Blow-off pipes** Blow-off pipes must meet the conditions of DIN 4751 T2, TRD 721, and for solar systems the conditions of DIN 4757 T1. Some requirements are summarized in the tables.




**Blow tanks**
Installation Blow tanks are integrated into the blow-off pipe of safety valves and serve for the phase separation of steam and water. At the bottom point of the blow tank a water discharge pipe must be connected that is able to discharge heating water in a safe and observable manner. The blow-off pipe for steam must be led from the high point of the blow tank to the **outside**.




Necessity According to DIN 4751 T2 for heat generators with a nominal thermal output > 350 kW. For indirectly heated heat generators (heat exchangers), blow tanks are not required if the safety valves are only dimensioned for the water discharge.
→Safety valves on heat generators page 35

**Blow-off pipes and reflex ‘T blow tanks’ in systems according to DIN 4751 T2**

Safety valves letter code H, blowing-off pressure $p_{SV}$ 2.5 and 3.0 bar



| Safety valve | | Nominal capacity Heat generator | SV without ‘T blow tank’ | | | SV with or without ‘T blow tank’ | | | | SV with ‘T blow tank’ | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Blow-off pipe | | | Feeding pipe SV | | | | Line SV – T | | | Blow-off pipe | | | Water outlet line |
| $d_1$ DN | $d_2$ DN | $\dot{Q}$ kW | $d_{20}$ DN | Length m | Bends No. | $d_{10}$ DN | Length m | Bends No. | Type T | $d_{21}$ DN | Length m | Bends No. | $d_{22}$* DN | Length m | Bends No. | $d_{40}$* DN |
| 15 | 20 | ≤ 50 | 20 | ≤ 2 | ≤ 2 | 15 | ≤ 1 | ≤ 1 | —- | —- | —- | —- | —- | —- | —- | —- |
| | | | 25 | ≤ 4 | ≤ 3 | | | | | | | | | | | |
| 20 | 25 | ≤ 100 | 25 | ≤ 2 | ≤ 2 | 20 | ≤ 1 | ≤ 1 | —- | —- | —- | —- | —- | —- | —- | —- |
| | | | 32 | ≤ 4 | ≤ 3 | | | | | | | | | | | |
| 25 | 32 | ≤ 200 | 32 | ≤ 2 | ≤ 2 | 25 | ≤ 1 | ≤ 1 | —- | —- | —- | —- | —- | —- | —- | —- |
| | | | 40 | ≤ 4 | ≤ 3 | | | | | | | | | | | |
| 32 | 40 | ≤ 350 | 40 | ≤ 2 | ≤ 2 | 32 | ≤ 1 | ≤ 1 | —- | —- | —- | —- | —- | —- | —- | —- |
| | | | 50 | ≤ 4 | ≤ 3 | | | | | | | | | | | |
| 40 | 50 | ≤ 600 | 50 | ≤ 2 | ≤ 4 | 40 | ≤ 1 | ≤ 1 | 380 | 80 | ≤ 5 | ≤ 2 | 100 | ≤ 15 | ≤ 3 | 80 |
| | | | 65 | ≤ 4 | ≤ 3 | | | | | | | | | | | |
| 50 | 65 | ≤ 900 | 65 | ≤ 2 | ≤ 4 | 50 | ≤ 1 | ≤ 1 | 480 | 100 | ≤ 5 | ≤ 2 | 125 | ≤ 15 | ≤ 3 | 100 |
| | | | 80 | ≤ 4 | ≤ 3 | | | | | | | | | | | |

Safety valves letter code D/G/H, blowing-off pressure $p_{SV}$ ≤ 10 bar

| Safety valve | | SV without ‘T blow tank’ | | | | SV with or without ‘T blow tank’ | | | | SV with ‘T blow tank’ | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Blow-off pipe | | | | Supply SV | | | | | Line SV – T | | | Blow-off pipe | | | Water outlet line |
| $d_1$ DN | $d_2$ DN | $d_{20}$ DN | Length m | Bends No. | Blowing-off press. bar | $d_{10}$ DN | Length m | Bends No. | Type T | Blowing-off press. bar | $d_{21}$ DN | Length m | Bends No. | $d_{22}$* DN | Lenght m | Bends No. | $d_{40}$* DN |
| 25 | 40 | 40 | ≤ 5,0 | ≤ 2 | ≤ 5 | 25 | ≤ 0,2 | ≤ 1 | 170 | ≤ 5 | 40 | ≤ 5,0 | ≤ 2 | 50 | ≤ 10 | ≤ 3 | 50 |
| | | 50 | ≤ 7,5 | ≤ 3 | > 5 ≤ 10 | 32 | ≤ 1,0 | ≤ 1 | 170 | > 5 ≤ 10 | 50 | ≤ 7,5 | ≤ 2 | 65 | ≤ 10 | ≤ 3 | 65 |
| 32 | 50 | 50 | ≤ 5,0 | ≤ 2 | ≤ 5 | 32 | ≤ 0,2 | ≤ 1 | 170 | ≤ 5 | 50 | ≤ 5,0 | ≤ 2 | 65 | ≤ 10 | ≤ 3 | 65 |
| | | 65 | ≤ 7,5 | ≤ 3 | > 5 ≤ 10 | 40 | ≤ 1,0 | ≤ 1 | 270 | > 5 ≤ 10 | 65 | ≤ 7,5 | ≤ 2 | 80 | ≤ 10 | ≤ 3 | 80 |
| 40 | 65 | 65 | ≤ 5,0 | ≤ 2 | ≤ 5 | 40 | ≤ 0,2 | ≤ 1 | 270 | ≤ 5 | 65 | ≤ 5,0 | ≤ 2 | 80 | ≤ 10 | ≤ 3 | 80 |
| | | 80 | ≤ 7,5 | ≤ 3 | > 5 ≤ 10 | 50 | ≤ 1,0 | ≤ 1 | 380 | > 5 ≤ 10 | 80 | ≤ 7,5 | ≤ 2 | 100 | ≤ 10 | ≤ 3 | 100 |
| 50 | 80 | 80 | ≤ 5,0 | ≤ 2 | ≤ 5 | 50 | ≤ 0,2 | ≤ 1 | 380 | ≤ 5 | 80 | ≤ 5,0 | ≤ 2 | 100 | ≤ 10 | ≤ 3 | 100 |
| | | 100 | ≤ 7,5 | ≤ 3 | > 5 ≤ 10 | 65 | ≤ 1,0 | ≤ 1 | 480 | > 5 ≤ 10 | 100 | ≤ 7,5 | ≤ 2 | 125 | ≤ 10 | ≤ 3 | 125 |
| 65 | 100 | 100 | ≤ 5,0 | ≤ 2 | ≤ 5 | 65 | ≤ 0,2 | ≤ 1 | 480 | ≤ 5 | 100 | ≤ 5,0 | ≤ 2 | 125 | ≤ 10 | ≤ 3 | 125 |
| | | 125 | ≤ 7,5 | ≤ 3 | > 5 ≤ 10 | 80 | ≤ 1,0 | ≤ 1 | 480 | > 5 ≤ 10 | 125 | ≤ 7,5 | ≤ 2 | 150 | ≤ 10 | ≤ 3 | 150 |
| 80 | 125 | 125 | ≤ 5,0 | ≤ 2 | ≤ 5 | 80 | ≤ 0,2 | ≤ 1 | 480 | ≤ 5 | 125 | ≤ 5,0 | ≤ 2 | 150 | ≤ 10 | ≤ 3 | 150 |
| | | 150 | ≤ 7,5 | ≤ 3 | > 5 ≤ 10 | 100 | ≤ 1,0 | ≤ 1 | 550 | > 5 ≤ 10 | 150 | ≤ 7,5 | ≤ 2 | 200 | ≤ 10 | ≤ 3 | 200 |
| 100 | 150 | 150 | ≤ 5,0 | ≤ 2 | ≤ 5 | 100 | ≤ 0,2 | ≤ 1 | 550 | ≤ 5 | 150 | ≤ 5,0 | ≤ 2 | 200 | ≤ 10 | ≤ 3 | 200 |

* If multiple lines are connected, the cross section of the power line must at least correspond to the sum of the cross sections of the individual lines.

## Pressure limiters

Pressure limiters are electro-mechanic switching devices that must be subject to a structural test according to the VdTÜV pressure leaflet 100/1. If the pressure is exceeded or fallen short of, the heating is immediately switched off and locked.

Pressure limiters are not included in the delivery program of Reflex.

**Maximumpressure limiter $DB_{max}$**

**DIN 4751:** "Each heat generator that is protected above 3 bar or has a nominal thermal output of more than 350 kW, must be equipped with a pressure limiter ..."

In general, pressure limiters are set to 0.2 bar below the safety valve opening pressure.

With respect to heat exchangers (indirect heating), pressure limiters are not required if the safety valve must only be dimensioned for the water discharge according to the criteria on page 35 (safety valves on heat generators). The blow tank is not needed, too.

**Minimum pressure limiter $DB_{min}$**

**DIN 4751 T2:** "The working pressure of **hot water** heat generation systems is to be monitored by means of a ... minimum pressure limiter!"

According to DIN 4751 T2 and the DDA interpretation 1988/1, protection temperatures of > 100°C are considered **hot water**. The minimum pressure limiter monitors the pressure of the pressure-maintaining system and is installed on the expansion line for suction and final pressure maintenance and on the analogy measurement section for medium pressure maintenance.

**Warm water**
STB ≤ 100°C
overshoot temp. ≤ 110°C

**Hot water**
STB >100°C
or
STB ≤ 100°C
overshoot temp. >110°C

## Expansion lines, shut-offs, evacuations

**Expansion lines**
Heat generators
up to 120°C

**DIN 4751 T2:** "Expansion lines are ... to be dimensioned such that their flow resistance $\Delta p$ ... can only effect a pressure increase ..., to which pressure limiters ($DB_{max}$) and safety valves ($p_{SV}$) do not respond."

1 litre/(hkW), referred to the nominal thermal output of the heat generator $\dot{Q}$ is to be used as volume flow.

With respect to the suction pressure maintenance, the admissible pressure loss $\Delta p$ mainly results from the difference between the safety valve opening pressure $p_{SV}$ or the set pressure of the pressure limiter $DB_{max}$ and the final pressure $p_e$, less a tolerance. The recalculation of the pressure loss is performed through the relation

$$\Delta p \text{ (1 litre/(hkW))} = \Sigma \text{ (Rl + Z)}.$$

The proof is not required if the following table values are used. With respect to reflex 'variomat' pressure-maintaining stations, the expansion lines are also dimensioned according to the deaeration capacity.
→reflex 'variomat' brochure

| expansion line | DN 20 ¾" | DN 25 1" | DN 32 1¼" | DN 40 1½" | DN 50 2" | DN 65 | DN 80 | DN 100 |
|---|---|---|---|---|---|---|---|---|
| $\dot{Q}$ / kW length ≤ 10 m | 350 | 2100 | 3600 | 4800 | 7500 | 14000 | 19000 | 29000 |
| $\dot{Q}$ / kW length > 10 m ≤ 30 m | 350 | 1400 | 2500 | 3200 | 5000 | 9500 | 13000 | 20000 |

By the way, it is admissible and also common practice that expansion lines on connections of expansion vessels or pressure-maintaining stations are "reduced" to smaller dimensions.

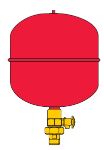


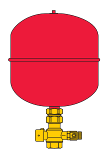
**Drinking water installations**

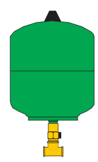
In water heating and pressure-intensifying systems, the connection lines for flowed through vessels according to the peak volume flow $V_s$ are determined according to the rules of the DIN 1988 T3. With respect to the dimension of bypass lines for repair purposes (closed during the operation) for 'refix DIT5' from 80 litres, in general a dimension one lower than the dimension of the main line is chosen. For 'refix DT5 junior' with flow-through fitting, a bypass (open during the operation) is already integrated. If 'refix' are used for the water hammer absorption, separate calculations must be performed.

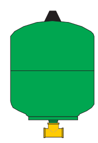
**Shut-offs**
**Evacuations**

**DIN 4751 T2:** "It must be possible to evacuate the water space of expansion vessels. All expansion vessels are to be installed with a shut-off towards the heating system." The same applies according to **DIN 4807 T5** for expansion vessels in drinking water systems. This is required to perform the annual maintenance work required according to DIN 4807 T2 (admission pressure control).


'reflex N' with 'SU express coupling'


'refix N' with 'SU cap ball valve'


'refix DD' with 'flowjet' flow-through fitting


'refix DD' with T-piece

Cap ball valves with low pressure drop that are protected from an inadvertent closing and are equipped with coupling connectors and a built-in evacuation and express couplings are available.

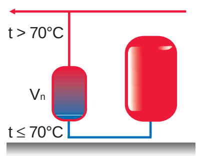
A 'flowjet' flow-through fitting Rp 1¼ is included for 'refix DT5 junior' 60-500 litres for the system-side installation. The fitting combines shut-off, evacuation, and bypass.
For 'refix DD' 8-33 litres, our 'flowjet' flow-through fitting Rp ¾ with secured shut-off and evacuation is available as an accessory. The included T-piece for the flow-through is included for the 'refix DD' for the model Rp ¾. Larger T-pieces must be provided on site.
For 'refix DIT5' 80-3000 litres the fittings must be provided on site. Here, it is recommended to use fittings that are provided for the installation anyway.

## reflex 'V auxiliary vessels'


'V auxiliary vessels' protect the diaphragms of expansion vessels from an inadmissible temperature load. According to DIN 4807 T3, the permanent temperature at the diaphragm must not exceed 70°C. In cooling water systems, a temperature ≤ 0°C should be avoided.

**in heating systems**

In general, heating systems are operated with return temperatures ≤ 70°C. The installation of auxiliary vessels is not required. With respect to old and industry systems, return temperatures > 70°C cannot be avoided in some cases.




A general formula for the calculation of the auxiliary vessel cannot be specified. The amount of water that is heated up to more than 70°C is the decisive factor. In general, this are approximately 50% of the system volume. For systems with heat accumulators, up to 100% are possible.

$$V_n = \frac{\Delta n}{100} V_A \; (0.5...1.0)$$

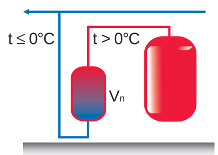
- 0,5 if return 50% of $V_A$
- 1,0 if heat storage with 100% $V_A$
- calculate with factor 1 for reasons of safety

→ Δn see physical characteristics and auxiliary values p. 6
→ $V_A$ system volume

**in cooling circuits**

With respect to temperature underflows of ≤ 0°C, we recommend to dimension the auxiliary vessel as follows.

$$V_n = 0.005 \; V_A$$





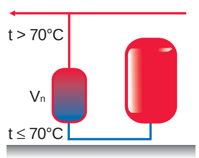

**in solar systems**

without evaporation

$$V_n = \frac{\Delta n}{100} V_A$$

with evaporation

$$V_n = \frac{\Delta n}{100} V_A + V_K$$




reflex

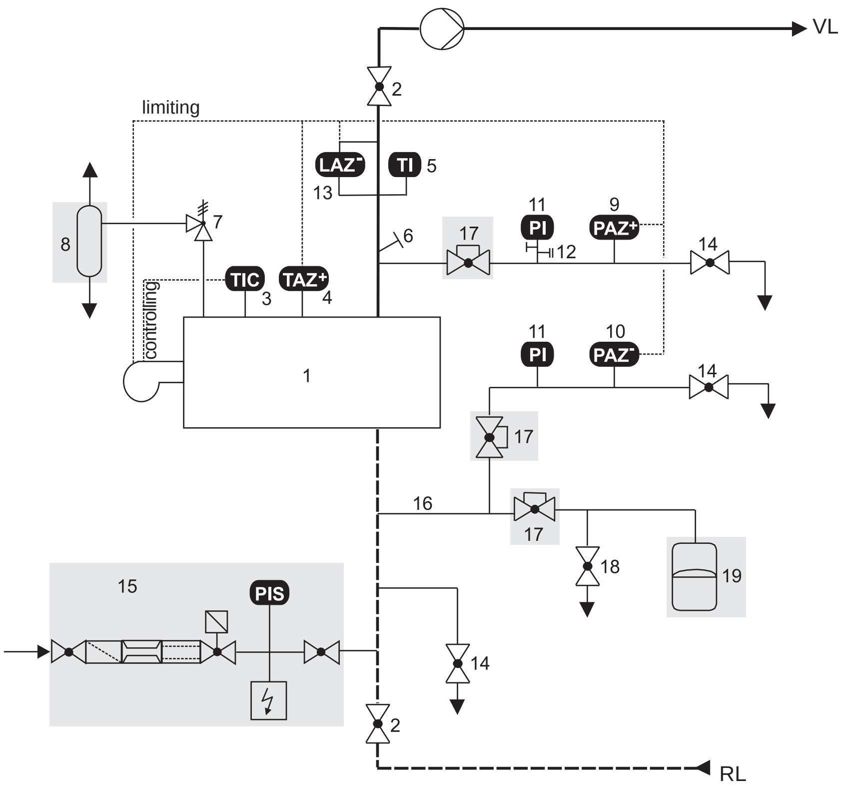
## Safety-related equipment of heat generating systems according to DIN 4751 T2, flow temperatures up to 120°C

| | | direct heating (heated with oil, gas, coal, or electrical energy) | | indirect heating (heated with fluids or steam) | |
|---|---|---|---|---|---|
| **Temperature protection** | | | | | |
| **Temperature measuring device** | | Thermometer, for STB > 100°C additional pocket tube for test thermometer | | | |
| **Safety temperature limiter sensor** type-certified acc. to DIN 3440 | | STB | | STW [2] not required if primary temp. ≤ adm. flow temp. | |
| **Temperature controller** type-certified [3] DIN 3440 | | Setting typically approximately 10 K below STB/STW | | | |
| **Water shortage protection** - for natural rotating boilers [1] | | $\dot{Q}_n \leq 350$ kW WMS or $SDB_{min}$ or flow sensors or STB upon proof of the boiler manufacturer | $\dot{Q}_n > 350$ kW WMS | To ensure the control ability, a **minimum volume flow** over the heat exchanger is to be ensured. [4] | |
| - for forced rotating boilers [1] | | flow limiter | | — | |
| **Heating** with solid **fuels** | $\dot{Q}_n \leq 100$ kW | thermal discharge protection, water pressure min. 2 bar/ Combustion air controller, supplementary air device | | | |
| | $\dot{Q}_n > 100$ kW | Safety heat consumer, control air and fuel supply, supplementary air device | | | |
| | $\dot{Q}_n \geq 350$ kW STB > 100°C | according to TRD 702 system 1 | | | |
| **Pressure protection** | | | | | |
| **Pressure gauge** | | Manometer (bar) reading tags $p_0$ u. $p_{SV}$, with STB/STW > 100°C additional connection for test manometer | | | |
| **Safety valve** according to TRD 721 | | Dimensioning for steam discharge | | $t_{PR} > t_S$ ($p_{SV}$) Steam discharge with $\dot{Q}_n$ | $t_{PR} \leq t_S$ ($p_{SV}$) Water discharge 1 litre/kWh |
| **'T blow tank'** per SV | | T for $\dot{Q}_n > 350$ kW, with STB ≤ 100°C alternatively additionally 1 STB + 1 $SDB_{max}$ | | | — |
| **Pressure limiter** | max | per heat generator with $\dot{Q}_n > 350$ kW or $p_{SV} > 3$ bar, $SDB_{max} = p_{SV}$ -0.2 bar | | | — |
| TÜV-certified | min | with STB/STW > 100°C, setting to minimum operating pressure $p_0$ | | | |
| **Pressure-maintenance** Expansion vessel | | - Pressure regulation within the limits $p_a...p_e$ as MAG or AG with external pressure generation<br>- It must be possible to shut-off (cap ball valve) and to evacuate AGs<br>- for external pressure generation and STB > 100°C, use a type-certified or double discharge device , normally closed, closes at minimum pressure | | | |
| **Filling devices** | | Protection of the operation-related min. hydraulic back pressure $V_V$, autom. water make-up with water meter | | | |
| **Heating** | | | | | |
| | | with hot water according to the provisions of the TRD 702 with warm water according to the provisions of the TRD 404 | | Primary control valve with safety feature n. DIN 3270, if primary temp. > adm. flow temp. | |

[1] In contrast to the natural rotating boiler, the control and limiting temperatures of the forced rotating boiler can only be determined with a sufficient exactness in case of a forced flow (circulating pump operates).
[2] STB is recommended as STW independently releases the heating if the limit value is fallen short off and, thus "sanctions" the error of the controller.
[3] If the temperature controller is not type-certified (e.g. DDC without structuring lock for max. target temperature), an additional type-certified temperature sensor is to be provided for the direct heating.
[4] see DIN 4751 T2, section 2, last but one paragraph

## Safety-related equipment of heat generating systems according to DIN 4751 T2, flow temperatures up to 120°C

**Example: direct heating**




**Legend:**

1 Heat generator
2 Shut-off valves flow/return
3 Temperature controller
4 Safety temperature limiter, STB
5 Temperature measurement device
6 Pocket tube for test thermometer (STB > 100°C)
7 Safety valve according to TRD 721
8 Blow tank ('T') > 350 kW [1) 2)]
9 $SDB_{max}$ [1)], 1. > 350 kW, 2. < 350 kW, SV > 3.0 bar
10 $SDB_{min}$ (STB > 100°C), with multiple boilers in the expansion line for the joint pressure maintenance
11 Pressure gauge
12 Connection for test manometer (STB > 100°C)
13 Water shortage protection, up to 350 kW alternatively $SDB_{min}$ or flow sensors or other approved measures
14 Filling, evacuation device / KFE cock
15 automatic water make-up ('magcontrol'+ 'fillset')
16 Expansion line
17 protected shut-off fitting ('MK cap ball valve')
18 Bleeding / evacuation before MAG
19 Expansion vessel (e.g. 'reflex N')

Letter codes, symbols
→ page 49



1) not required
for an indirect heating if SV (7) may be calculated for the water discharge (see also p. 34)
2) not required
for STB ≤ 100°C and with the installation of an additional STB and $SDB_{max}$

# Equipment - Accessories - Safety Engineering - Inspection

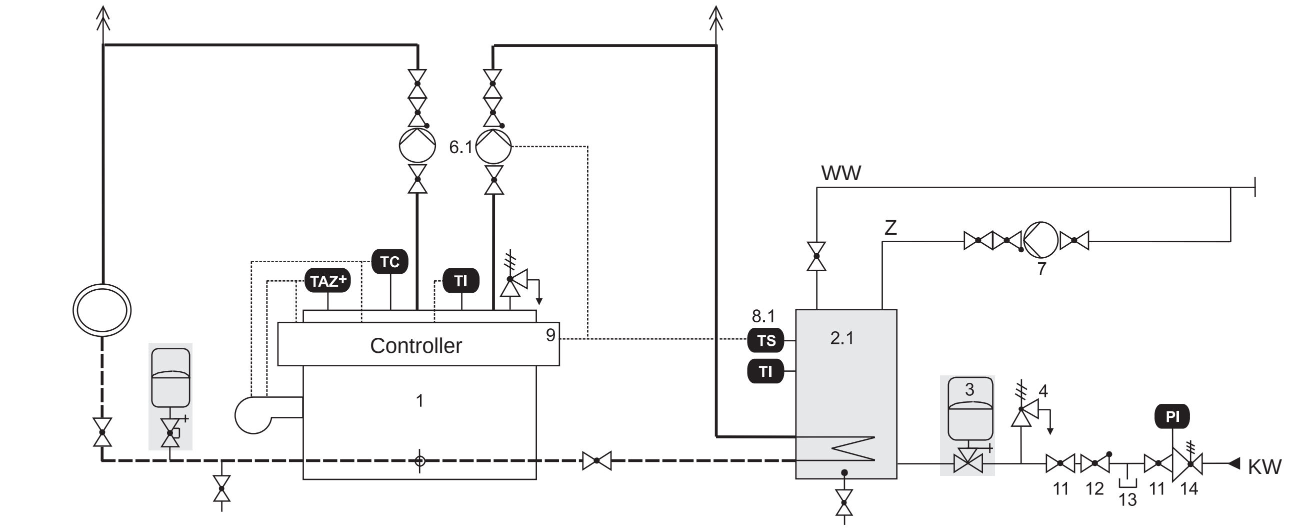
## Safety-related equipment of water heating systems according to DIN 4753 T1

**Requirements to drinking water heating systems**
Drinking water heater closed, indirectly heated
Group classification according to DIN 4753 T1: Gr. I p x I ≤ 300 bar x litre and at the same time $\dot{Q}$ ≤ 10 kW or V ≤ 15 l and $\dot{Q}$ ≤ 50 kW
Gr. II if the limit values according to Gr. I are exceeded

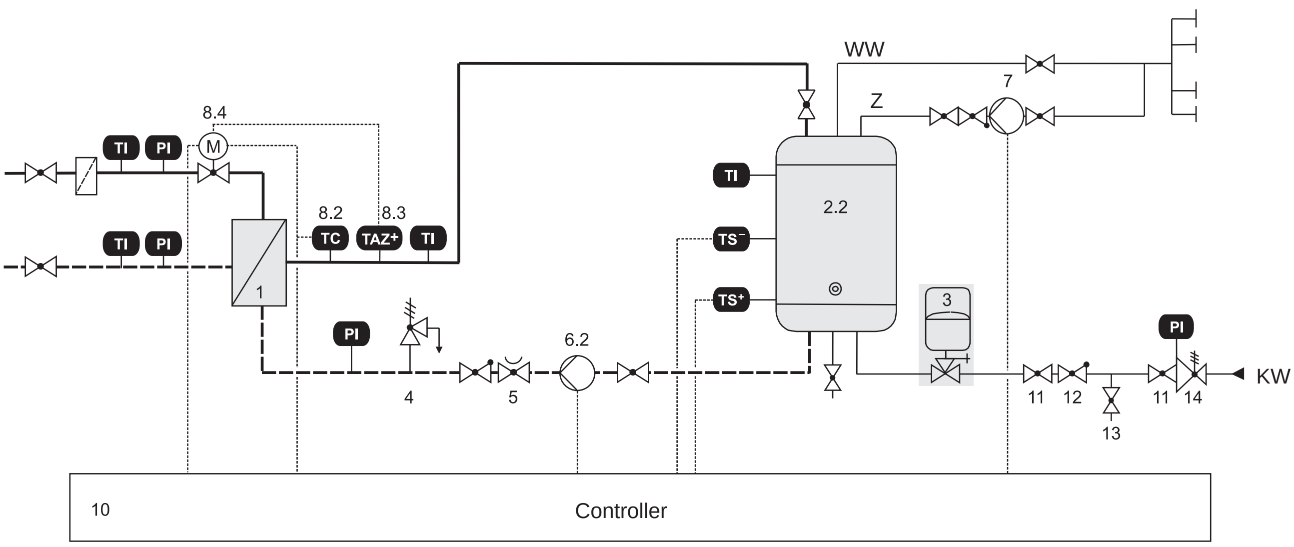
| | |
|---|---|
| **Temperature protection** | DIN 4753 T1, DIN 4747 |
| **Thermometer** | may be a component of the controller, not required for size I |
| **Temperature controller** type-certified | from heating media temperatures > 100°C, target value ≤ 60°C, maximum value 95°C (not required for size I) |
| **Safety temperature limiter** according to DIN 3440 | from heating media temperatures > 110°C, target value ≤ 95°C, maximum value 110°C<br>for V < 5000 l and $\dot{Q}$ ≤ 250 kW no inherent safety according to DIN 3440 required;<br>for district heating systems control valve with safety feature according to DIN 32730 |
| **Pressure protection** | DIN 4753 T1 |
| **Manometer** | prescribed for storages > 1000 l, general installation near the safety valve,<br>recommended in cold water systems |
| **Safety valve**<br>component-inspected according to TRD 721<br>letter code W | - installation in the cold water pipe<br>- no shut-offs and inadmissible throats between water heater and safety valve<br>Nominal contents water space / max. heating capacity / Nominal connection width<br>≤ 200 l / 75 kW / DN 15<br>≤ 1.000 l / 150 kW / DN 20<br>≤ 5000 l / 250 kW / DN 25<br>>5.000 l / Selection according to the max. heating capacity |
| **pressure reducer**<br>DVGW-certified | required: - if the pressure of the cold water supply pipe > 80% of the safety valve opening pressure<br>- with the installation of diaphragm pressure expansion vessels (MAG-W according to DIN 4807 T5) to ensure a constant non-operative pressure level before the vessel |
| **Diaphragm pressure expansion vessels**<br>MAG-W<br>DIN 4807 T5 | - requirements DIN 4807 T5: Flow-through under defined conditions<br>Colour green<br>Diaphragms and non-metallic parts at least according to KTW C<br>Installation of a pressure reducer<br>protected shut-off of the MAG<br>- Admission pressure setting 0.2 bar below pressure reducer |
| **Protection of the drinking water** | DIN 4751 T1, DIN 1988 T2, T4 |
| **Return valve**<br>DVGW-certified | prescribed for drinking water heaters > 10 litres, to be shut off on both sides, after the first shut-testing device to be provided |
| **Design of the Drinking water heaters**<br>according to DIN 1988 T2 for heating medium heating water class 3 according to DIN 1988 T4 (without or with few toxic additives, e.g. ethylene glycol, copper sulphate solution), for other media and designs see DIN | **Design B**, corrosion-proof heating surfaces and linings (CU, special steel, enamelled)<br>e.g. plate heat exchangers reflex 'longtherm'<br>admissible for max. operating pressure on the heating side ≤ 3 bar |
| | **Design C** = B + no detachable connections, the quality of perfect bondings<br>must be proven by means of a procedural check (e.g. the AD leaflets, HP series)<br>e.g. tube heat exchangers also admissible for max. operating pressure on the heating side > 3 bar |

## Safety-related equipment of water heating systems according to DIN 4753 T1

**Example A:** Water heating systems in the storage system, boiler protection ≤ 100°C




**Example B:** Water heating systems in the storage load system, heating medium protected > 110°C






**Legend:**

| | |
|---|---|
| 1 | Heat generator (boiler, heat exchanger) |
| 2.1 | WW storage with integrated heating surface |
| 2.2 | WW storage without heating surface |
| 3 | Diaphragm expansion vessel for drinking water (see also p. 24-25) |
| 4 | Diaphragm SV, letter code W |
| 5 | Quantity adjusting valve |
| 6.1 | Load pump heating side |
| 6.2 | Load pump drinking water side |
| 7 | Circulation pump |
| 8.1 | Heat valve for the activation of the load pump 6.1 |
| 8.2 | type-certified temperature controller |
| 8.3 | type-certified temperature limiter |
| 8.4 | Control valve with safety feature |
| 9 | Boiler control with triggering possibility of a warm water heating |
| 10 | Heating control with triggering possibility of a storage load system |
| 11 | Shut-off valve |
| 12 | Return valve |
| 13 | Testing device |
| 14 | Pressure reducer |

11–14: Deployment also as combi fitting in combination with safety valve 4

Letter codes, symbols
→ page 49

## Inspection and maintenance of systems and pressure vessels

**Reasons for the inspection**

Pressure vessels can be diaphragm pressure expansion vessels, auxiliary vessels, blow-off vessels, but also heat exchangers or heating boilers. They provide a risk potential that is mainly determined by the pressure, the volume, the temperature, and the medium itself.

Special requirements that are legally set forth apply to the manufacturing, commissioning, and operation of pressure vessels and entire systems.

**Manufacturing according DGRL**

The manufacturing with the **original inspection** performed by the manufacturer and the marketing of pressure devices has been subject to the **Directive 97/23/EC on Pressure Equipment (DGRL)** since 1 June 2002. The Directive applies to all European countries. According to this Directive, only pressure devices complying with the Directive may be put on the market.

Reflex diaphragm pressure expansion vessels comply with the Directive 97/23/EC and are labelled CE with 0044.

“0044” stands for the RWTÜV as notified inspection agency.

The new thing for the customers is that the manufacturer’s certificate that had been issued according to the regulations on steam boilers or the pressure vessel directive is replaced by a so-called **declaration of conformity**. → page 48



For Reflex pressure vessels, the declaration of conformity is part of the included installation, operating, and maintenance instruction.

**Operation according to BetrSichV**

In the sense of the regulations, operation is considered to be the installation, the operation, the **inspection prior to the (German Operational Safety Regulation)** commissioning and the **recurring inspections** of systems that are subject to a monitoring procedure. If the control was previously performed according to the pressure vessel and steam boiler regulation in Germany, the **Operational Safety Regulation (BetrSichV)** will be applicable from 1 January 2003.

With the Operational Safety Regulation and the Directive on Pressure Devices, **harmonized regulations** will be available from 1 January 2003 that finally supersedes the previously valid pressure vessel and steam boiler regulation.

The requirement of inspections prior to the commissioning and recurring inspections as well as the body that may perform the inspection is established in dependence on the risk potential according to the provisions of the **DGRL** and the **BetrSichV**. To this purpose, a classification into categories corresponding to the medium (fluid), pressure, volume, temperature according to the conformity assessment diagrams in Appendix II of the **DGRL** is performed. Please refer to tables 1 and 2 (→ page 46) for an evaluation with respect to the Reflex product range. The specified maximum periods apply if the specifications in the corresponding Reflex assembly, operating, and maintenance instruction are observed.

The conformity assessment by the **manufacturer according to the DGRL** is based on the maximum admissible parameters referred to the vessel. With respect to the assessment by the **operator according to the BetrSichV**, the maximum parameters referred to the system may be used. Therefore, the maximum possible pressure that can occur also under extreme operating conditions, during a failure operation and operating errors corresponding to the pressure protection of the system or the system component is to be used for the evaluation and the classification into categories for the pressure PS. The fluid group is to be chosen according to the actual medium.

**§ 14 Inspection prior to the commissioning**
- Assembly, installation
- Installation conditions
- Safe function

**§ 15 Recurring inspections**
- Control inspection
- Technical inspection
  External inspection
  Internal inspection
  Strength test

> With respect to recurring inspections, it is the operator's responsibility to establish the **inspection intervals** based on a **safety assessment** considering the set forth maximum intervals. (Tables 1 and 2, → page 46)

If the system had to be commissioned by an authorized inspection agency **ÜS**, the inspection intervals established by the operator are to be communicated to the competent authority and co-ordinated with the authority.
With respect to the **safety-related assessment**, the following distinction is to be made:
- **overall system** that can consist of multiple pressure devices and is with respect to pressure and temperature set to defined safety-related limit values, e.g. hot water boiler with pressure expansion vessel, protected through the safety valve and the STB of the boiler
- and the **system components**, e.g. hot water boiler and pressure expansion vessel that may belong to different categories and are, thus, assessed differently with respect to the safety-related aspects.

If the overall system only consists of system components that may be inspected by a qualified **qp**, also the overall system may be inspected by a qualified person **qp**.

With respect to external and internal inspections, visual inspections may be replaced by other, equivalent procedures. With respect to strength tests, the static pressure tests may be replaced by equivalent, non-destructive procedures.



**Transitional provisions**

For systems with pressure devices that were initially operated before 01 January, 2003, a transitional period until 31 December, 207 applies. Until that time, the old quality requirements shall apply. The operator is, however, obliged to perform a **safety-related assessment** of the existing systems until the expiration of the above period.

> From 01 January, 2008, the provisions of the BetrSichV (German Operational Safety Regulation) apply to systems subject to a monitoring procedure without limitations.

**Maintenance**

While the provisions of the DGRL and the BetrSichV are mainly focused on the safety-related aspect regarding the health protection, a regular maintenance serves for the guarantee of an optimum, troublefree, and energy-saving operation. The maintenance is performed by an **expert** on behalf of the operator. This can be a plumber or the Reflex service ((→ page 50).

The maintenance of diaphragm pressure expansion vessels is set forth in the **DIN 4807 T2**. It must be performed annually and mainly covers the control and setting of the vessel admission pressure and the system filling or initial pressure. → page 9

Furthermore, we recommend to annually maintain our pressure-maintaining, water make-up, and deaeration systems, analogously to the diaphragm pressure expansion vessels.

> Reflex offers an installation, operating, and maintenance instruction (→ page 48) with the required notes for the installer and the operator for each product.

reflex

**Table 1: Inspection of Reflex pressure vessels according to BetrSichV as of 27 September 2003, for an operation according to the Reflex installation, operation, and maintenance instructions**

applicable to all
- 'reflex', 'refix', 'variomat', 'gigamat', 'reflexomat' vessels and the 'servitec' spray tube independent of the admissible operating temperature

and
- 'V auxiliary vessels', 'EB desludging vessels', and 'longtherm' plate heat exchangers at admissible operating temperatures > 110°C of the system (e.g. STB setting)

**Classification** into fluid group 2, according to DGRL - e.g. water, air, nitrogen = not explosive, not toxic, not easily inflammable.

| **Evaluation/category** according to diagram 2, Appendix II DGRL | **prior to commissioning, § 14 Inspector** | **recurring inspections § 15 Inspector** | **Maximum intervals in years: external** [1)] | **internal** [2)] | **strength** [2)] |
|---|---|---|---|---|---|
| V ≤ 1 litre and<br>PS ≤ 1000 bar<br>PS x V ≤ 50 bar x litres | no special requirements, control is the responsibility of the operator according to the state of the art and the specifications contained in the operating instructions [3)] | | | | |
| **'reflex', 'refix', 'V', 'EB', 'longtherm', 'reflexomat', 'variomat', 'gigamat' vessels, 'servitec'** | | | | | |
| PS x V > 50 ≤ 200 bar x litres | qp | qp | no maximum intervals specified [4)] | | |
| PS x V > 200 ≤ 1000 bar x litres | ÜS | qp | no maximum intervals specified [4)] | | |
| PS x V > 1000 bar x litres | ÜS | ÜS | —- | 5* | 10 |

* Recommendation:
for 'reflex' and 'refix' with bubble diaphragm and 'variomat' and 'gigamat' vessels max. 10 years, at least, however, during an opening in the framework of maintenance works (e.g. exchange of diaphragm) according to Appendix 5 Section 2 and Section 7 BetrSichV



**Table 2: Inspection according to BetrSichV for reflex 'longtherm' soldered plate heat exchangers in systems with hazardous media with an operation according to the Reflex installation, operating, and maintenance instructions**

**Classification** into fluid group 1, e.g. benzene = explosive, highly inflammable, toxic, fire promoting. This fluid group is only admissible for 'longtherm'!
applicable at admissible operating temperatures $t > t_{boiling}$ at atmospheric pressure + 0.5 bar

| **Evaluation/category** according to diagram 1, Appendix II DGRL | **prior to commissioning, § 14 Inspector** | **recurring inspections § 15 Inspector** | **Maximum intervals in years: external** [1)] | **internal** [2)] | **strength** [2)] |
|---|---|---|---|---|---|
| V ≤ 1 litre and<br>PS ≤ 200 bar<br>PS x V ≤ 25 bar x litres | no special requirements, control is the responsibility of the operator according to the state of the art and the specifications contained in the operating instructions | | | | |
| PS x V > 25 ≤ 200 bar x litres<br>PS ≤ 200 bar | qp | qp | no maximum intervals specified [4)] | | |
| PS x V > 200 ≤ 1000 bar x litres<br>PS ≤ 200 bar | ÜS | qp | no maximum intervals specified [4)] | | |
| PS x V > 1000 bar x litres | ÜS | ÜS | —- | 5 | 10 |

Note:
'longtherm' plate heat exchangers are to be put into the higher category of the two chambers.

Note: If the Evaluation/category column contains multiple criteria without an “and” relation, the next higher category is to be entered even if only one criterion is exceeded.

PS maximum possible excess pressure in bar that may occur due to the type of the system and the mode of operation
V Nominal volume in litres
qp qualified person according to § 2 (7) BetrSichV who provides of the required specialized knowledge for the inspection of the working substances (pressure devices) due to his/her professional education, professional experience and professional activity
ÜS authorized inspection agency according to § 21 BetrSichV, until further notice the TÜV

[1] External inspections every 2 years are not required for the usual Reflex applications. Only required if the pressure device is heated with fire, waste gas, or electrically.
[2] **Visual inspections** and **strength tests** can be replaced by other suitable inspection procedures if their execution is not possible for reasons of the pressure vessel design or if it is not useful for reasons of the mode of operation (e.g. stationary diaphragm).
The strength test does not have to be performed for ‘refix’ if no damage of the diaphragm and the coating was detected during the internal inspection (Appendix 5, 7.(1) BetrSichV).
[3] Referred to the admissible excess operating pressure of the **device**, the following products are concerned:
‘reflex’ up to N 12 litres/3 bar, ‘servitec’ type ≤ 120
‘longtherm’ rhc 15, rhc 40 ≤ 50 plates, rhc 60 ≤ 30 plates
[4] Determination based on manufacturer information and experience with the operation mode and the charging material. The inspection may be performed by a qualified person qp according to § 2 (7) BetrSichV.

## ’reflex’

**Montage-, Betriebs- und Wartungsanleitung**
**Installation, operating and maintenance instructions**

**General notes on safety**

’reflex’ Membran-Druckausdehnungsgefäße sind Druckgeräte im Sinne der EU Richtlinie 97/23/EG. Eine Membrane teilt das Gefäß in einen Wasser- und Gasraum mit Druckpolster.

**Qualified persons**
Prüfungs- und Instandsetzungsarbeiten dürfen nur durch autorisierte Personen, Installations- und Wartungsarbeiten nur durch Fachpersonal und der Betrieb nur durch eingewiesene Personen durchgeführt werden.

**Installation**
Es dürfen nur ’reflex’ ohne äußere sichtbare Schäden am Druckkörper installiert und betrieben werden.

**Veränderungen am Gefäß**,
z. B. Schweißarbeiten oder mechanische Verformungen, sind unzulässig. Bei Austausch von Teilen sind nur die Originalteile des Herstellers zu verwenden.

**Observing the parameters**
Angaben zum Hersteller, Baujahr, Herstellnummer sowie die technischen Daten sind dem Typenschild zu entnehmen. Es sind geeignete sicherheitstechnische Maßnahmen zu treffen, damit die angegebenen zulässigen max. und min. Betriebsparameter nicht über- bzw. unterschritten werden. Eine Überschreitung des zulässigen Betriebsüberdruckes wasser- und gasseitig sowohl im Betrieb als auch beim gasseitigen Befüllen ist auszuschließen. Der Gasvordruck $p_0$ darf keinesfalls den zul. Betriebs-überdruck überschreiten. Selbst bei Gefäßen mit zul. Betriebsüberdruck größer 4 bar darf der Gasvordruck bei Lagerung und Transport nicht mehr als 4 bar betragen. Zur Gasbefüllung ist vorzugsweise ein Inertgas, z. B. Stickstoff, zu verwenden.

**Corrosion**
’reflex’ sind aus Stahl gefertigt, außen beschichtet und innen roh. Der Einsatz darf nur in atmosphärisch geschlossenen Systemen mit nicht aggressiven und nicht giftigen Wassern erfolgen. Der Zutritt von Luftsauerstoff in das gesamte Heiz- und Kühlwasser-system durch Permeation, Trinkwassernachspeisung usw. ist im Betrieb nach dem aktuellen Stand der Technik zuverlässig zu minimieren.

**Heat insulation**
In Heizwasseranlagen ist bei Personengefährdung durch zu hohe Oberflächentemperaturen vom Betrei-ber ein Warnhinweis in der Nähe des ’reflex’ Gefäßes anzubringen.

**Aufstellungsort**
Eine ausreichende Tragfähigkeit des Aufstellortes ist unter Beachtung der Vollfüllung des ’reflex’ mit Wasser sicherzustellen. A discharge is to be provided for the evacuation water. If required, the addition of cold water is to be planned.

Das Missachten dieser Anleitung, insbesondere der Sicherheitshinweise, kann zur Zerstörung und Defekten am ’reflex’ Gefäß führen, Personen gefährden sowie die Funktion beeinträchtigen. Bei Zuwiderhandlung sind jegliche Ansprüche auf Gewährleistung und Haftung ausgeschlossen.

**General safety instructions**

’reflex’ diaphragm pressure expansion vessels are pressure devices in terms of the EU guidelines 97/23/EC. They have an gas cushion. A diaphragm separates ’reflex’ in a gas and a water space.

**Qualified Persons**
Inspection and repair operations may only be performed by authorised persons, installation and maintenance operations only by specialist personnel.

**Installation**
Only ‘reflex’ without visible external damage to the pressure body may be installed and operated.

**Changes to the vessel**
for instance welding operations or mechanical deformations are impermissible. Only original parts of the manufacturer may be used when replacing parts.

**Observe the parameters**
Details concerning manufacturer, year of manufacture, serial number and the technical data are provided on the name plate. Suitable measures must be taken so that the specified permissible maximum and minimum operating parameters are adhered to. Exceeding the

**Konformitätserklärung** für eine Baugruppe
**Declaration of conformity** of an assembly

Konstruktion, Fertigung, Prüfung von Druckgeräten
Design - Manufacturing - Product Verification

Angewandtes Konformitätsbewertungsverfahren nach Richtlinie für Druckgeräte 97/23/EG des Europäischen Parlaments und des Rates vom 29. Mai 1997
Operative Conformity Assessment according to Pressure Equipment Directive 97/23/EC of the European Parliament and the Council of 29 May 1997

**Druckgefäße: ’reflex F’, ’N’, ’S’, ’A’, ’E’, ’G’**
sind universell einsetzbar für Heizungs-, Solar- und Kühlwasseranlagen.

**Pressure vessels: ’reflex F’, ’N’, ’S’, ’A’, ’E’, ’G’**
are in operation for Heating-, Solar-, Cooling Plants.

| | | |
|---|---|---|
| Angaben zum Behälter und Betriebsgrenzen<br>Data about the vessel and working limits | gemäß Typenschild<br>according to the name plate | |
| Beschickungsgut<br>Operating Medium | Wasser / Inertgas gemäß Typenschild<br>Water / Inert gas according to the name plate | |
| Normen, Regelwerk<br><br>Standards | Druckgeräterichtlinie, prEN 13831:2000<br>oder AD 2000 gemäß Typenschild<br>Pressure Equipment Directive, prEN 13831:2000<br>or AD 2000 according to the name plate | |
| Druckgerät<br><br>Pressure Equipment | Baugruppe: Artikel 3 Abs. 2.2<br>Behälter: Artikel 3 Abs. 1.1a) 2. Gedankenstr. (Anhang II Diagr. 2)<br>Membrane, Ventil, Manometer (soweit vorhanden): Artikel 3 Abs. 1.4<br>assembly: article 3 paragraph 2.2<br>vessel: article 3 paragraph 1.1a) 2. bar (enclosure II Diagraph 2)<br>diaphragm, valve, manometer (as available): article 3 paragraph 1.4 | |
| Fluide Gruppe<br>Fluid Group | 2 | |
| Kategorie (Behälter, Baugruppe)<br>Category (vessel, assembly) | Modul<br>module | Kennzeichnung gem. Druckgeräterichtlinie<br>Label acc. to Pressure Equipment Directive 97/23/EC |
| I, II, III, IV | B+D | CE 0044 |
| I (Typ F) | A | CE |
| Notified body for EC type testing (module B) and evaluation of the quality assurance system (module D)<br>Notified Body for EG inspection (module B), and evaluation of quality assurance system (module D). | RWTÜV Systems GmbH<br>Langemarckstr. 20, D - 45141 Essen | |
| Registrier-Nr. der Benannten Stelle<br>Registration No. of the Notified Body | 0044 | |
| Hersteller:<br>Manufacturer:<br>**Reflex Winkelmann GmbH + Co. KG**<br>Gersteinstraße 19<br>D - 59227 Ahlen/Westf.<br>Phone: ++49 (0) 2382 / 7069-0<br>Fax: ++49 (0) 2382 / 7069-588 | Der Hersteller bescheinigt hiermit, dass Konstruktion, Herstellung und Prüfung dieser Baugruppe den Anforderungen der Richtlinie 97/23/EG entsprechen.<br>The manufacturer herewith certifies that construction, production and examination of this assembly are in conformity with directive 97/23/EC.<br><br>Franz Tripp<br>Geschäftsführer / Managing director | |

Example:
Reflex installation, operation, and maintenance instruction with declaration of conformity according to DGRL

# Terms, letter codes, symbols

## Terms

| Formula letter | Explanation | see page |
|---|---|---|
| $A_D$ | Working area of the pressure maintenance | 18 |
| $A_{SV}$ | Blow-down pressure difference for safety valves | 5, 9 |
| $n$ | Expansion coefficient for water | 6, 10, 24 |
| $n^*$ | Expansion coefficient for water compounds | 6, 13, 16 |
| $nR$ | Expansion coefficient referred to the return temperature 11 | |
| $p_0$ | Minimum operating pressure | 5, 9, 18, 23, 24 |
| $p_a$ | Initial pressure | 5, 9, 18, 23, 24 |
| $p_D$ | Evaporation pressure for water | 6 |
| $p_D^*$ | Evaporation pressure for water compounds | 6 |
| $p_e$ | Final pressure | 5, 9, 18 |
| $p_F$ | Filling pressure | 5, 9 |
| $p_{st}$ | static pressure | 5, 9 |
| $p_{SV}$ | Safety valve opening pressure | 5, 9 |
| $p_Z$ | Minimum flow pressure for pumps | 7 |
| $p_{adm}$ | admissible excess operating pressure | 7 |
| $\dot{V}$ | Compensating volume flow | 19 |
| $V_A$ | System volume | 6 |
| $v_A$ | Specific water content | 6 |
| $V_e$ | Expansion volume | 5, 9, 23 |
| $V_K$ | Collector contents | 12, 14, 39 |
| $V_n$ | Nominal volume | 9, 18 |
| $V_V$ | Hydraulic back pressure | 5, 9 |
| $\Delta p_P$ | Pump difference pressure | 7 |
| $\rho$ | Density | 6 |

## Letter codes

**T – Temperature**

| | |
|---|---|
| T | Temperature measurement connector |
| TI | Thermometer |
| TIC | Temperature controller with display |
| TAZ$^+$ | Temperature limiter, STB, STW |

**P – Pressure**

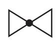
| | |
|---|---|
| P | Pressure measurement connector |
| PI | Manometer |
| PC | Pressure controller |
| PS | Pressure switch |
| PAZ$^-$ | Pressure limiter - min, $SDB_{min}$ |
| PAZ$^+$ | Pressure limiter - max, $SDB_{max}$ |

**L – Water level**

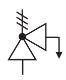
| | |
|---|---|
| LS | Water level switch |
| LS$^+$ | Water level switch - max |
| LS$^-$ | Water level switch - min |
| LAZ$^-$ | Water level limiter - min |

Letter codes according to DIN 19227 T1, “Graphical symbols and letter codes for the process measurement and control equipment”

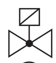
## Symbols

 Shut-off fitting

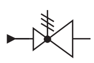
 Fitting with protected shut-off and evacuation

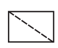
 Spring safety valve

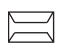
 Return valve

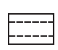
 Solenoid valve

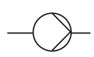
Motor operated valve

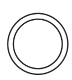
 Overflow valve

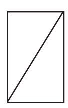
 Dirt trap

 Water meter

 System separator

 Pump

 Thermal consumer

 Heat exchanger

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reflex

# Quick selection table for ‘reflex N’ and ‘reflex S’

Heating systems : 70/50°C heating surfaces: Flat radiators
for an extensive calculation also for other parameters or vessel types see p. 17 and our ‘Reflex 4’ calculation program

| Safety valve $p_{sv}$ | bar | 2,5 | | | $V_n$ | 3,0 | | | | $V_n$ | 4,0 | | | | $V_n$ | 5,0 | | | | | $V_n$ | 6,0 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Admission pressure $p_0$ | bar | 0,5 | 1,0 | 1,5 | litres | 0,5 | 1,0 | 1,5 | 1,8 | litres | 1,5 | 2,0 | 2,5 | 3,0 | litres | 2,0 | 2,5 | 3,0 | 3,5 | 4,0 | litres | 2,0 | 2,5 | 3,0 | 3,5 | 4,0 | 5,0 |
| | kW | 10 | 4 | — | **8** | 11 | 7 | 3 | — | **8** | 7 | 4 | 1 | — | **8** | 8 | 5 | 2 | — | — | **8** | 11 | 8 | 6 | 3 | 1 | — |
| | kW | 14 | 6 | — | **12** | 18 | 11 | 4 | — | **12** | 11 | 6 | 1 | — | **12** | 12 | 8 | 3 | — | — | **12** | 16 | 12 | 9 | 5 | 1 | — |
| | kW | 24 | 11 | — | **18** | 29 | 18 | 8 | 2 | **18** | 19 | 11 | 4 | — | **18** | 20 | 14 | 7 | 1 | — | **18** | 26 | 21 | 16 | 10 | 4 | — |
| | kW | 37 | 21 | 4 | **25** | 44 | 30 | 16 | 8 | **25** | 32 | 21 | 10 | — | **25** | 32 | 24 | 15 | 6 | — | **25** | 41 | 33 | 26 | 18 | 11 | — |
| | kW | 55 | 34 | 11 | **35** | 65 | 47 | 27 | 16 | **33** | 46 | 32 | 17 | 3 | **33** | 47 | 35 | 24 | 11 | — | **33** | 55 | 48 | 38 | 28 | 18 | — |
| | kW | 80 | 55 | 19 | **50** | 90 | 70 | 44 | 27 | **50** | 70 | 55 | 32 | 10 | **50** | 75 | 60 | 41 | 24 | 6 | **50** | 85 | 75 | 60 | 48 | 33 | 3 |
| | kW | 130 | 85 | 24 | **80** | 150 | 110 | 75 | 37 | **80** | 110 | 85 | 55 | 17 | **80** | 120 | 95 | 70 | 46 | 17 | **80** | 140 | 120 | 100 | 80 | 60 | 12 |
| installed heating | kW | 160 | 110 | 30 | **100** | 180 | 140 | 90 | 46 | **100** | 140 | 110 | 70 | 20 | **100** | 150 | 120 | 90 | 60 | 17 | **100** | 170 | 150 | 120 | 100 | 75 | 18 |
| capacity $\dot{Q}$ | kW | 220 | 150 | 41 | **140** | 260 | 190 | 130 | 65 | **140** | 200 | 150 | 100 | 29 | **140** | 200 | 160 | 120 | 80 | 24 | **140** | 240 | 210 | 170 | 140 | 100 | 20 |
| | kW | 320 | 210 | 60 | **200** | 370 | 270 | 180 | 90 | **200** | 280 | 210 | 140 | 41 | **200** | 290 | 230 | 170 | 120 | 34 | **200** | 340 | 300 | 250 | 200 | 150 | 29 |
| | kW | 400 | 270 | 75 | **250** | 460 | 340 | 230 | 120 | **250** | 360 | 270 | 180 | 50 | **250** | 360 | 290 | 220 | 150 | 42 | **250** | 430 | 370 | 310 | 250 | 190 | 36 |
| | kW | 480 | 320 | 90 | **300** | 550 | 410 | 270 | 140 | **300** | 430 | 320 | 210 | 60 | **300** | 440 | 350 | 260 | 170 | 50 | **300** | 520 | 440 | 370 | 300 | 220 | 43 |
| | kW | 640 | 430 | 120 | **400** | 730 | 550 | 370 | 190 | **400** | 570 | 430 | 280 | 80 | **400** | 580 | 470 | 350 | 230 | 70 | **400** | 690 | 590 | 490 | 390 | 300 | 60 |
| | kW | 800 | 530 | 150 | **500** | 910 | 690 | 460 | 230 | **500** | 710 | 530 | 360 | 100 | **500** | 730 | 580 | 440 | 290 | 85 | **500** | 860 | 740 | 620 | 490 | 370 | 70 |
| | kW | 960 | 640 | 180 | **600** | 1100 | 820 | 550 | 280 | **600** | 850 | 640 | 430 | 120 | **600** | 870 | 700 | 520 | 350 | 100 | **600** | 1030 | 890 | 740 | 590 | 440 | 85 |
| | kW | 1280 | 850 | 240 | **800** | 1460 | 1100 | 730 | 370 | **800** | 1140 | 850 | 570 | 160 | **800** | 1160 | 930 | 700 | 470 | 140 | **800** | 1380 | 1180 | 990 | 790 | 590 | 120 |
| | kW | 1600 | 1070 | 300 | **1000** | 1830 | 1370 | 910 | 460 | **1000** | 1420 | 1070 | 710 | 200 | **1000** | 1460 | 1160 | 870 | 580 | 170 | **1000** | 1720 | 1480 | 1230 | 990 | 740 | 140 |

**Reflex recommendations:**

- select a safety valve opening pressure that is high enough: $p_{SV} \geq p_0 + 1.5$ bar
- If possible, choose an additional factor of 0.2 bar for the calculation of the gas admission pressure: $p_0 \geq \frac{H\,[m]}{10} + 0.2$ bar
- Due to the required flow pressure for the circulating pumps, choose an admission pressure of at least 1 bar for central roof units: $p_0 \geq 1$ bar
- Set the water side filling or initial pressure for a bled system in the cold state at least 0.3 bar above the admission pressure: $p_F \geq p_0 + 0.3$ bar

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