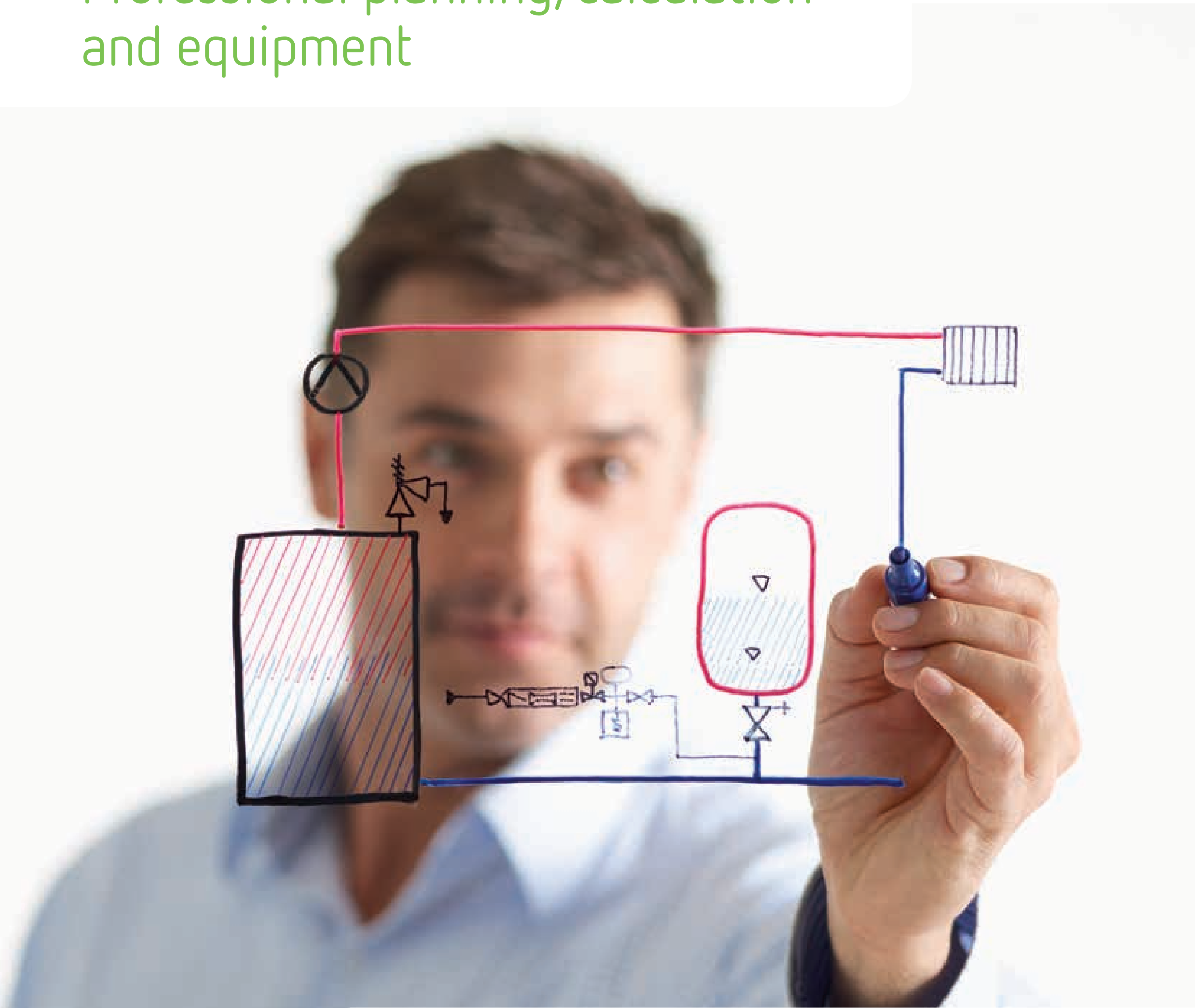
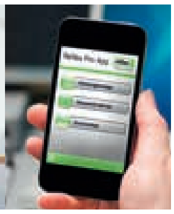
reflex

Thinking solutions.

Professional planning, calculation and equipment



Compact professional expertise for pressure maintenance, degassing, water make-up and water treatment systems



Cooke Industries - Phone: +64 9 579 2185 Email: sales@cookeindustries.co.nz Web: www.cookeindustries.co.nz

We are only satisfied if you

Reflex has set itself the goal of supporting you with well thought-out solutions. Whatever job you need doing in water supply engineering, why not put your trust in our comprehensive range of products and accompanying tailored services? We will ensure that your decision to opt for Reflex is the right one in every respect – from advice and design to installation and ongoing operation.

reflex

Thinking solutions.

Reflex's mission is embodied in the company's slogan: "Thinking solutions". Reflex's strength is to think in terms of solutions. Reflex develops ideas that help you to move forward based on decades of experience, in-depth technical understanding and our intimate knowledge of the industry!

are.

We make sure that everything fits

Heating, cooling and hot water supply systems – the demands on supply equipment are varied and complex. The range of services from Reflex offers a wide selection of products to meet any demand, which according to requirements can be used individually or combined to form carefully designed solutions. All our products reflect the fundamental understanding that Reflex has gathered through its intensive engagement with water supply engineering systems in all areas of water supply engineering.

In this brochure, we have compiled the essential notes and information regarding the planning, calculation and equipment of Reflex systems for the most common applications. Here we include the most important calculation parameters and physical principles, as well as insights into current legal framework conditions and additional technical recommendations. Should have any further questions, your Reflex sales contact will be happy to help.

Contents

The aim of this guide is to provide you with the most important information required to plan, calculate and equip Reflex pressure-maintaining, degassing and heat exchanger systems. Calculation forms are provided for individual systems. Overviews detail the most important auxiliary variables and properties for calculation as well as relevant requirements for safety equipment.

Please contact us if you require any additional information. We will be happy to help you.

- Calculation forms
- Auxiliary variables

Standards, guidelines

Standards, guidelines
The following standards and guidelines contain basic information on planning, calculation, equipment and operation:

DIN EN 12828	Heating systems in buildings – Planning of hot water heating systems
DIN 4747 T1	District heating systems, safety equipment
DIN 4753 T1	Water heaters and water heating systems
DIN EN 12976/77	Thermal solar systems
VDI 6002 (Draft)	Solar heating for potable water
VDI 2035 Part 1	Prevention of damage through scale formation in domestic hot water and water heating systems
VDI 2035 Part 2	Prevention of damage through water-side corrosion in water heating systems
EN 13831	Closed expansion vessels with built in diaphragm for installation in water systems
DIN 4807	Expansion vessels
DIN 4807 T1	Terms...
DIN 4807 T2	Calculation in conjunction with DIN EN 12828
DIN 4807 T5	Expansion vessels for potable water installations
DIN 1988	Technical rules for potable water installations, pressure increase and reduction
DIN EN 1717	Protection against pollution of potable water
DGRL	Pressure Equipment Directive 97/23/EC
BetrSichV	German Ordinance on Industrial Safety and Health (as of 01/01/2003)
EnEV	Energy Saving Ordinance

Planning documentation

The product-specific information required for calculations can be found in the relevant product documents and, of course, at www.reflex.de.

Systems

Not all systems are covered by the standards, nor is this possible. Based on new findings, we therefore also provide you with information for the calculation of special systems, such as solar energy systems, cooling water circuits and district heating systems.
With the automation of system operation becoming ever more important, the pressure monitoring and water make-up systems are thus also discussed, in addition to central deaeration and degassing systems.

Calculation program

Computer-based calculations of pressure-maintaining systems and heat exchangers can be performed via our **Reflex Pro calculation program** which is available for download at www.reflex.de. Alternatively you could use our Reflex Pro app!
Both tools represent a quick and simple means of finding your ideal solution.

Special systems

In the case of special systems, such as pressure-maintaining stations in district heating systems with an output of more than 14 MW or flow temperature over 105 °C, please contact our technical sales department directly.

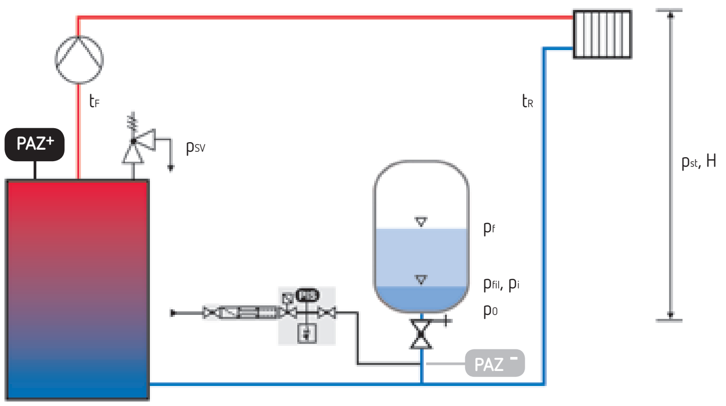
Role of pressure-maintaining systems

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

1. They keep the pressure within permissible limits at all points of the system, thus ensuring that the max. excess operating pressure is maintained while safeguarding a minimum pressure to prevent vacuums, cavitation and evaporation.
2. They compensate for volume fluctuations of the heating or cooling water as a result of temperature variations.
3. Provision for system-based water losses by means of a water seal.

Careful calculation, start-up and maintenance are essential to the correct functioning of the overall system.

Calculation parameters

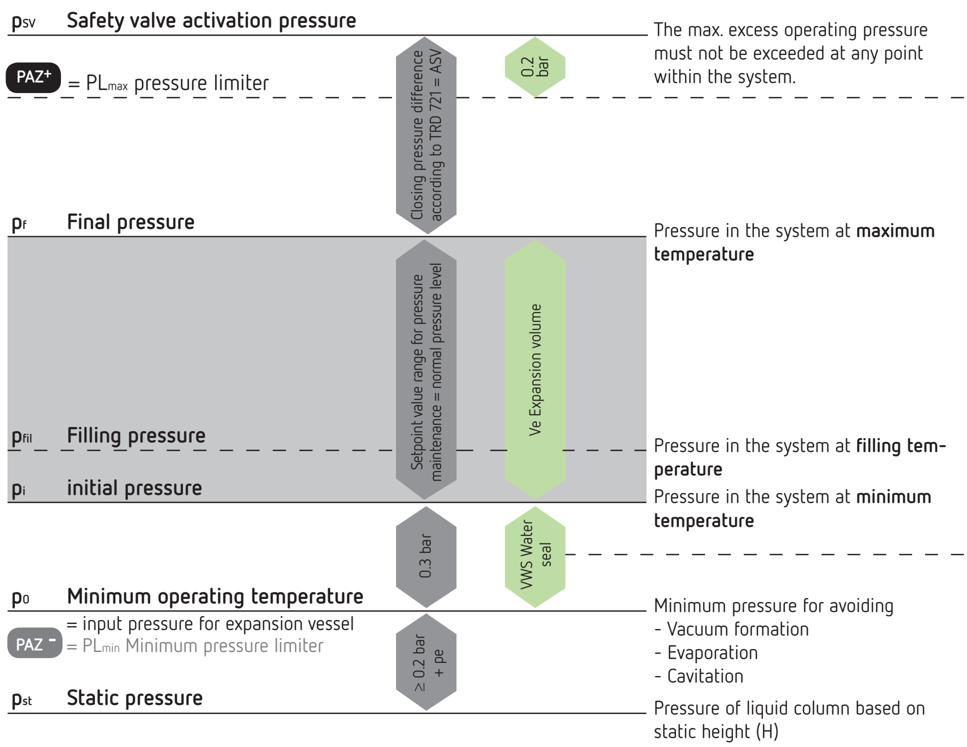


Most common configuration:
- Circulating pump in advance
- Expansion vessel in return

= suction pressure maintenance

Definitions according to DIN EN 12828 and following DIN 4807 T1/T2 based on the example of a heating system with a diaphragm expansion vessel (MAG)

Pressures are given as overpressures and relate to the expansion vessel connection or the pressure gauge on pressure-maintaining stations. The configuration corresponds to the diagram above.



PL_{max} required according to DIN EN 12828 if individual boiler output > 300 kW

Normal pressure range = pressure maintenance setpoint value between p_i and p_f

Water seal V_{WS} to cover system-related water losses

PL_{min} according to DIN EN 12828; to ensure p_0 in hot water systems, an automatic water make-up system is recommended, along with an optional minimum pressure limiter.

Properties and auxiliary variables

Properties of water and water mixtures

Pure water without antifreeze additive

t / °C	0	10	20	30	40	50	60	70	80	90	100	105	110	120	130	140	150	160
n / % (+10 °C for 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_e / 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 addition of antifreeze* 20 % (vol.), lowest permissible 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 for 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_e* / 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 addition of antifreeze* 34 % (vol.), lowest permissible 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 for 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_e* / 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 based on a minimum system temperature of +10 °C (generally filling water)
n* - Percentage expansion for water with antifreeze additive* based on a minimum system temperature of –10 °C to –20 °C
Δn - Percentage expansion for water for calculation of temperature layer containers between 70 °C and max. return temperature
pe - Evaporation pressure for water relative to atmosphere
pe* - Evaporation pressure for water with antifreeze additive
ρ - Density
* - Antifreeze Antifrogen N; when using other antifreeze additives, the relevant properties must be obtained from the manufacturer

Approximate calculation of water content V_s of heating systems

- $V_s = \dot{Q}_{tot} \times v_s$ + pipelines + other → for systems with natural circulation boilers
- $V_s = \dot{Q}_{tot} (v_s - 1.4\ l)$ + pipelines + other → for systems with heat exchangers
- $V_s = \dot{Q}_{tot} (v_s - 2.0\ l)$ + pipelines + other → for systems without heat generators

($\dot{Q}_{tot}$: Installed heating output)

V_s = ---------------------- + --------------------- + -------------------- = -------------------- litres

- Specific water content v_s in litres/kW of heating systems (heat generators, distribution, heating surfaces)

t_F/t_R °C	Radiators: Cast iron radiators	Radiators: Tube and steel radiators	Plates	Convectors	Ventilation	Floor heating
60/40	27.4	36.2	14.6	9.1	9.0	V_s = 20 l/kW V_s** = 20 l/kW $\frac{n_{FH}}{n}$
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	

- Important: approximate values; significant deviations possible in individual cases

** If the floor heating is operated and protected as part of the overall system with lower flow temperatures, v_s** must be used to calculate the total water volume.

n_{FH} = percentage expansion based on the max. flow temperature of the floor heating

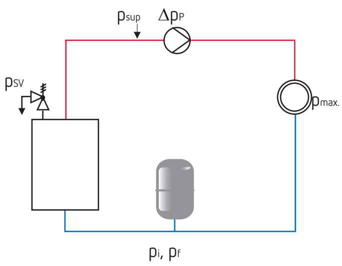
- Approx. water content of heating pipes

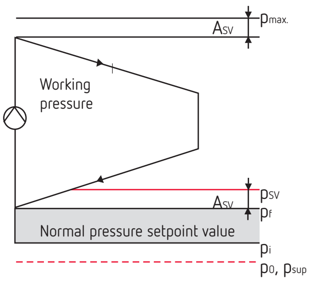
DN	10	15	20	25	32	40	50	60	65	80	100	125	150	200	250	300
Litres/m	0.13	0.21	0.38	0.58	1.01	1.34	2.1	3.2	3.9	5.3	7.9	12.3	17.1	34.2	54.3	77.9

Hydraulic integration

The hydraulic integration of pressure maintenance in the overall system greatly influences the pressure profile. This is made up of the normal pressure level of the pressure maintenance and the differential pressure generated when the circulating pump is running. Three main types of pressure maintenance are distinguished, although additional variants exist in practice.

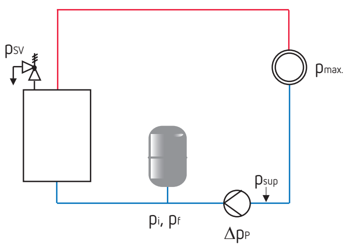
Input pressure maintenance (suction pressure maintenance)
The pressure maintenance is integrated **before** the circulating pump, i.e. on the suction side. This method is used almost exclusively since it is the easiest to manage.

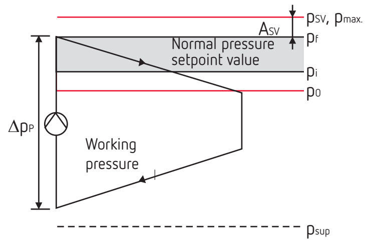




- Advantages:
  - Low normal pressure level
  - Operating pressure > normal pressure, thus no risk of vacuum formation
- Disadvantages:
  - High operating pressure in the case of high circulating pump pressure (large-scale systems) $p_{max.}$ must be observed

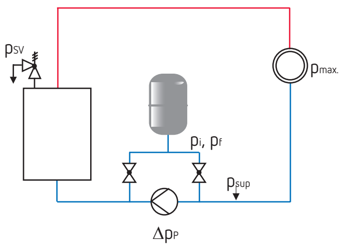
Follow-up pressure maintenance
The pressure maintenance is integrated **after** the circulation pump, i.e. on the pressure side. When calculating the normal pressure, a system-specific differential pressure share of the circulating pump (50 to 100 %) must be included. This method is restricted to a limited number of applications → solar energy systems.

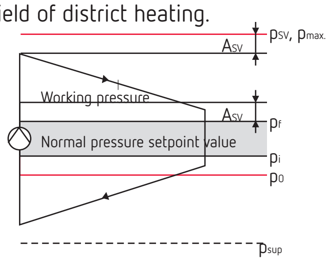




- Advantages:
  - Low normal pressure level, provided the full pump pressure is not required
- Disadvantages:
  - High normal pressure level
  - Increased need to observe the required supply pressure p_{sup} for the circulating pump acc. to manufacturer specifications

Medium pressure maintenance
The measuring point of the normal pressure level is "moved" into the system by means of an analogy measurement section. The normal and operating pressure levels can be perfectly coordinated in a variable manner (symmetrical, asymmetrical medium pressure maintenance). Due to the technically demanding nature of this method, its use is restricted to systems with complicated pressure ratios, mainly in the field of district heating.





- Advantages:
  - Optimised, variable coordination of operating and normal pressure
- Disadvantages:
  - Highly demanding with regard to system technology

Reflex recommendation
Use suction pressure maintenance! A different method should only be used in justified exceptional cases. Contact us for more information!

Special pressure-maintaining systems - overview

Reflex manufactures two different types of pressure-maintaining system:

Input pressure maintenance (suction pressure maintenance)

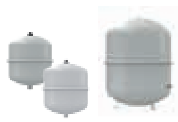
- **Reflex diaphragm expansion vessels with gas cushions** can function without auxiliary energy and are thus also classed as static pressure-maintaining systems. The pressure is created by a gas cushion in the vessel. To enable automatic operation, the system is ideally combined with Reflex Fillcontrol Plus as well as Reflex Servitec make-up and degassing stations.

- **Reflex pressure-maintaining systems with external pressure generation** require auxiliary energy and are thus classed as dynamic pressure-maintaining systems. A differentiation is made between pump- and compressor-controlled systems. While Reflex Variomat and Reflex Gigamat control the pressure in the system directly on the water side using pumps and overflow valves, the pressure in Reflex Minimat and Reflexomat systems is controlled on the air side by means of a compressor and solenoid valve.

Both systems have their own advantages. Water-controlled systems, for example, are very quiet and react very quickly to changes in pressure. Thanks to the unpressurised storage of the expansion water, such systems can also be used as central deaeration and degassing units (Variomat). Compressor-controlled systems, such as Reflexomat, offer extremely flexible operation within the tightest pressure limits, specifically within ± 0.1 bar (pump-controlled approx. ± 0.2 bar) of the setpoint value. A degassing function can also be implemented in this case in combination with Reflex Servitec.

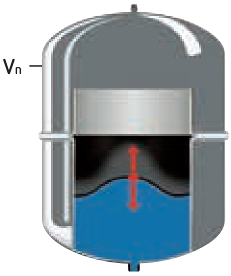
Our Reflex Pro calculation program will help you identify the ideal solution.

- **Preferred applications** are detailed in the following table. Based on experience, we recommend that the pressure maintenance be **automated** – i.e. pressure monitoring with timely water make-up – and that systems be automatically and **centrally vented**. This eliminates the need for conventional air separators and laborious post-venting, while ensuring safer operation and lower costs.

	Flow temp. up to 120 °C	Pressure mainte-nance	Autom. operation with make-up	Central deaeration and degassing	Preferred output range	
Reflex	- Without additional equipment - With Control make-up - With Servitec	X X X	--- X X	--- --- X	up to 1000 kW	
Variomat	1 Single-pump system 2-1 Single-pump system 2-2 Dual-pump system	X X X	X X X	X X X	150 – 2000 kW 150 – 4000 kW 500 – 8000 kW	
Variomat Giga	- Without additional equipment - With Servitec	X X	X X	X* X	5000 – 60,000 kW	
	- Special systems	As required				
Reflexomat Compact	- Without additional equipment - With Control make-up - With Servitec	X X X	--- X X	--- --- X	100 – 2000 kW	
Reflexomat	- Without additional equipment - With Control make-up - With Servitec	X X X	--- X X	--- --- X	150 – 24,000 kW	

* In the case of return temperatures < 70 °C, the Variomat Giga can also be used for degassing purposes without additional equipment.

Reflex diaphragm expansion vessels types: Reflex N, F, S, G



Nominal volume V_n

The pressure in the expansion vessel is generated by a gas cushion. The water level and pressure in the gas space are linked (p x V = constant). Therefore, it is not possible to use the entire nominal volume for water intake purposes. The nominal volume is greater than the water intake volume $V_e + V_{WS}$ by a factor of $\frac{p_f + 1}{p_f - p_0}$.

This is one reason why dynamic pressure-maintaining systems are preferable in the case of larger systems and small pressure ratios ($p_f - p_0$). When using Reflex Servitec degassing systems, the volume of the degassing pipe (5 litres) must be taken into account during sizing.

Without degassing

$$V_n = (V_e + V_{WS})\ \frac{p_f + 1}{p_f - p_0}$$

with Reflex Servitec

$$V_n = (V_e + V_{WS} + 5\ l)\frac{p_f + 1}{p_f - p_0}$$

Pressure monitoring, input pressure p_0, minimum operating pressure

The gas input pressure must be manually checked before start-up and during annual maintenance work; it must be set to the minimum operating pressure of the system and entered on the name plate. The planner must specify the gas input pressure in the design documentation. To avoid cavitation on the circulating pumps, we recommend that the minimum operating pressure not be set to less than 1 bar, even in the case of roof-mounted systems and heating systems in low-rise buildings.

The expansion vessel is usually integrated on the suction side of the circulating pump (input pressure maintenance). In the case of pressure-side integration (follow-up pressure maintenance) the differential pressure of the circulating pumps Δp_P must be taken into account to avoid vacuum formation at high points.

When calculating p_0 we recommend the addition of a 0.2 bar safety margin. This margin should only be dispensed with in the case of very small pressure ratios.

Input pressure maintenance

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

$p_0 \geq 1$ bar Reflex recommendation

Follow-up pressure maintenance

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

Initial pressure p_i, make-up

This is one of the most important pressures! It limits the lower setpoint value range of the pressure maintenance and safeguards the water seal V_{WS}, that is the minimum water level in the expansion vessel.

Accurate checking and monitoring of the input pressure is only ensured if the Reflex formula for the input pressure is followed. Our calculation program takes this into account. With these higher input pressures compared to traditional configurations (larger water seal), stable operation is assured. Known problems with expansion vessels caused by an insufficient or even missing water seal are thus avoided. Particularly in the case of small differences between the final pressure and input pressure, the new calculation method can result in somewhat larger vessels. However, in terms of enhanced operational safety, the difference is insignificant.

Reflex make-up stations automatically monitor and secure the initial or filling pressure. → Reflex make-up stations

Reflex formula for initial pressure

$p_i \geq p_0 + 0.3$ bar

Filling pressure p_{fil}

The filling pressure p_{fil} is the pressure that must be applied, relative to the temperature of the filling water, to fill a system such that the water seal V_{WS} is maintained at the lowest system temperature. In the case of heating systems, the filling pressure and initial pressure are generally the same (minimum system temperature = filling temperature = 10 °C). In cooling circuits with temperatures below 10 °C, for instance, the filling pressure is higher than the initial pressure.

Final pressure p_f

The final pressure restricts the upper setpoint value range of the pressure maintenance. It must be set such that the pressure on the system safety valve is lower by at least the closing pressure difference A_{SV} according to TRD 721. The closing pressure difference depends on the type of the safety valve.

Reflex recommendation

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

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

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

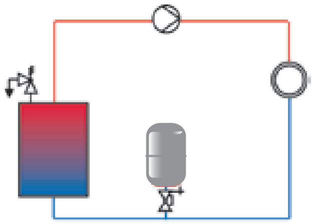
Closing pressure difference according to TRD 721 A_{SV}

SV-H	0.5 bar
SV-D/G/H	0.1 p_{SV} 0.3 bar for $p_{SV} < 3$ bar

Degassing, deaeration

Targeted venting is very important, particularly in the case of closed systems; otherwise, accumulations of nitrogen in particular can lead to troublesome malfunctions and customer dissatisfaction. Reflex Servitec degasses and makes up water automatically. → p. 53

Heating systems



Reflex Variomat
Variomat Giga
Reflexomat

Calculation
According to DIN 4807 T2 and DIN EN 12828.

Configuration
Usually in the form of suction pressure maintenance as per adjacent diagram with circulating pump in advance and expansion vessel in return – i.e. on the suction side of the circulating pump.

Properties n, p_e
Generally properties for pure water without antifreeze additive. → page 6

Expansion volume V_e, highest temperature t_{TR}
Calculation of percentage expansion, usually between lowest temperature = filling temperature = 10 °C and highest setpoint value adjustment of temperature regulator t_{TR}.

Minimum operating pressure p_0
Particularly in the case of low-rise buildings and roof-mounted systems, the low static pressure p_{st} requires that the minimum supply pressure for the circulating pump be verified on the basis of manufacturer specifications. Even with lower static heights, we therefore recommend that the minimum operating pressure p_0 not be set to less than 1 bar.

▶ **Caution** with roof-mounted systems and low-rise buildings
Reflex recommendation: $p_0 \geq 1$ bar

Filling pressure p_{fil}, initial pressure p_i
Since a filling temperature of 10 °C generally equates to the lowest system temperature, the filling pressure and input pressure of an expansion vessel are identical. In the case of pressure-maintaining stations, it should be noted that filling and make-up systems may have to operate at a level approaching the final pressure. This only applies to Reflexomat.

Pressure maintenance
In the form of static pressure maintenance with Reflex N, F, S, G also in combination with make-up and degassing stations, or from approx. 150 kW as a Variomat pressure-maintaining station for pressure maintenance, degassing and water make-up, or in the form of a compressor-controlled Reflexomat pressure-maintaining station. → page 18
In systems with oxygen-rich water (e.g. floor heating with non-diffusion-resistant pipes), Refix D, Refix DE or Refix C are used up to 70 °C (all water-carrying parts corrosion-resistant).

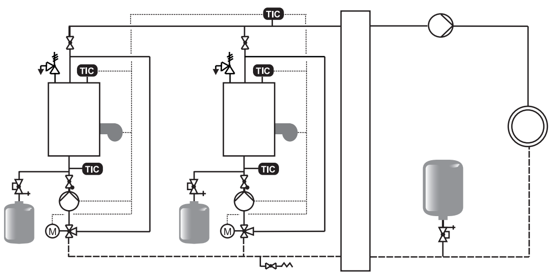
▶ Use Refix in the case of corrosion risk

Degassing, deaeration, water make-up
To ensure ongoing safe and automatic operation of the heating system, the pressure-maintaining units should be equipped with make-up systems and supplemented with Servitec degassing systems. → page 28

Intermediate vessels
If a temperature of 70 °C is permanently exceeded by the pressure maintenance, an intermediate vessel must be installed to protect the diaphragms in the expansion vessel. → page 43

Individual protection
According to DIN EN 12828, all heat generators must be connected to at least one expansion vessel. Only protected shut-offs are permitted. If a heat generator is shut off hydraulically (e.g. in-line boiler circuits), the connection with the expansion vessel must remain intact. Therefore, in the case of multi-boiler systems, each boiler is usually secured with a separate expansion vessel. This is only included in the calculation for the relevant boiler water content.

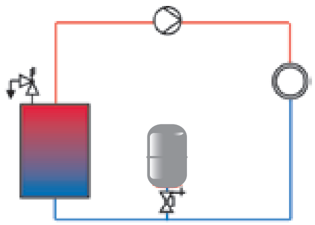
Due to the excellent degassing performance of Variomat, we recommend that the switch frequency be minimised by also fitting a diaphragm expansion vessel (e.g. Reflex N) to the heat generator in this case.



Reflex N, F, G in heating systems

Configuration: Input pressure maintenance, expansion vessel in return, circulating pump in advance, observe information on page 9 for follow-up pressure maintenance.

Object:



▶ at t_R > 70 °C
V intermediate vessel required

Initial data			
Heat generator	1 / 2 / 3 / 4		
Heat output	$\dot{Q}_h$ = ... kW / .... kW / .... kW / .... kW		$\dot{Q}_{tot}$ = ... kW
Water content	V_W = ... litres		
System flow temperature	t_F = ... °C	→ p. 6 Approximate water content $v_s = f(t_F, t_R, Q)$	V_s = ... litres
System return temperature	t_R = ... °C		
Water content known	V_s = ... litres		
Highest setpoint value adjustment Temperature regulator	t_{TR} = ... °C	→ p. 6 Percentage expansion n (with antifreeze additive n*)	n = ... %
Antifreeze additive	= .... %		
Safety temperature limiter	t_{STL} = ... °C	→ p. 6 Evaporation pressure p_e at > 100 °C (with antifreeze additive p_e*)	p_e = ... bar
Static pressure	p_{st} = ... bar		p_{st} = ... bar
Pressure calculation			
Input pressure	p_0 = stat. pressure p_{st} + evaporation pressure p_e + (0.2 bar)[1]		p_0 = ... bar
	p_0 = ...+....................+ (0.2 bar)[1] = ... bar		
Reflex recommendation	p_0 ≥ 1.0 bar		
Safety valve actuation pressure	p_{SV} → Reflex recommendation		p_{SV} = ... bar
	p_{SV} ≥ input pressure p_0 + 1.5 bar for p_{SV} ≤ 5 bar		
	p_{SV} ≥ input pressure p_0 + 2.0 bar for p_{SV} > 5 bar		
	p_{SV} ≥ .... + ... = ... bar		
Final pressure	p_f ≤ safety valve p_{SV} - closing pressure difference according to TRD 721		p_f = ... bar
	p_f ≤ p_{SV} - 0.5 bar for p_{SV} ≤ 5 bar		
	p_f ≤ p_{SV} - 0.1 x p_{SV} for p_{SV} > 5 bar		
	p_f ≤ .... – .... = ... bar		
Vessel			
Expansion volume	$V_e = \frac{n}{100} \times V_s$ = ... x .... = ... litres		V_e = ... litres
Water seal	$V_{WS} = 0.005 \times V_s$ for V_n > 15 litres with V_{WS} ≥ 3 litres		V_{WS} = ... litres
	$V_{WS} \geq 0.2 \times V_n$ for V_n ≤ 15 litres		
	V_{WS} ≥ .... x .... = ... x .... = ... litres		
Nominal volume Without Servitec	$V_n = (V_e + V_{WS}) \times \frac{p_f + 1}{p_f - p_0}$		V_n = ... litres
With Servitec	$V_n = (V_e + V_{WS} + 5 \text{ litres}) \times \frac{p_f + 1}{p_f - p_0}$		
	V_n ≥ .... x .... = ... litres		
	Selected V_n Reflex = ... litres		
Initial pressure check			
Without Servitec	$p_i = \frac{p_f + 1}{1 + \frac{V_e(p_f + 1)(n + n_R)}{V_n(p_0 + 1)\,2n}} - 1 \text{ bar}$		p_i = ... bar
With Servitec	$p_i = \frac{p_f + 1}{1 + \frac{(V_e + 5 \text{ litres})(p_f + 1)(n + n_R)}{V_n(p_0 + 1)\,2n}} - 1 \text{ bar}$		
	p_i = ... / (1+ .... / ....) - 1 bar = ... bar		
	Condition: $p_i \geq p_0$ + 0.25...0.3 bar, otherwise calculation for greater nominal volume		
Result summary			
Reflex ... / ... bar .... litres	Input pressure	p_0 = ... bar → check before start-up	
Refix ... / ... bar .... litres	Initial pressure	p_i = ... bar → check make-up configuration	
Refix only for oxygen-rich water (e.g. floor heating)	Final pressure	p_f = ... bar	

[1] Recommendation

▶ Check rec. supply pressure of circulation pump acc. to manufacturer specifications

▶ Check compliance with max. operating pressure

▶ Filling pressure
=
Initial pressure at 10 °C filling temperature

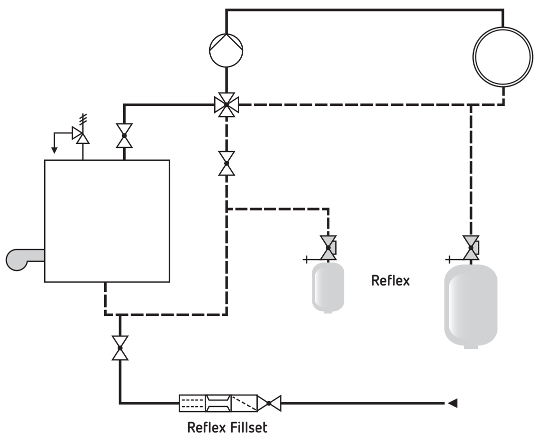
Reflex installation examples (notes for the installer – hydraulic integration)

In accordance with DIN EN 12828:
every heat generator must be connected to one or more expansion vessels by at least one expansion line.

You should select the appropriate circuit as follows:
Diaphragm expansion vessel in boiler return – circulating pump in boiler flow line
- Direct connection between diaphragm expansion vessel and heat generator
- Low temperature load on diaphragm
- Diaphragm expansion vessel on the suction side of the circulation pump to minimise the risk of a vacuum forming

Please consult your specialist adviser in the event of any deviations!

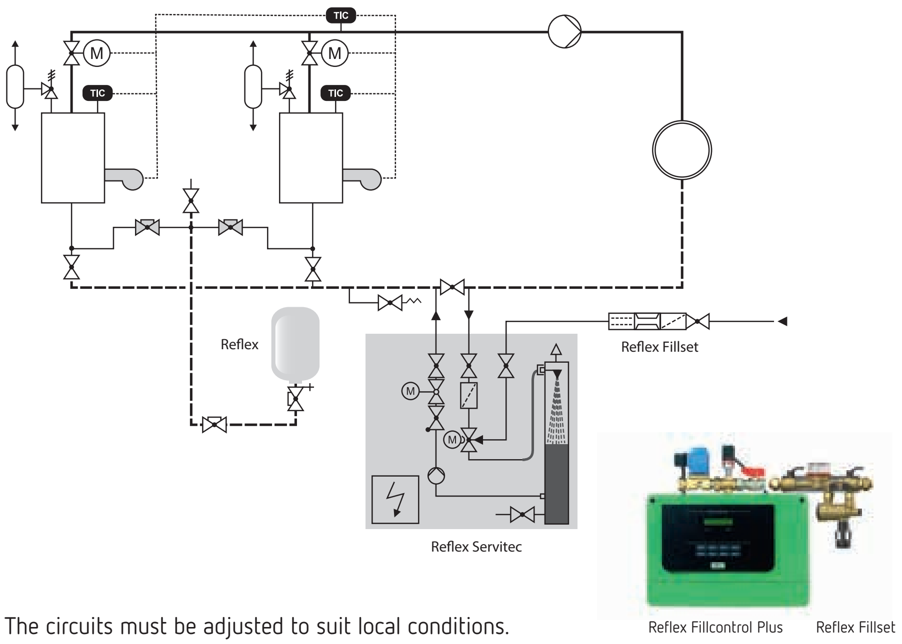
Reflex in a boiler system with 4-way mixer



Notes for the installer

- The boiler and system each have an expansion vessel. This ensures that no vacuum can form in the system circuit, even with fully sealing mixers.
- Reflex Fillset is a pre-packaged valve assembly providing a direct connection to potable water systems for making up and filling the system.

Reflex with automatic filling pressure monitoring



Notes for the installer

- A Reflex Fillcontrol Plus make-up station provides optimum functional support for your Reflex. It ensures your expansion vessel always contains water, which minimises vacuum formation and the ensuing air problems at high points.
- Reflex Fillset with system separator and water meter is easy to connect upstream to provide a direct connection to the potable water system.

→ Brochure Reflex
Water treatment
Make-up volume

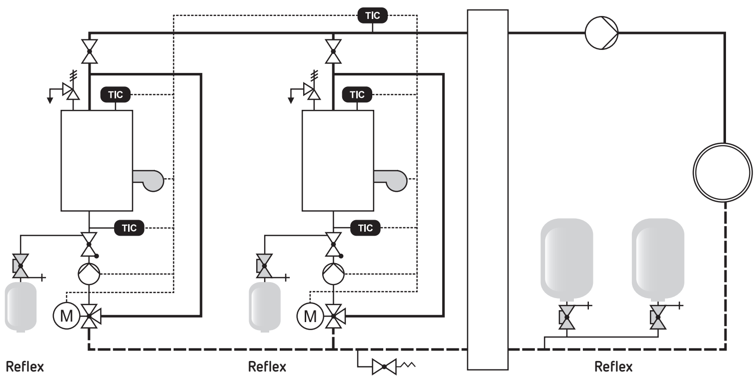
The circuits must be adjusted to suit local conditions.

Reflex installation examples (notes for the installer – hydraulic integration)

In accordance with DIN EN 12828:
every heat generator must be connected to one or more expansion vessels by at least one expansion line.

Which circuit should you choose?
You can have individual protection for each boiler through an expansion vessel, or opt for a common boiler and system protection option. When using shut-offs via boiler sequential circuits, you must ensure that the boiler in question is connected to at least one expansion vessel. It is always best to consult the boiler manufacturer.

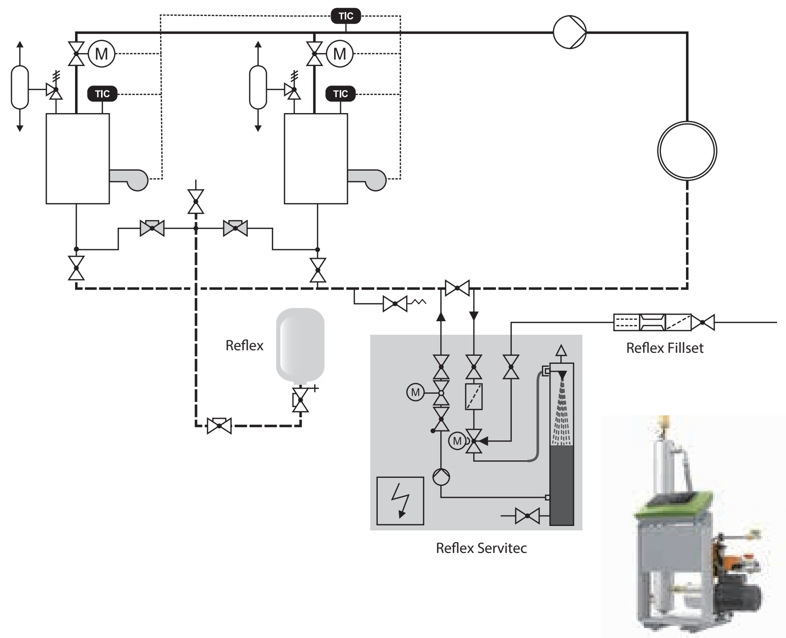
Reflex N - battery circuit in a multi-boiler system with individual protection



Notes for the installer

- Connecting numerous Reflex N 6 or 10 bar vessels to a battery circuit is usually a more cost-effective alternative to using larger Reflex G vessels.
- The burner is used to shut off the corresponding boiler circulating pump and close the motorised valve **M**. This enables the boiler to remain connected to the Reflex. It is the most frequently used circuit for boilers with a minimum return flow temperature, When the burner is switched off, boiler circulation is prevented.

Reflex in a multi-boiler system with common boiler and system protection



Reflex Servitec
vacuum spray tube degassing unit

Notes for the installer

- When the burner is switched off, the corresponding actuator **M** is closed via the temperature control while preventing unwanted circulation in the shut-off boiler. In addition, the boiler expansion line above the centre of the boiler prevents gravity circulation. This is ideally suited to systems without a minimum boiler return flow temperature (e.g. condensing systems).
- Our Reflex Servitec vacuum spray-tube degassing unit guarantees effective system service:
  - Displays and monitors pressure
  - Provides automatic water make up and filling
  - Centrally degasses and bleeds the contained, filling and make-up water

  → Brochure Reflex degassing systems and separation technology

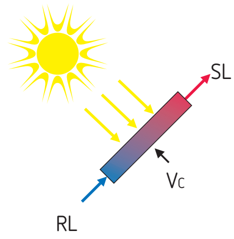
The circuits must be adjusted to suit local conditions.

Solar thermal systems

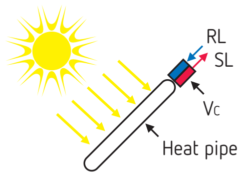
Calculation
On the basis of VDI 6002 and DIN 4807 T2.

In the case of solar heating plants, the highest temperature cannot be defined via the regulator on the heat generator, but instead is determined by the stagnation temperature on the collector. This gives rise to two possible calculation methods.

Direct heating in a flat collector or direct-flow tube collector



Indirect heating in a tube collector according to the heat pipe principle



Note manufacturer specifications for stagnation temperatures!

Nominal volume
Calculation without evaporation in the collector
The percentage expansion n* and evaporation pressure p_e* are based on the stagnation temperature. Since some collectors can reach temperatures of over 200 °C, this calculation method cannot be applied here. In the case of indirectly heated tube collectors (heat pipe system), it is possible for systems to restrict the stagnation temperature. If a minimum operating pressure of $p_0 \leq 4$ bar is sufficient to prevent evaporation, the calculation can usually be performed without taking evaporation into account.

With this option, it should be noted that an increased temperature load will impact the antifreeze effect of the heat transfer medium in the long term.

Nominal volume without evaporation

$$V_n = (V_e + V_{WS}) \frac{p_f + 1}{p_f - p_0}$$

Nominal volume
Calculation with evaporation in the collector
For collectors with stagnation temperatures in excess of 200 °C, evaporation in the collector cannot be excluded. In this case, the evaporation pressure is only included in the calculation up to the desired evaporation point (110 - 120 °C). When calculating the nominal volume of the expansion vessel, the entire collector volume V_c is included in addition to the expansion volume Ve and the water seal V_{WS}.

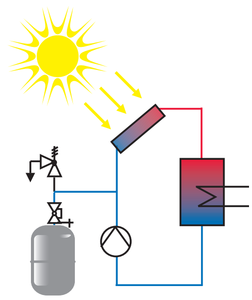
This is the preferred option, as the lower temperature has a lesser impact on the heat transfer medium and the antifreeze effect is maintained for a longer period.

Nominal volume with evaporation

$$V_n = (V_e + V_{WS} + V_c) \frac{p_f + 1}{p_f - p_0}$$

Reflex S in solar thermal systems

Configuration
Since the expansion vessel with safety valve in the return must be installed such that it cannot be shut off from the collector, this inevitably leads to follow-up pressure maintenance, i.e. integration of the expansion vessel on the pressure side of the circulating pump.



Properties n*, p_e*
When determining the percentage expansion n* and the evaporation pressure p_e* antifreeze additives of up to 40 % must be taken into account according to manufacturer specifications.
→ p. 6, properties for water mixtures with Antifrogen N

If calculating with evaporation, the evaporation pressure p_e* is included up to the boiling temperature 110 °C or 120 °C. The percentage expansion n* is then determined between the lowest ambient temperature (e.g. -20 °C) and the boiling temperature.

With evaporation
p_e* = 0
n* = f (boiling temp.)

If calculating without evaporation, the evaporation pressure p_e* and the percentage expansion n* must be based on the stagnation temperature of the collector.

Without evaporation
p_e* = f (stagnation temp.)
n* = f (stagnation temp.)

Input pressure p_0, minimum operating pressure
Depending on the calculation method employed, the minimum operating pressure (= input pressure) is adapted to the stagnation temperature in the collector (= without evaporation) or the boiling temperature (= with evaporation). In both cases, the normal configuration of the circulating pump pressure DpP must be taken into account since the expansion vessel is integrated on the pressure side of the circulating pump (follow-up pressure maintenance).

Without evaporation

$$p_0 = p_{st} + p_e^*(\text{stagnation}) + \Delta p_P$$

With evaporation

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

Filling pressure p_{fil}, input pressure p_i
As a rule, the filling temperature (10 °C) is much higher than the lowest system temperature, such that the filling pressure is greater than the initial pressure.

▶ Enter set input pressure on name plate

Pressure maintenance
Generally in the form of static pressure maintenance with Reflex S, also in combination with make-up stations.

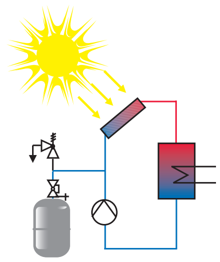
Intermediate vessels
If a stable return temperature ≤ 70 °C cannot be guaranteed on the consumer side, an intermediate vessel must be fitted to the expansion vessel. → p. 68

Reflex S in solar energy 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. **evaporation is permitted in the collector** at stagnation temperature.

Configuration: Follow-up pressure maintenance, diaphragm expansion vessel in return to collector.

Object:



Initial data			
Number of collectors	z .... units		
Collector surface area	A_C .... m²	$A_{Ctot} = z \times A_C$ $A_{Ctot} =$ .... m²	A_{Ctot} = ... bar
Water content per collector	V_C .... litres	$V_{Ctot} = z \times A_C$ $V_{Ctot} =$ .... litres	V_{Ctot} = ... litres
Highest advance temperature Lowest ambient temperature Antifreeze additive	t_F 110 °C or 120 °C t_a – 20 °C .... %	→ p. 6 Percentage expansion n* and evaporation pressure p_e*	n* = ... % p_e* = ... bar
Static pressure	p_{st} .... bar		p_{st} = ... bar
Difference at circulating pump	Δp_P .... bar		Δp_P = ... bar
Pressure calculation			
Input pressure	p_0 = stat. pressure p_{st} + pump pressure Δp_e + evaporation pressure p_e* p_0 = ... + ... + ... = ... bar		p_0 = ... bar
Safety valve actuation pressure	p_{SV} → Reflex recommendation p_{SV} ≥ input pressure p_0 + 1.5 bar for p_{SV} ≤ 5 bar p_{SV} ≥ input pressure p_0 + 2.0 bar for p_{SV} > 5 bar p_{SV} ≥ .... + ... = ... bar		p_{SV} = ... bar
Final pressure	p_f ≤ safety valve p_{SV} – Closing pressure difference according to TRD 721 p_f ≤ p_{SV} – 0.5 bar for p_{SV} ≤ 5 bar p_f ≤ p_{SV} – 0.1 bar x p_{SV} > 5 bar p_f ≤ .... – .... = ... bar		p_f = ... bar
Vessel			
System volume	V_s = collector vol. V_{Ctot} + pipelines + buffer tank + other V_s = ... + ... + ... + ... = ... litres		V_s = ... litres
Expansion volume	$V_e = \frac{n^*}{100} \times V_s$ = ... + ... = ... litres		V_e = ... litres
Water seal	V_{WS} = 0.005 x V_s for V_n > 15 litres with V_{WS} ≥ 3 litres V_{WS} ≥ 0.2 x V_n for V_n ≤ 15 litres V_{WS} ≥ .... x .... = ... x .... = ... litres		V_{WS} = ... litres
Nominal volume	$V_n = (V_e + V_{WS} + V_{Ctot}) \times \frac{p_f + 1}{p_f - p_0}$ V_n ≥ .... x .... = ... litres Selected V_n Reflex S = ... litres		V_n = ... litres
Check of initial pressure	$p_i = \frac{p_f + 1}{1 + \frac{(V_e + V_{Ctot})(p_f + 1)}{V_n (p_0 + 1)}} - 1$ bar p_i = ... / (1 + ... / ....) – 1 bar = ... bar Condition: $p_i \geq p_0$ + 0.25...0.3 bar, otherwise calculation for greater nominal volume		p_i = ... bar
Percentage expansion	Between lowest temperature (- 20 °C) and filling temperature (usually 10 °C) → p. 6 n^*_F = ... %		n^*_F = ... %
Filling pressure	$p_{fil} = V_n \times \frac{p_0 + 1}{V_n - V_s \times n_F^* - V_{WS}} - 1$ bar p_{fil} = ... x .... – 1 bar = ... litres		p_{fil} = ... bar
Result summary			
Reflex S/10 bar .... litres	Input pressure p_0 = ... bar → check before start-up Initial pressure p_i = ... bar → Check make-up configuration Filling pressure p_{fil} = ... bar → Refilling of system Final pressure p_f = ... bar		

Check compliance with minimum supply pressure p_{sup} for circulating pumps acc. to manufacturer specifications
$p_{sup} = p_0 - \Delta p_P$

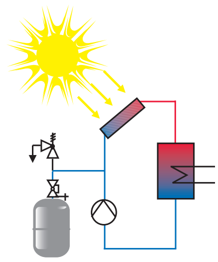
Check compliance with max. operating pressure

Reflex S in solar energy systems without evaporation

Calculation method: The minimum operating pressure p_0 is set such that no **evaporation** occurs in the collector – generally possible at stagnation temperatures ≤ 150 °C.

Configuration: Follow-up pressure maintenance, diaphragm expansion vessel in return to collector.

Object:



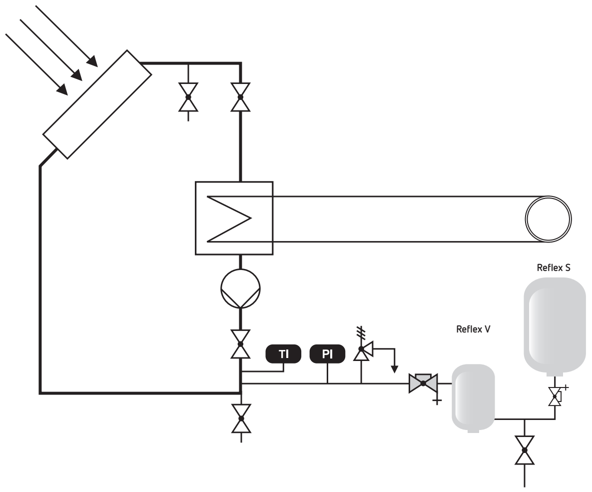
Initial data		
Number of collectors z .... units		
Collector surface area A_C .... m²	$A_{Ctot} = z \times A_C$ $A_{Ctot} =$ .... m²	A_{Ctot} = ... bar
Water content per collector V_C .... litres	$V_{Ctot} = z \times A_C$ $V_{Ctot} =$ .... litres	V_{Ctot} = ... litres
Highest advance temperature t_F Lowest ambient temperature t_a – 20 °C Antifreeze additive .... %	→ p. 6 Percentage expansion n* and evaporation pressure p_e*	n* = ... % p_e* = ... bar
Static pressure p_{st} .... bar		p_{st} = ... bar
Difference at circulating pump Δp_P .... bar		Δp_P = ... bar
Pressure calculation		
Input pressure	p_0 = stat. pressure p_{st} + pump pressure Δp_e + evaporation pressure p_e* p_0 = ... + ... + ... = ... bar	p_0 = ... bar
Safety valve actuation pressure	p_{SV} → Reflex recommendation p_{SV} ≥ input pressure p_0 + 1.5 bar for p_{SV} ≤ 5 bar p_{SV} ≥ input pressure p_0 + 2.0 bar for p_{SV} > 5 bar p_{SV} ≥ .... + ... = ... bar	p_{SV} = ... bar
Final pressure	p_f ≤ safety valve p_{SV} – Closing pressure difference according to TRD 721 p_f ≤ p_{SV} – 0.5 bar for p_{SV} ≤ 5 bar p_f ≤ p_{SV} – 0.1 bar x p_{SV} > 5 bar p_f ≤ .... – .... = ... bar	p_f = ... bar
Vessel		
System volume	V_s = collector vol. V_{Ctot} + pipelines + buffer tank + other V_s = ... + ... + ... + ... = ... litres	V_s = ... litres
Expansion volume	$V_e = \frac{n^*}{100} \times V_s$ = ... + ... = ... litres	V_e = ... litres
Water seal	V_{WS} = 0.005 x V_s for V_n > 15 litres with V_{WS} ≥ 3 litres V_{WS} ≥ 0.2 x V_n for V_n ≤ 15 litres V_{WS} ≥ .... x .... = ... x .... = ... litres	V_{WS} = ... litres
Nominal volume	$V_n = (V_e + V_{WS} + V_{Ctot}) \times \frac{p_f + 1}{p_f - p_0}$ V_n ≥ .... x .... = ... litres Selected V_n Reflex S = ... litres	V_n = ... litres
Check of initial pressure	$p_i = \frac{p_f + 1}{1 + \frac{V_e + (p_f + 1)}{V_n (p_0 + 1)}} - 1$ bar p_i = ... / (1 + ... / ....) – 1 bar = ... bar Condition: p_i ≥ p_0 + 0.25...0.3 bar, otherwise calculation for greater nominal volume	p_i = ... bar
Percentage expansion	Between lowest temperature (- 20 °C) and filling temperature (usually 10 °C) → p. 6 n^*_F = ... %	n^*_F = ... %
Filling pressure	$p_{fil} = V_n \times \frac{p_0 + 1}{V_n - V_s \times n_F^* - V_{WS}} - 1$ bar p_{fil} = ... x .... – 1 bar = ... litres	p_{fil} = ... bar
Result summary		
Reflex S/10 bar .... litres	Input pressure p_0 = ... bar → check before start-up Initial pressure p_i = ... bar → check make-up configuration Filling pressure p_{fil} = ... bar → refilling of system Final pressure p_i = ... bar	

▶ Check compliance with minimum supply pressure p_{sup} for circulating pumps acc. to manufacturer specifications
$p_{sup} = p_0 - \Delta p_P$

▶ Check compliance with max. operating pressure

Reflex installation examples (notes for the installer – hydraulic integration)

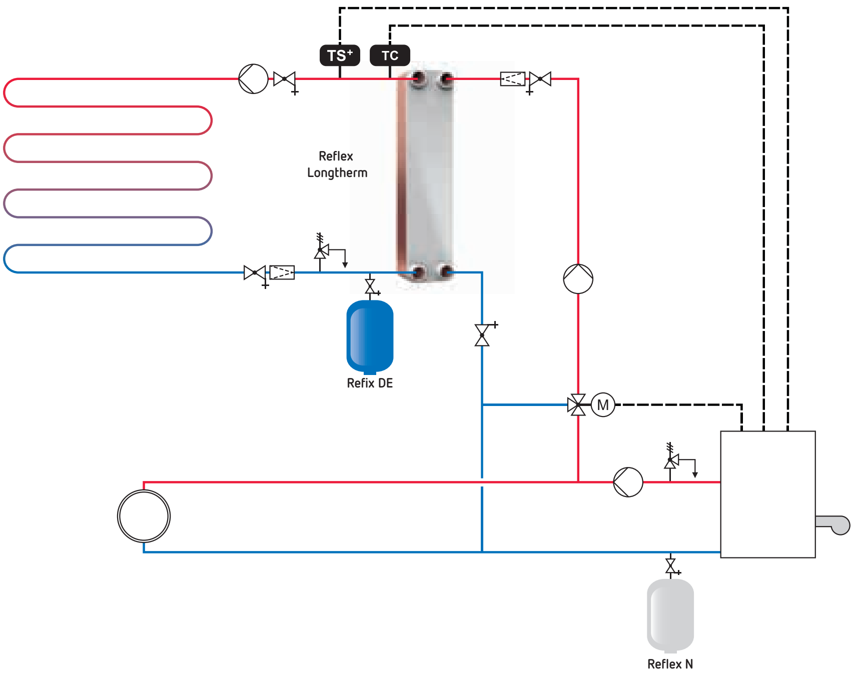
Reflex S in a solar heating application



Notes for the installer

- Because of the low temperature load, the circulating pump and Reflex S are located in the collector return. This means that the expansion vessel must be installed on the pressure side of the circulating pump. **The circulating pump pressure must therefore be considered when calculating the input pressure p_0.**
- There is no need to install the Reflex V intermediate vessel where the maximum possible temperature load for the expansion vessel is 70 °C.

Refix DE in a system with floor heating



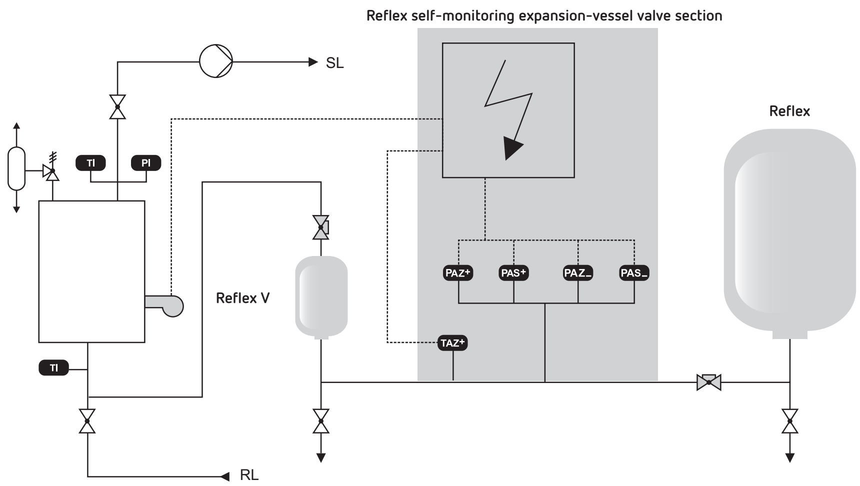
Notes for the installer

- If the floor heating circuit does not use **oxygen-tight** plastic tubing, there is a risk of corrosion.
- Even so, the safest option is to implement system separation between the boiler and floor circuit, e.g. with a Reflex Longtherm plate heat exchanger. We recommend using the Refix DE with special corrosion protection to prevent corrosion of the expansion vessel.
→ Refix brochure

The circuits must be adjusted to suit local conditions.

Reflex installation examples (notes for the installer – hydraulic integration)

Reflex in a hot water system > 120 °C

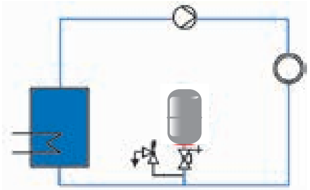


Notes for the installer

- TRD 402, 18.6: The **actual operating temperature** can be used as the calculation temperature for expansion vessels and collection vessels.
- TRD 604 Part 2, 1.3.: There is no need to install a water level limiter with an expansion vessel if a minimum pressure limiter is activated for the expansion vessel when the water level drops below minimum.
- We recommend:
  - Reflex V intermediate vessel > 120 °C with Reflex self-monitoring expansion-vessel valve section each with a max/min pressure limiter PAZ / PAZ and monitor PAS / PAS plus a safety temperature limiter TAZ for on-site installation.

The circuits must be adjusted to suit local conditions.

Cooling water systems



Calculation
On the basis of DIN EN 12828 and DIN 4807 T2.

Configuration
In the form of input pressure maintenance as per adjacent diagram with expansion vessel on the suction side of the circulating pump, or in the form of follow-up pressure maintenance.

Properties n*
When determining the percentage expansion n*, antifreeze additives appropriate for the lowest system temperature must be included according to manufacturer specifications.
For Antifrogen N → p. 6

Expansion volume V
Calculation of the percentage expansion n* usually between the lowest system temperature (e.g. winter downtime: -20 °C) and the highest system temperature (e.g. summer downtime +40 °C).

Minimum operating pressure p
Since no temperatures > 100 °C are used, no special margins are required.

▸ Enter set input pressure on name plate

Filling pressure p_{fil}, initial pressure p_i
In many cases, the lowest system temperature is less than the filling temperature, meaning that the filling pressure is higher than the initial pressure.

Pressure maintenance
Generally in the form of static pressure maintenance with Reflex, also in combination with Control and Servitec make-up and degassing stations.

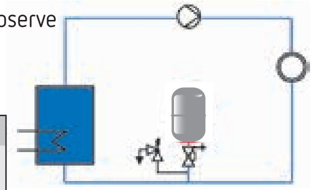
Degassing, deaeration, water make-up
To ensure ongoing safe and automatic operation in cooling water systems, the pressure-maintaining units should be equipped with make-up systems and supplemented with Servitec degassing systems. This is particularly important with cooling water systems, since no thermal deaeration effects apply. → p. 53.

Intermediate vessels
Although Reflex diaphragms are suitable for temperatures down to -20 °C and vessels to -10 °C, the possibility of the diaphragms freezing to the container cannot be excluded. We therefore recommend the integration of an intermediate vessel in the return to the refrigerating machine at temperatures ≤ 0 °C. → page 68

Individual protection
As in the case of heating systems, we recommend the use of individual protection for multiple refrigerating machines.
→ Heating systems, p. 10

Reflex N, F, S, G in cooling water systems

Configuration: Input pressure maintenance, diaphragm expansion vessel on the suction side, circulating pump, observe information on page 7 for follow-up pressure maintenance.



Object:

Initial data		
Return temperature to refrigerating machine	t_R = °C	
Advance temperature to refrigerating machine	t_F = °C	
Lowest system temperature	t_{Smin} = litres (e.g. winter downtime)	
Highest system temperature	t_{Smax} = litres (e.g. summer downtime)	
Antifreeze additive	p_{st} = %	
Percentage expansion n* → p. 6	n* = n* at highest temp. (t_{Smax} o. t_R) - n* at lowest temp. (t_{Smin} o. t_F) n* = ... - .... = ... °C	n* = ... %
Percentage expansion between lowest temperature and filling temperature Static pressure	= .... °C p_{SV} = ... bar	n_F* = ... % p_{st} = ... bar
Pressure calculation		
Input pressure	p_0 = static pressure p_{st} + 0.2 bar[1)] p_0 = ... + 0.2 bar[1)] = ... bar	p_0 = ... bar
Safety valve actuation pressure	p_{SV} → Reflex recommendation p_{SV} ≥ input pressure p_0 + 1.5 bar for p_{SV} ≤ 5 bar p_{SV} ≥ input pressure p_0 + 2.0 bar for p_{SV} > 5 bar p_{SV} ≥ .... + ... = ... bar	p_{SV} = ... bar
Final pressure	p_f ≤ safety valve p_{SV} p_f ≤ p_{SV} p_f ≤ p_{SV} p_f ≤	p_f = ... bar
Vessel		
System volume	V_s = refrigerating machines : ....litres = cooling registers : ....litres = buffer tanks : ....litres = pipelines : ....litres = other : ....litres = system volume V_s : ....litres	V_s = ... litres
Expansion volume	$V_e = \frac{n^*}{100} \times V_s$ = ... = ...litres	V_e = ... litres
Water seal	V_{WS} = 0.005 for V_n > 15 litre water with VWS ≤ 3 litres V_{WS} ≥ 0.2 for V_n ≥ 15 litres V_{WS} ≥ .... x .... = ... = ...litres	V_{WS} = ... litres
Nominal volume Without Servitec With Servitec	$V_n = (V_e + V_{WS}) \times \frac{p_f + 1}{p_f - p_0}$ $V_n = (V_e + V_{WS + 5\ litres}) \times \frac{p_f + 1}{p_f - p_0}$ V_n ≥ .... x .... = ...litres Selected V_n Reflex = ...litres	V_n = ... litres
Initial pressure check Without Servitec Condition:	$p_i = \frac{p_f + 1}{1 + \frac{V_e + (p_f + 1)}{V_n (p_0 + 1)}}$ $p_i = \frac{p_f + 1}{1 + \frac{(V_e + 5\ litres)\ (p_f + 1)}{V_n (p_0 + 1)}}$ p_i = ... / (1 + ... / ....) p_i ≥ p_0 + 0.25...0.3 bar, otherwise calculation for greater nominal volume	p_i = ... bar
Filling pressure	$p_{fil} = V_n \times \frac{p_0 + 1}{V_n - V_s \times n_F^* - V_{WS}}$ p_{fil} = ... x .... – 1 bar = ... litres	p_{fil} = ... bar
Result summary		
Reflex .....S/ ..... bar .... litres	Input pressure p_0 = ... bar → check before start-up Initial pressure p_i = ... bar → check make-up configuration Filling pressure p_{fil} = ... bar → refilling of system Final pressure p_i = ... bar	

- at t_R > 70 °C V intermediate vessel required

1) Recommendation

- Check rec. supply pressure of circulation pump acc. to manufacturer specifications
- Check compliance with max. operating pressure

Reflex pressure-maintaining systems with external pressure generation: Variomat, Reflexomat

Configuration

In principle, the same applies as for the selection and calculation of Reflex diaphragm expansion vessels.

→ Heating systems page 10
→ Solar thermal systems page 16
→ Cooling water systems page 24

However, such systems generally cover higher output ranges. → page 8

Nominal volume V_n

The main feature of pressure-maintaining systems with external pressure generation is that the pressure is regulated by a control unit independently of the water level in the expansion vessel. As a result, virtually the entire nominal volume Vn can be used for water intake purposes (V_e + V_{WS}). This represents a significant advantage of this method over pressure maintenance with expansion vessels.

$V_n = 1.1\ (V_e + V_{WS})$

Pressure monitoring, minimum operating pressure p_0

When calculating the minimum operating pressure, we recommend the addition of a 0.2 bar safety margin to ensure sufficient pressure at high points. This margin should only be dispensed with in exceptional cases, since this will otherwise increase the risk of outgassing at high points.

Suction pressure maintenance

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

Final pressure maintenance

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

Initial pressure p_i

This restricts the lower setpoint value range of the pressure maintenance. If the pressure falls below the initial pressure, the pressure pump or compressor is activated before being deactivated with a hysteresis of 0.2 ... 0.1 bar. The Reflex formula for the initial pressure guarantees the required minimum of 0.5 bar above saturation pressure at the high point of a system.

$p_i \geq p_0 + 0.3$ bar

Final pressure p_f

The final pressure restricts the upper setpoint value range of the pressure maintenance. It must be set such that the pressure on the system safety valve is lower by at least the closing pressure difference A_{SV} e.g. according to TRD 721. The overflow or discharge mechanism must open, at the very latest, when the final pressure is exceeded.

$p_f \geq p_i + A_p$

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

Closing pressure difference according to TRD 721 A_{SV}

SV-H	0.5 bar
SV-D/G/H	0.1 p_{SV} 0.3 bar for p_{SV} < 3 bar

Working range A_p of pressure maintenance

This depends on the type of pressure maintenance and is limited by the initial and final pressure. The adjacent values must be followed as a minimum.

	$A_p = p_f - p_i$
Variomat	≥ 0.4 bar
Variomat Giga	≥ 0.4 bar
Reflexomat	≥ 0.2 bar

Degassing, deaeration, water make-up

Targeted venting is very important, particularly in the case of closed systems; otherwise, accumulations of nitrogen in particular can lead to troublesome malfunctions and customer dissatisfaction. Reflex Variomat are already equipped with integrated make-up and degassing. Reflex Variomat Giga and Reflexomat pressure-maintaining systems are complemented by Reflex Servitec make-up and degassing stations as appropriate.

Partial flow degassing is only useful when integrated in the representative main flow of the system.
→ p. 53

Compensating volume flow V
In the case of heating systems that are equipped with pressure-maintaining systems controlled by an external energy source, the required compensating volume flow must be determined on the basis of the installed nominal heat output of the heat generators.

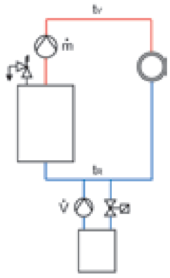
For example, with a homogeneous boiler temperature of 140 °C, the specific volume flowrequired is 0.85 l/kW. Deviations from this value are possible upon verification.

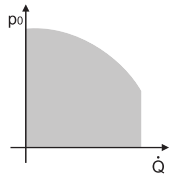
Cooling circuits are generally operated in a temperature range < 30 °C. The compensating volume flow is approximately half that of heating systems. Therefore, when making selections using the heating system diagram, only half of the nominal heat output $\dot{Q}$ must be taken into account.

To facilitate your selection, we have prepared diagrams allowing you to determine the achievable minimum operating pressure p_0 directly on the basis of the nominal heat output $\dot{Q}$.

Redundancy due to partial load behaviour
To improve partial load behaviour for pump-controlled systems in particular, we recommend the use of dual-pump systems, at least as of a heating output of 2 MW. In areas with particularly high operational safety requirements, the operator frequently demands system redundancy. In this context, it is practical to halve the output of each pump unit. Full redundancy is not generally required when you consider that less than 10 % of the pump and overflow output is required during normal operation.

Not only are Variomat 2-2 and Gigamat systems equipped with two pumps, but they also feature two type-tested overflow valves. Switching is performed on a load basis and in the case of malfunctions.





Reflex recommendation:
Configuration 50 % + 50 % = 100 % as of 2 MW dual-pump systems
→ Variomat 2-2

Variomat ≤ 8 MW
pump-controlled

Variomat Giga ≤ 60 MW
pump-controlled

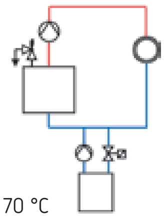
Reflexomat Compact ≤ 2 MW
compressor-controlled

Reflexomat ≤ 24 MW
compressor-controlled

Reflex Variomat in heating and cooling systems

Configuration: Input pressure maintenance, Variomat in return, circulating pump in advance, observe information on page 7 for follow-up pressure maintenance.

Object:



Initial data

		1	2	3	4	
Heat generator		1	2	3	4	
Heat output	$\dot{Q}_h$ = ... kW		.... kW	.... kW	.... kW	$\dot{Q}_{tot}$ = ... kW
Water content	V_W = ... litres					
System flow temperature	t_F = ... °C					
System return temperature	t_R = ... °C	→ p. 6	Approximate water content $V_s = f(t_F, t_R, \dot{Q})$			V_s = ... litres
Water content known	V_s = ... litres					
Highest setpoint value adjustment Temperature regulator	t_{TR} = ... °C	→ p. 6	Percentage expansion n (with antifreeze additive n*)			n = ... %
Antifreeze additive	= .... %					
Safety temperature limiter	t_{STL} = ... °C	→ p. 6	Evaporation pressure p_e at > 100 °C (with antifreeze additive p_e*)			p_e = ... bar
Static pressure	p_{st} = ... bar					p_{st} = ... bar

▸ at t_R > 70 °C intermediate vessel required

▸ t_{TR} max. 105 °C

▸ if 110 < STL ≤ 120 °C, contact our specialist department

Pressure calculation

Minimum operating pressure p_0 = stat. pressure p_{st} + evaporation pressure p_e + (0.2 bar)[1]

p_0 = ... + ... + (0.2 bar)[1] = ... bar

Condition p_0 ≥ 1.3 bar

p_0 = ... bar

Final pressure p_f ≥ minimum operating pressure p_0 + 0.3 bar + working range Reflexomat A_p

p_f ≥ .... + 0.3 bar + 0.4 bar = ... bar

p_f = ... bar

Safety valve actuation pressure p_{SV} ≥ final pressure + closing pressure difference A_{SV}

p_{SV} ≥ p_f + 0.5 bar for p_{SV} ≤ 5 bar

p_{SV} ≥ p_f + 0.1 x p_{SV} for p_{SV} > 5 bar

p_{SV} ≥ .... + ... = ... bar

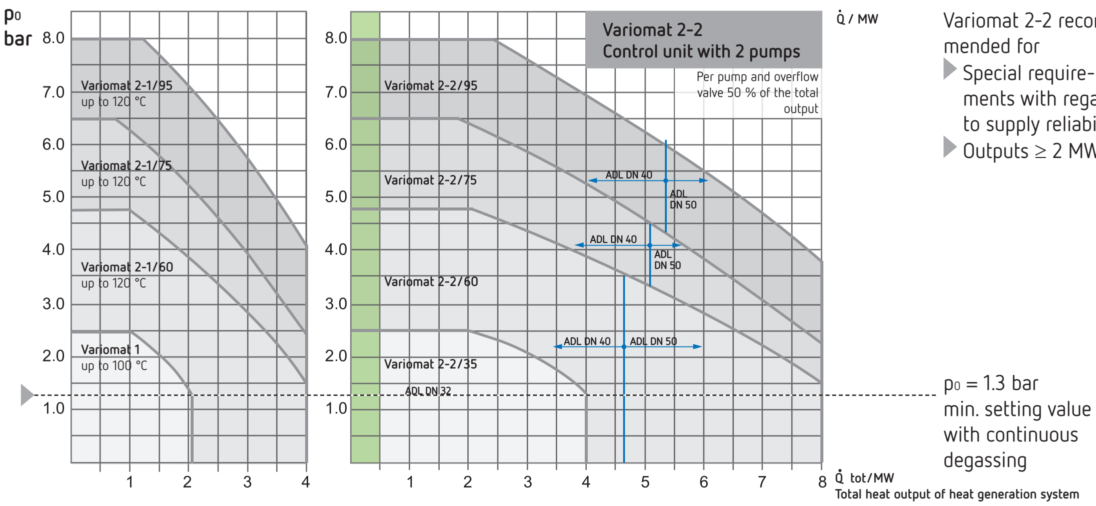
p_{SV} = ... bar

[1] The higher the value of p_0 over p_{st}, the better the degassing function; 0.2 bar is required as a minimum.

▸ Check compliance with max. operating pressure

Control unit selection

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



Variomat 2-2 recommended for
▸ Special requirements with regard to supply reliability
▸ Outputs ≥ 2 MW

p_0 = 1.3 bar min. setting value with continuous degassing

▸ **Expansion lines** (ADL) see the entries in the adjacent curves
Please observe the pressure-dependent dimensions for dual-pump systems.
We recommend choosing one dimension larger for the nominal connection in the case of an expansion line length > 10 m.

	Variomat 1	Variomat 2-1	Variomat 2-2/35	Variomat 2-2/60-95
V	2 m³/h	4 m³/h	2 m³/h	4 m³/h

◂ Minimum volume flow $\dot{V}$ in system circuit at integration point of Variomat

▸ Automatic, load-specific activation and fault changeover of pumps and overflow units for Variomat 2-2

Vessel

Nominal volume V_n taking water seal into account

$V_n = 1.1 \times V_s \frac{n + 0.5}{100}$ = 1.1 x .... x ....= .... bar

V_n = ... litres

▸ The nominal volume can be distributed across multiple vessels.

Result summary

Variomat	....	litres	
VG basic vessel	....	litres	$\frac{n + 0.5}{100}$
VF secondary vessel	....	litres	
VW thermal insulation (for heating systems only)	....	litres	

Minimum operating pressure p_0 .... bar

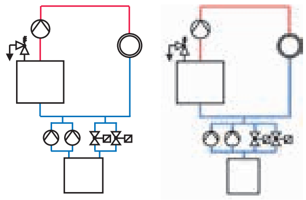
Final pressure p_f .... bar

Note: Due to the excellent degassing performance of Variomat, we generally recommend individual protection of the heat generator using Reflex diaphragm expansion vessels.

Reflex Variomat Giga in heating and cooling systems

Configuration: Input pressure maintenance, Variomat Giga in return, circulating pump in advance, observe information on page 7 for follow-up pressure maintenance.

Object:



Initial data

Heat generator		1	2	3	4	
Heat output	$\dot{Q}_h$ = ... kW		.... kW	.... kW	.... kW	$\dot{Q}_{tot}$ = ... kW
Water content	V_W = ... litres					
System water content	V_s = ... °C	→ p. 6	Approximate water content $V_s = f(t_F, t_R, \dot{Q})$			V_s = ... litres
Highest setpoint value adjustment Temperature regulator	t_{TR} = ... °C	→ p. 6	Percentage expansion n (with antifreeze additive n*)			n = ... %
Antifreeze additive	= .... %					
Safety temperature limiter	t_{STL} = ... °C	→ p. 6	Evaporation pressure p_e at > 100 °C (with antifreeze additive p_e*)			p_e = ... bar
Static pressure	p_{st} = ... bar					p_{st} = ... bar

▶ at t_R > 70 °C, intermediate vessel required

▶ t_{TR} max. 105 °C

▶ if 110 < STL ≤ 120 °C Contact our specialist department

Specific characteristic values

Minimum operating pressure p_0 = stat. pressure p_{st} + evaporation pressure p_e + (0.2 bar)[1]
p_0 = ... + ... + (0.2 bar)[1] = ... bar — p_0 = ... bar
Condition p_0 ≥ 1.3 bar

[1] Recommendation

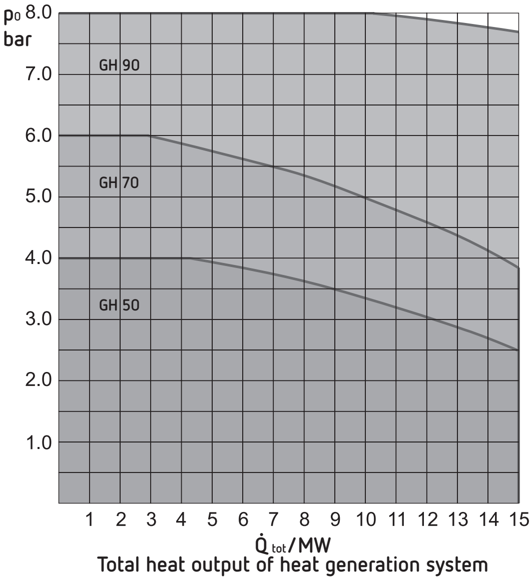
Final pressure p_f ≥ minimum operating pressure p_0 + 0.3 bar + working range Reflexomat A_p
p_f ≥ .... + 0.3 bar + 0.4 bar = ... bar — p_f = ... bar

Safety valve Response pressure p_{SV} ≥ final pressure + closing pressure difference A_{SV}
p_{SV} ≥ p_f + 0.5 bar for p_{SV} ≤ 5 bar
p_{SV} ≥ p_f + 0.1 x p_{SV} for p_{SV} > 5 bar
p_{SV} ≥ .... + ... = ... bar — p_{SV} = ... bar

▶ Check compliance with max. operating pressure

Control unit selection

Diagram valid for **heating systems STL ≤ 120 °C**
for **cooling systems** t_{max} ≤ 30 °C, only 50 % of Q_{tot} is to be considered



▶ For systems outside the displayed output ranges, please contact us

Please contact our technical sales team.

Vessel

Nominal volume V_n taking water seal into account

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

▶ The nominal volume can be distributed across multiple vessels.

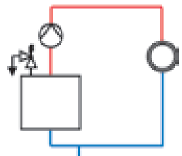
Result summary

GH hydraulic unit	....	Minimum operating pressure p_0	bar
GG basic vessel	.... litres	Final pressure p_f	bar
GF secondary vessel	.... litres		

Reflexomat and Reflexomat Compact in heating and cooling systems

Configuration: Input pressure maintenance, Reflexomat, Reflexomat Compact in return, circulating pump in advance, observe information on page 9 for follow-up pressure maintenance.

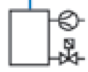
Object:



Initial data							
Heat generator		1	2	3	4		
Heat output	Q_h	= .... kW	.... kW	.... kW	.... kW	Q_{tot} = ...	kW
Water content	V_W	= .... litres					
System flow temperature	t_F	= .... °C	→ p. 6	Approximate water content		V_s = ...	litres
System return temperature	t_R	= .... °C		$V_s = f(t_F, t_R, Q)$			
Water content known	V_s	= .... litres					
Highest setpoint value adjustment							
Temperature regulator	t_{TR}	= .... °C	→ p. 6	Percentage expansion n (with antifreeze additive n*)		n = ...	%
Antifreeze additive		= .... %					
Safety temperature limiter	t_{STL}	= .... °C	→ p. 6	Evaporation pressure p_e at > 100 °C (with antifreeze additive p_e*)		p_e = ... bar	
Static pressure	p_{st}	= .... bar				p_{st} = ... bar	

Pressure calculation		
Minimum operating pressure	p_0 = stat. pressure p_{st} + evaporation pressure p_e + (0.2 bar)[1]	
	p_0 = ...+..+ (0.2 bar)[1] = ... bar	p_0 = ... bar
Recommendation	p_0 ≥ 1.0 bar	
Final pressure	p_f ≥ minimum operating pressure p_0 + 0.3 bar + working range Reflexomat A_p	p_f = ... bar
	p_f ≥ .... + 0.3 bar + 0.2 bar = ... bar	
Safety valve actuation pressure	p_{SV} ≥ final pressure + closing pressure difference A_{SV}	p_{SV} = ... bar
	p_{SV} ≥ p_f + 0.5 bar for p_{SV} ≤ 5 bar	
	p_{SV} ≥ p_f + 0.1 x p_{SV} for p_{SV} > 5 bar	
	p_{SV} ≥ ....+.. = ... bar	

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



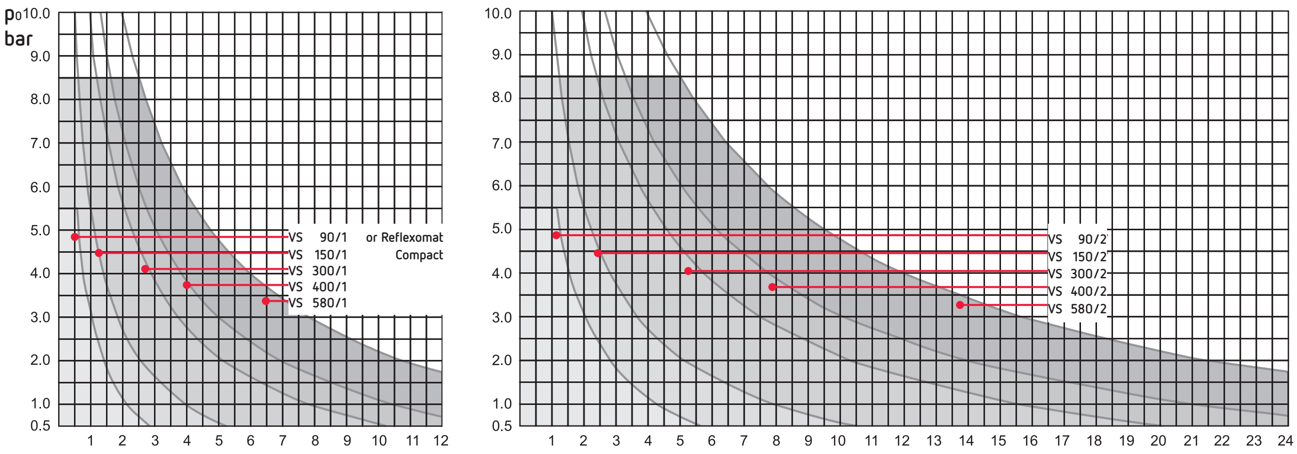
▸ at t_R > 70 °C, intermediate vessel required

▸ t_{TR} max. 105 °C

▸ if 110 < STL ≤ 120 °C Contact our specialist department

[1] Recommendation

▸ Check compliance with max. operating pressure



▸ Automatic, load-specific activation and fault changeover of compressors for VS .../2 control units

Vessel		
Nominal volume	V_n taking water seal into account	
	V_n = 1.1 x V_s = 1.1 x .... x ....= .... bar	V_n = ... litres

Result summary			
Reflexomat with control unit VS	............/.....	Minimum operating pressure p_0	.... bar
RG basic vessel	.... litres	Final pressure p_f	.... bar
or Reflexomat Compact	.... litres		

▸ The nominal volume can be distributed across multiple vessels.

District heating systems, large-scale and special systems

Calculation
The usual approach for heating systems, e.g. using DIN EN 12828, is often not applicable to district heating systems. In this case, we recommend that you coordinate with the network operator and the relevant authorities for systems subject to inspection. Contact us for more information!

Configuration
In many cases, the configurations for district heating systems differ from those used for heating installations. As a result, systems with follow-up and medium pressure maintenance are used in addition to classic input pressure maintenance. This has a direct impact on the calculation procedure.

Properties n, p_e
As a rule, properties for pure water without antifreeze additive are used.

Expansion volume V_e
Due to the frequently very large system volumes and minimal daily and weekly temperature fluctuations, when compared to heating systems,the calculations methods employed deviate from DIN EN 12828 and often produce smaller expansion volumes. When determining the expansion coefficient, for example, both the temperatures in the network advance and the network return are taken into account. In extreme cases, calculations are only based on the temperature fluctuations between the supply and return.

Minimum operating pressure p_0
The minimum operating pressure must be adapted to the safety temperature of the heat generator and determined such that the permitted normal and operating pressures are maintained throughout the network and cavitation on the pumps and control fittings is avoided.

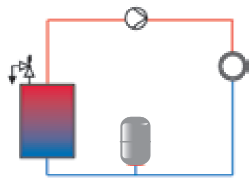
Initial pressure p_i
In the case of pressure-maintaining stations, the pressure pump is activated if the pressure falls below the initial value. Particularly in the case of networks with large circulating pumps, dynamic start-up and shutdown procedures must be taken into account. The difference between p_i and p_0 (= PL_{min}) should then be at least 0.5 - 1 bar.

Pressure maintenance
In the case of larger networks, almost exclusively in the form of pressure maintenance with external pressure generation, e.g. Variomat, Variomat Gigamat, Reflexomat Compact or Reflexomat. With operating temperatures over 105 °C or safety temperatures STL > 110°C, the special requirements of DIN EN 12952, DIN EN 12953 or TRD 604 Bl 2 can be applied.

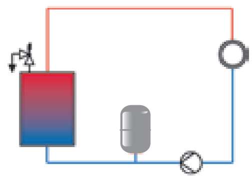
Degassing
We recommend that heat generation systems that do not have a thermal degassing system be equipped with a Servitec vacuum spray-tube degassing unit.

▶ Special pressure maintenance
Technical sales

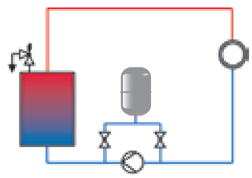
Input pressure maintenance



Follow-up pressure maintenance



Medium pressure maintenance



Reflex
Variomat
Variomat Giga
Reflexomat
Special stations

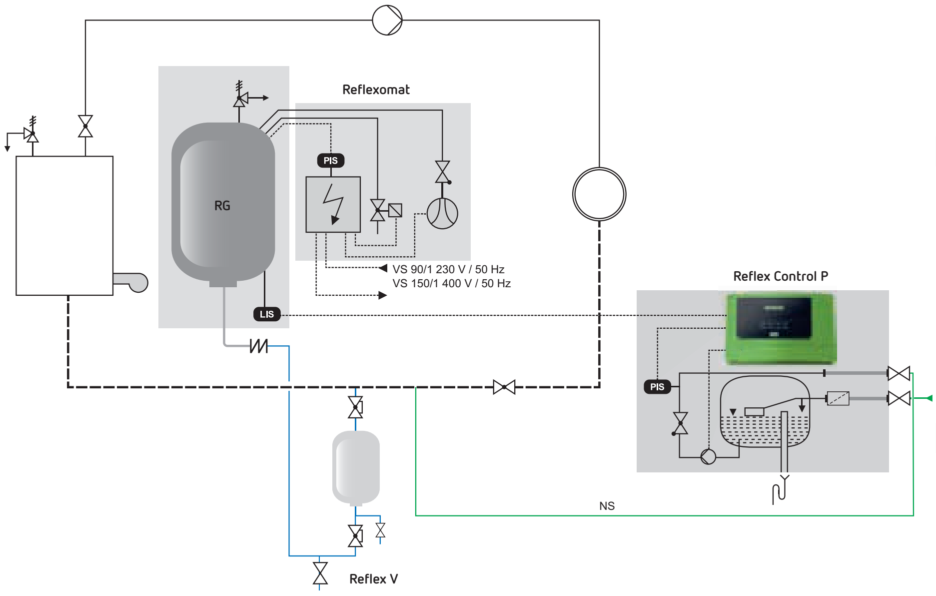
Reflex Reflexomat installation examples (general notes)

Hydraulic integration
You should select the appropriate circuit as follows:
Reflexomat in boiler return – circulating pump in boiler flow line
Direct connection between the Reflexomat and heat generator
Low temperature load on diaphragm
If the continuous load of the diaphragm is at risk > 70 °C,
Reflex V intermediate vessels are to be installed in the expansion lines
Install Reflexomat on the suction side of the circulation pump to minimise the risk of a vacuum forming

For multi-boiler systems (→ page 16–17) it is standard practice to protect each boiler individually with an additional expansion vessel and also to protect the boiler and system together as a whole. When using shut-offs via boiler sequential circuits, you must ensure that the boiler in question is connected to at least one expansion vessel. It is always best to consult the boiler manufacturer.

Please consult your specialist adviser in the event of any deviations!

Reflexomat with RS.../1 in a single-boiler system, make-up with **Reflex Fillcontrol Auto Compact**



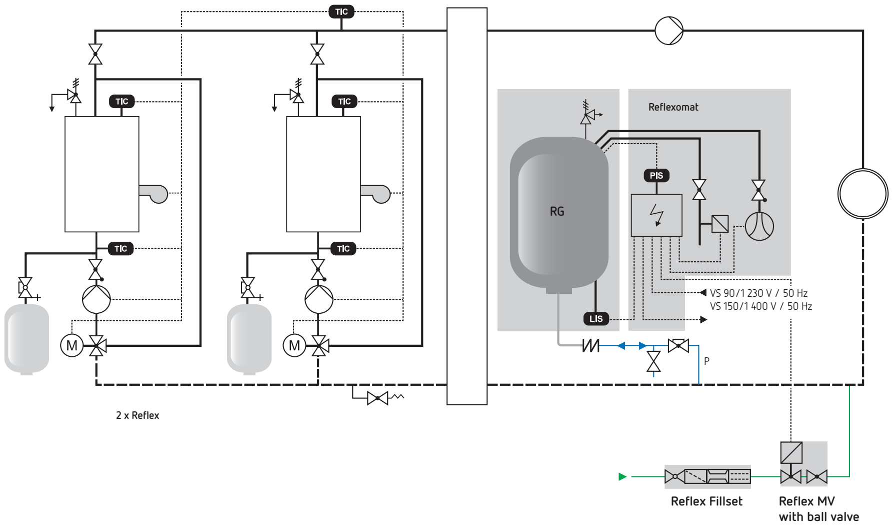
Notes for the installer

- The Reflexomat is integrated into the return between the boiler shut-off and the boiler and with the Reflex V intermediate vessel for return temperatures > 70 °C.
- Reflex Fillcontrol Auto Compact
Make-up with pump is adjusted during use in Reflexomat systems to "level-dependent controller". Make-up is then performed based on the filling level in the RG basic vessel. The 230 V signal of the Reflexomat is to be switched to floating via an attached coupling relay on site.
- Reflex Fillcontrol Auto Compact has an open system separation tank and can be connected directly to the potable water system. The delivery rate is between 120 and 180 l/h for a delivery pressure of up to max. 8.5 bar.

The circuits must be adjusted to suit local conditions.

Reflex Reflexomat installation examples (notes for the installer)

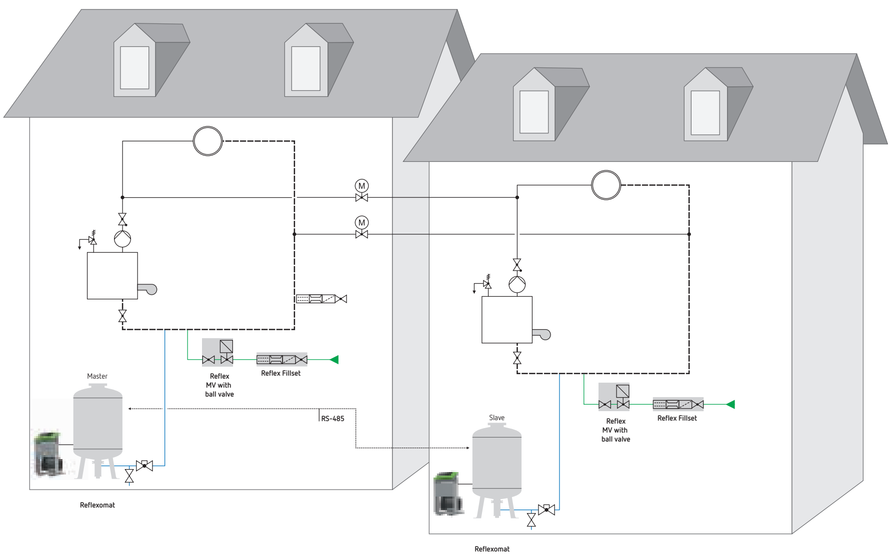
Reflexomat with RS.../1 in a multi-boiler system, make-up with **Reflex MV with ball valve**



Individual boiler protection
The burner is used to shut off the corresponding boiler circulating pump and close the motorised valve. During this, the boiler remains connected to the Reflexomat; the most frequently used circuit for boilers with a minimum return flow temperature. When the burner is switched off, boiler circulation is prevented.

Water make-up systems without pump
If the make-up volume is at least 1.3 bar above the final pressure of the Reflexomat, the Reflex solenoid valve with ball valve can be used for making up directly without an additional pump. For make-up from the potable water system, Reflex Fillset is to be prefixed.

Reflexomat in master-slave operation (from RS 90/2)



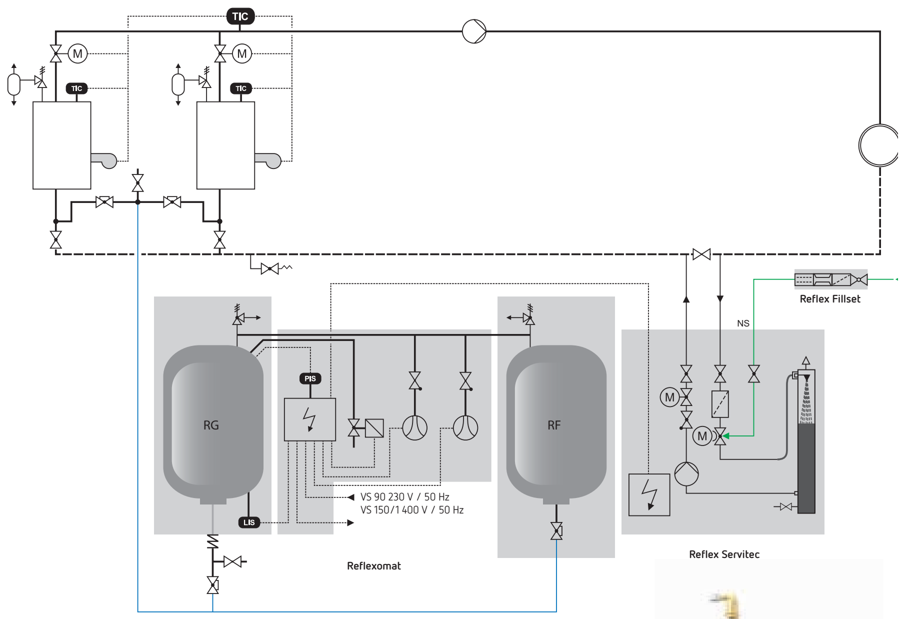
If hydraulic systems are selectively separated or operated together, then “master-slave operation” is necessary. Summer and winter operation of cooling and heating systems or the connection of several heat generator systems are examples of this.

Thus, both Reflexomats in the network operation example (open motorised valves) communicate with each other via the RS-485 interface in master-slave, whereby the “master” is responsible for pressure maintenance and the “slave” is solely responsible for volume compensation.
For stand-alone operation (motor valve **M** closed), both Reflexomats are operated independently from each other as “masters” with the function of maintaining pressure.

The circuits must be adjusted to suit local conditions.

Reflex Reflexomat (notes for the installer)

Reflexomat with RS.../2 in a multi-boiler system, make-up and degassing with **Reflex Servitec**



The circuits must be adjusted to suit local conditions.

Reflex Servitec
vacuum spray tube degassing unit

Joint boiler and system protection
When the burner is switched off, the corresponding actuator **M** is closed via the temperature control while preventing unwanted circulation in the shut-off boiler. In addition, the boiler expansion line above the centre of the boiler prevents gravity circulations. This is ideally suited to systems without a minimum boiler return flow temperature (e.g. condensing systems).

Reflexomat and Reflex Servitec - the ideal combination!
Combine the Reflexomat with the Servitec spray-tube degassing. The unit does not only perform make-up and rid the make-up water of dissolved gases; it also provides practically gas-free water content in the system. This reliably prevents air problems caused by free gas bubbles at high points in the system, circulating pumps or control valves andeffectively averts corrosion problems.

The same applies to the combination of Reflexomat and Reflex Servitec: The pressure in the highly degassed, bubble-free water content is "gently absorbed" by the Reflexomat.

Reflex Variomat assembly

Excerpts from the assembly, operating, and maintenance instructions

- Vertical installation in a frost-free, well-ventilated room with drainage facility.
- Control unit and the vessels should be preferably installed **on the same level**, control unit should under no circumstances be installed above vessels! Install vessels in a vertical position.
- The pressure cell for the level gauge is to be mounted on the base provided for the VG basic vessel.
  In order not to affect the level gauge, the VG basic vessel and the first VF secondary vessel must always be connected to the connection sets provided **in a flexible manner**.
- The VG basic vessel must not be rigidly attached to the floor.
- In the case of heating systems, the VW thermal insulation is recommended for the VG basic vessel.
- Flush connection lines before start-up!

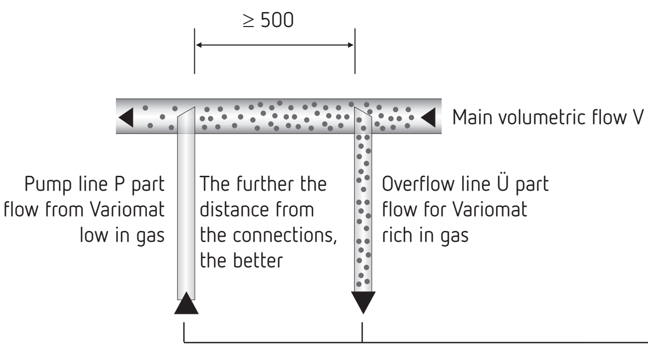
Tender specifications, assembly, operating, and maintenance instructions and more online at **www.reflex.de**, in an extra brochure and in our new Reflex Pro app!

Close-up:

- Variomat connection

Operation of the Servitec degassing unit is ensured only if the Servitec unit is integrated in a representative main current of the system. The following minimum flow rates V must be maintained during operation.
In the case of an inclination of Δt = 20 K this corresponds to a minimum power range of the consumer facility for Q.

	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
$\dot{Q}$	47 kW	94 kW	47 kW	94 kW



In order to prevent coarse dirt from entering the Variomat directly, the connection lines must be integrated from above or, as illustrated, integrated as an immersion tube in the main line.

The dimension of the expansion line is selected according to page 12.

Attention, dirt!

- – Integration of the pump and overflow lines in the system to prevent coarse dirt from entering (see detail).
  Dimensions for the expansion lines.

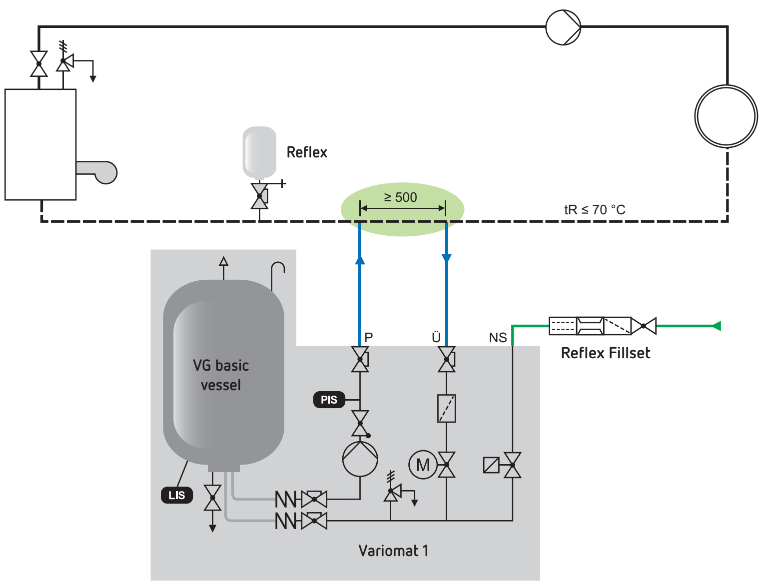
  – If the Reflex Fillset is not fitted, a dirt trap must be installed (mesh size 0.25 mm) in the make-up line NS.

Reflex Variomat installation examples (general notes)

Individual protection: Due to the excellent degassing performance of Variomat, we recommend that the switch frequency be minimised by also fitting a diaphragm expansion vessel (e.g. Reflex N) to the heat generator.

Integration in the system: In order to prevent coarse dirt from entering the Variomat and clogging up the dirt trap, integration must be performed according to the diagram on page 24. The pipelines for the heating system and potable water make-up unit must be flushed before start-up.
Connection line for make-up: When directly connecting the make-up line to a potable water system, Reflex Fillset must be prefixed (shut-off, system separator, water meter, dirt trap). If Reflex Fillset is not installed, a dirt trap with , a mesh size of ≤ 0.25 mm must be fitted, at least to protect the make-up solenoid valve. The line between the dirt trap and the solenoid valve must be kept as short as possible and flushed.

Reflex Variomat 1 in a single-boiler system ≤ 350 kW, < 100 °C, make-up with potable water



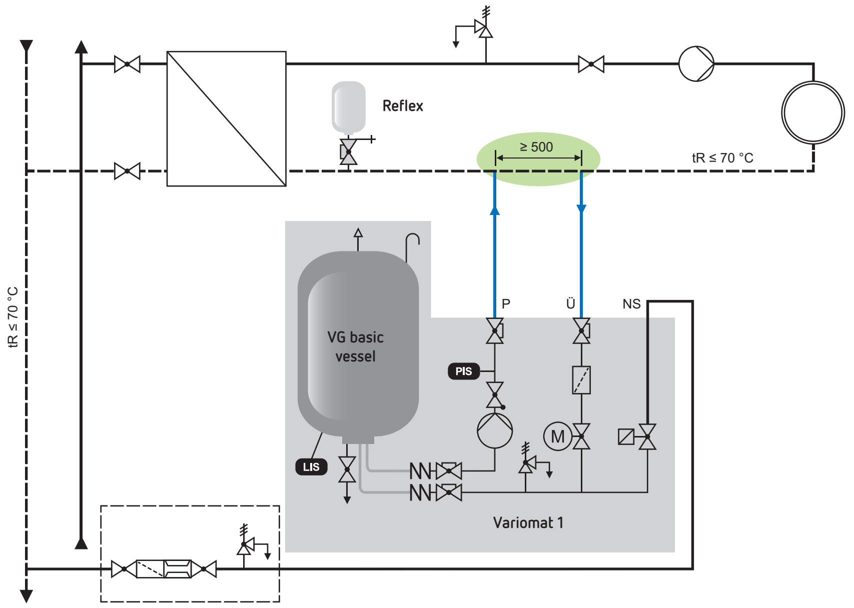
The circuits must be adjusted to suit local conditions.

Notes for the installer

- It is not necessary to mount additional cap valves in the expansion line.
- Reflex Fillset with integrated system separator must be prefixed when connecting it to the potable water system.
- For expansion lines over 10 m in length, we recommend choosing one dimension larger for the nominal values, e.g. DN 32 instead of DN 20. See also p. 67.

Reflex Variomat installation examples (notes for the installer)

Reflex Variomat 1 in a district heating substation, make-up via FW return flow

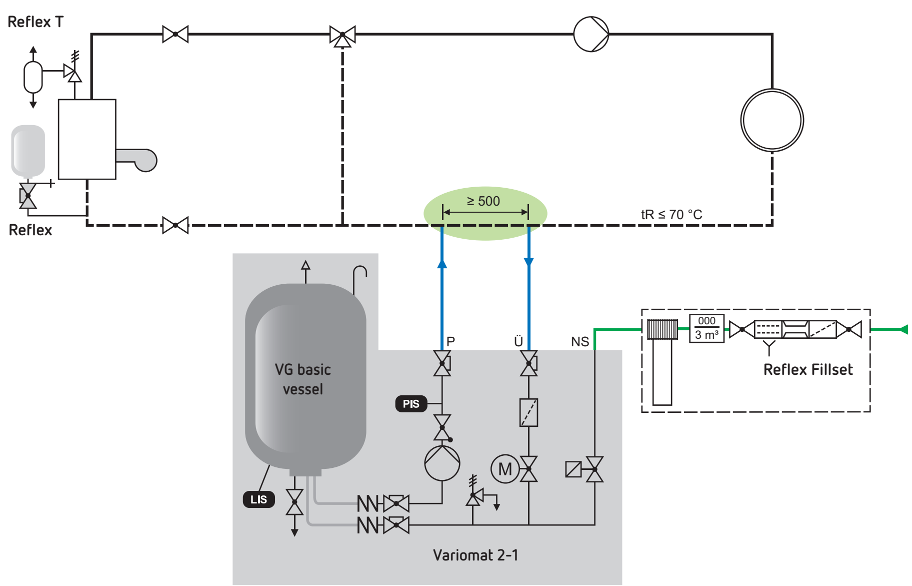


- District heating water is generally best suited as make-up water. Water treatment can be omitted.
- Coordination with the heating supplier is necessary! Observe connection conditions!

1) Lay expansion lines over 10 m in length in DN 32. → p. 31/67

- Variomat 2:
  For special requirements, e.g. in district heating, an optional board is available with 6 digital input and 6 floating output contacts and pressure and level outputs via an isolation amplifier.
  Please contact us for more information!

Reflex Variomat 2-1 in a system with central return flow addition, make-up via softening system



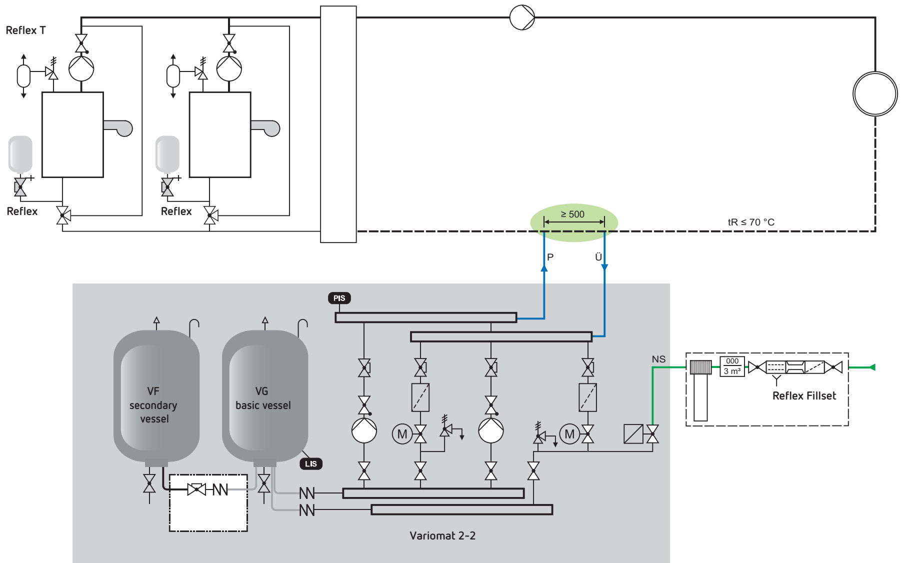
- Variomat must always be integrated in the main volumetric flow so that a representative part flow can be degassed. In the case of central return flow addition, this is on the system side. This provides individual protection for the boiler.
- If the capacity of the Reflex Fillset is exceeded (k_{VS} = 1 m³/h), then an alternative corresponding connection group is provided by the customer in the make-up supply. A filter mesh size of max. 0.25 mm is permissible.

→ p. 31/67

EXTRAS: 2 pumps with soft start, electrical main switch, load-specific activation and fault switchover

Reflex Variomat installation examples (notes for the installer)

Reflex Variomat 2-2 in a multi-boiler system,
advance > 100 °C, make-up via softening system



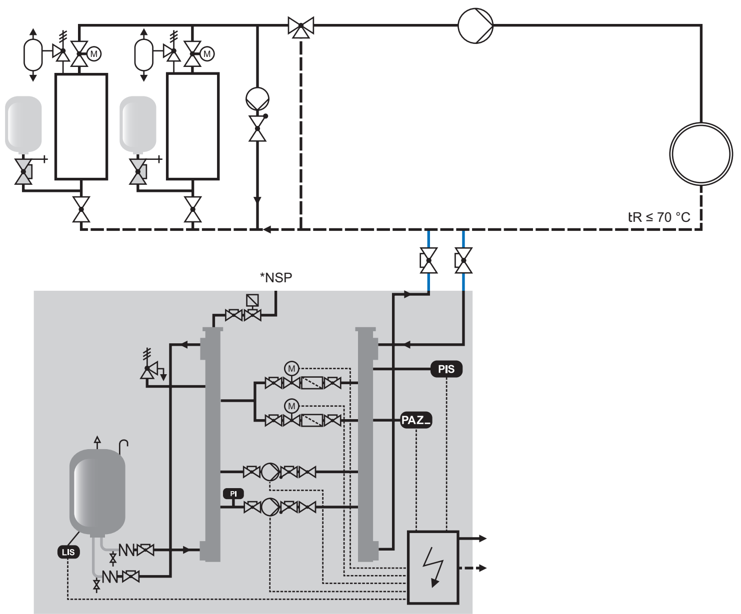
The circuits must be adjusted to suit local conditions.

- For water treatment systems, Reflex Fillset is installed with system separator and water meter in front of the softening system.
- Provide individual protection for multi-boiler systems with Reflex.
- Several F secondary vessels can be connected.

EXTRAS:
- 2 pumps with soft start
- Electrical main switch
- Load-specific activation and fault switchover

Reflex Variomat Giga installation examples (notes for the installer)

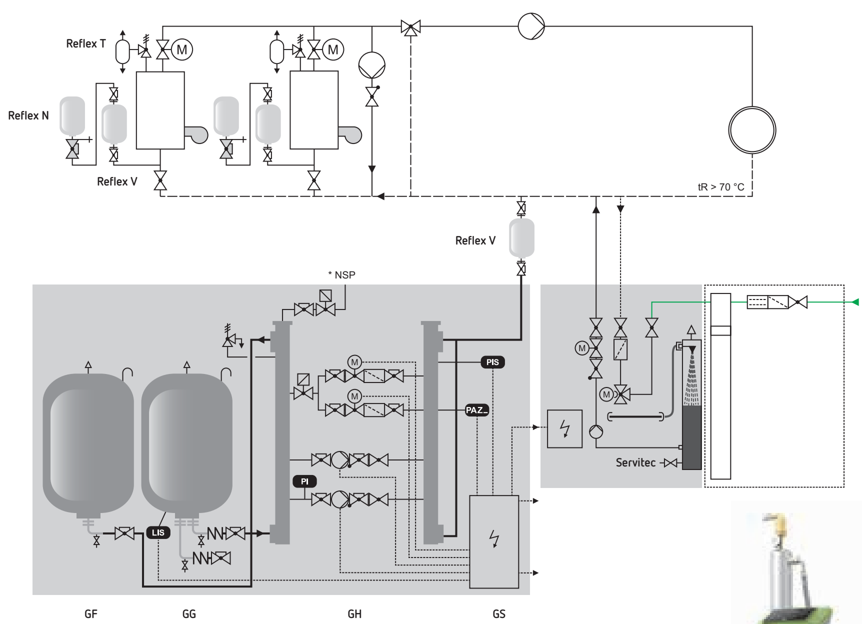
Reflex Variomat Giga up to TR ≤ 105 °C with GH hydraulics and controller GS 1.1 in a multi-boiler system, return flow temperature ≤ 70 °C



- In order to minimise the temperature load of the vessel diaphragm, installation of the Variomat Giga is recommended before the integration point of the return flow temperature-raising facility (seen in flow fitting).

* When using Servitec systems, this connection must be closed, since the medium is directly fed into the network via the Servitec.

Reflex Variomat Giga up to TR ≤ 105 °C with GH hydraulics and GS 3 controller in a multi-boiler system, return flow temperature > 70 °C

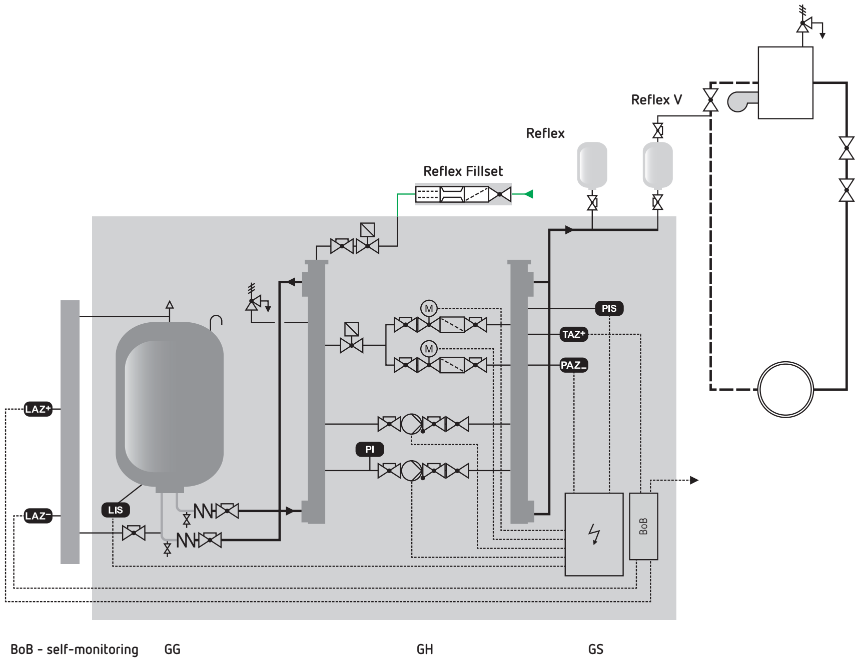


Reflex Servitec
vacuum spray tube degassing unit

- For multi-boiler systems with hydraulic points, the integration of the expansion line on the consumer side and individual protection for the boiler is recommended due to the low temperature load of the Gigamat.
- For Variomat Giga, the minimum pressure protection is ensured by using an additional solenoid valve, which is connected from the minimum pressure limiter at the station.
- Variomat Giga systems are generally used in large output ranges. Here (RL > 70 °C) we recommend the use of Reflex Servitec spray-tube degassing units for active corrosion protection, as a central “system bleeding point” and for central make-up.

Reflex Variomat Giga installation examples (notes for the installer)

Reflex Variomat Giga with TR > 105 °C with self-monitoring for 72 h according to TRD 604 Part 2



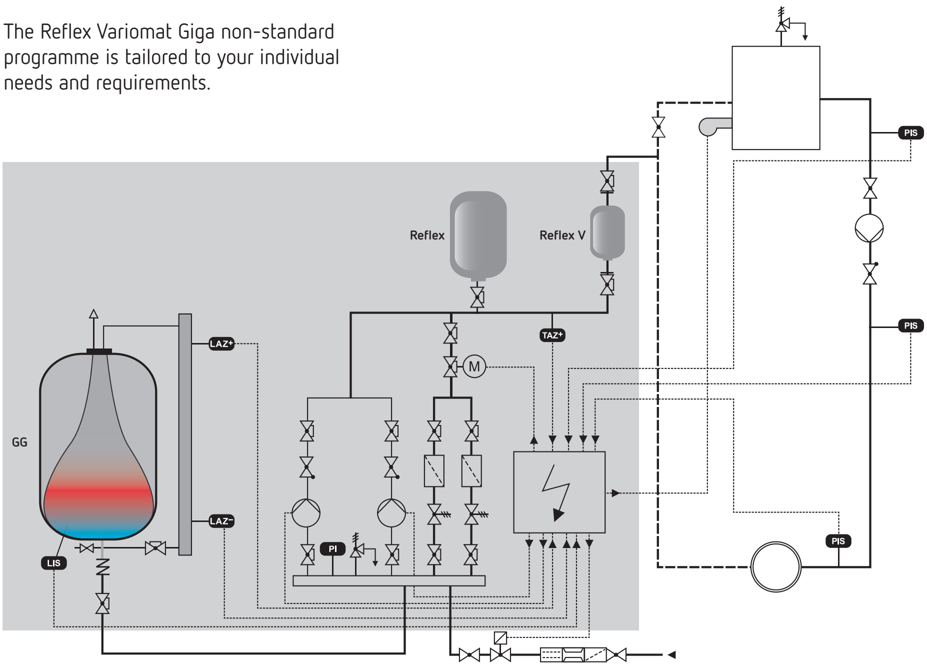
The circuits must be adjusted to suit local conditions.

- Up to outputs of 30 MW, a standardised programme is also available for use in systems above 105 °C with self-monitoring operation according to TRD 604 Part 2, DIN EN 12952 and 12953. The Variomat Giga and the corresponding accessory technology can be selected using the Reflex Product Manager.
- Apart from the pressure maintenance **PIS** and pressure protection **PAZ**, temperature protection **TAZ** is also integrated, which is triggered by the safety circuit when a set temperature has been exceeded (generally > 70 °C).

Reflex Variomat Giga – the individual non-standard programme (with TÜV inspection)

Reflex Variomat Giga non-standard programme explained using an example with medium pressure maintenance

The Reflex Variomat Giga non-standard programme is tailored to your individual needs and requirements.



red signal lines
= safety circuit with switch-off of heat generation

PIS **Medium, suction and final pressure maintenance**

With complicated network pressure conditions in particular, it may be necessary to use medium pressure maintenance instead of the standard suction or final pressure maintenance. → p. 27

PAZ – **Minimum pressure monitoring**

If the minimum operating pressure is not reached on the component-tested minimum pressure limiter PAZ – then the electrical actuator in the overflow line is closed and the heat generation switched off. The minimum pressure limiter must be mounted on the expansion line, and in the case of medium pressure maintenance, in the medium pressure maintenance.

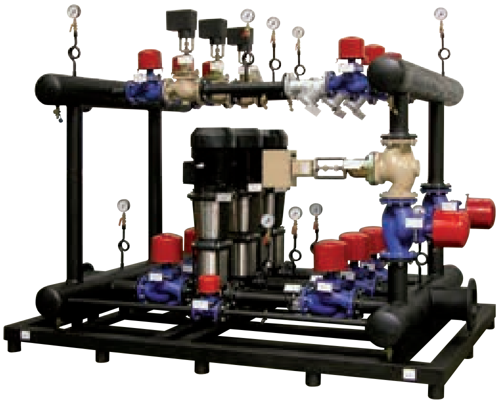
LAZ ± **Operation acc. to TRD 604 ASV Part 2**

For systems > 105 °C with self-monitoring operation, the water level in the expansion vessels is monitored with additional component-tested water level sensors.

TAZ + **Temperature monitoring**

For systems > 105 °C, a safety temperature limiter is installed after the intermediate vessel, which is integrated into the safety chain.

Reflex Variomat Giga – the individual non-standard programme (with TÜV inspection)



Reflex Variomat Giga non-standard control unit
with electrical overflow valves, electrical actuator
and SPS

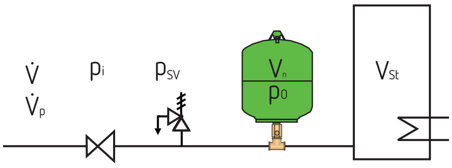
Hot water systems

Potable water is essential to life! For this reason, the expansion vessels in drinking water installations must meet the special requirements of DIN 4807 T5. Only water-carrying vessels are permitted.

Calculation
According to DIN 4807 T5. → form on p. 25

Configuration
As per adjacent diagram.
As a rule, the safety valve should be installed directly at the cold water inlet of the water heater. In the case of Refix DD and DT, the safety valve can also be fitted directly before the flow fitting (in water flow direction), provided that the following conditions are met:

Refix DD with T-piece:	Rp ¾	max. 200 l	Water heater
	Rp 1	max. 1000 l	Water heater
	Rp 1¼	max. 5000 l	Water heater
Refix DT flow fitting	Rp 1¼	max. 5000 l	Water heater



Enter set input pressure on name plate.

Properties n, p_e
Generally calculation between cold water temperature of 10 °C and max. hot water temperature of 60 °C.

Input pressure p_0, minimum operating pressure
The minimum operating pressure or input pressure p_0 in the expansion vessel must be at least 0.2 bar below the minimum flow pressure. Depending on the distance between the pressure reducing valve and the Refix unit, the input pressure must be adjusted to between 0.2 and 1.0 bar below the set pressure of the pressure reducing valve.

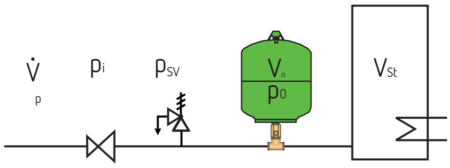
Initial pressure p_i
The initial pressure is identical to the set pressure of the pressure reducing valve. Pressure reducing valves are required according to DIN 4807 T5 to ensure a stable initial pressure and thus achieve the full capacity of the Refix unit.

Expansion vessel
In potable water systems according to DIN 1988, only water-carrying Refix vessels meeting the specifications of DIN 4807 T5 may be used. In the case of non-potable water systems, Refix units with a single connection are sufficient.

Cooke Industries - Phone: +64 9 579 2185 Email: sales@cookeindustries.co.nz Web: www.cookeindustries.co.nz

Refix in hot water systems

Object:



Initial data

Tank volume	V_{St}	= .... litres		
Heating output	Q	= .... kW		
Water temperature in tank	t_{HW}	= .... °C	As per controller setting 50 to 60 °C → p. 6 Percentage expansion n	n = ... %
Set pressure of pressure reducing valve	p_i	= .... bar		
Safety valve setting	p_{SV}	= .... bar	Reflex recommendation: p_{SV} = 10 bar	
Peak flow	$\dot{V}_S$	= .... m³/h		

Selection according to nominal volume V_n

Input pressure p_0 = set pressure of pressure reducing valve p_i – (0.2 - 1.0 bar)

p_0 = ... bar

$p_0 = \dots\dots \dfrac{n \text{ x } (p_{SV} + 0.5)(p_0 + 1.2)}{100 \text{ x } (p_0 + 1)(p_{SV} - p_0 - 0.7)} \dots\dots$ bar

Nominal volume V_n = V_{St}

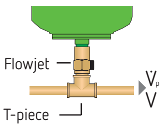
V_n = ... – .... = ... litres

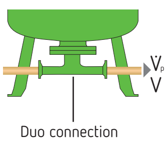
Selection according to brochure = ... litres

Set input pressure 0.2 -1.0 bar below pressure reducing valve (depending on distance between pressure reducing valve and Refix)

Selection according to peak volume flow V_p

When the nominal volume of the Refix unit has been selected, it must be checked in the case of water-carrying vessels whether the peak volume flow V_p, resulting from the piping calculation according to DIN 1988 can be implemented on the Refix. If this is the case, the 8-33 litre vessel of the Refix DD unit may have to be replaced with a Refix DT 60 litre vessel to enable a higher flow rate. Alternatively, a Refix DD with a correspondingly large T-piece can also be used.





	Recomm. max. peak flow $\dot{V}_p$*	Actual pressure loss with volume flow $\dot{V}$
Refix DD 8 – 33 litres With or without Flowjet T-piece duct Rp ¾ = standard	≤ 2.5 m³/h	$\Delta p = 0.03 \text{ bar} \cdot \left(\dfrac{\dot{V}\,[m^3/h]}{2.5\ m^3/h}\right)^2$
T-piece Rp 1 (by the customer)	≤ 4.2 m³/h	negligible
Refix DT 60 – 500 litres With Flowjet Rp 1¼	≤ 7.2 m³/h	$\Delta p = 0.04 \text{ bar} \cdot \left(\dfrac{\dot{V}\,[m^3/h]}{7.2\ m^3/h}\right)^2$
Refix DT 80 – 3000 litres Duo-connection DN 50	≤ 15 m³/h	$\Delta p = 0.14 \text{ bar} \cdot \left(\dfrac{\dot{V}\,[m^3/h]}{15\ m^3/h}\right)^2$
Duo-connection DN 65	≤ 27 m³/h	$\Delta p = 0.11 \text{ bar} \cdot \left(\dfrac{\dot{V}\,[m^3/h]}{27\ m^3/h}\right)^2$
Duo-connection DN 80	≤ 36 m³/h	negligible
Duo connection DN 100	≤ 56 m³/h	negligible
Refix DE, DC (non water-carrying)	Unlimited	Δp = 0

Δp = ... bar

G = ...

* calculated for a speed of 2 m/s

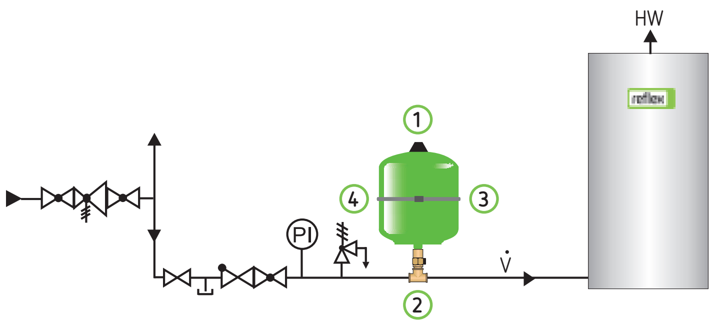
Result summary

Refix DT	....	litres	Nominal volume	V_n	.... litres
			Input pressure	p_0	.... bar
Refix DD	....	litres, G = ... (standard Rp ¾ included)			
Refix DT	....	litres			

Refix installation examples in hot water systems (general notes/notes for the installer)

Quoted from DIN 4807 T5:
"In order to perform maintenance and inspection of the gas input pressure, ... a ... protected shut-off fitting with an emptying facility must be installed."
"For safe continuous operation ... maintenance with inspection of the set input pressure must be performed at least once annually."
Set input pressure p_0 of Refix to between 0.2 and 1 bar below the set value of the pressure reducing valve.

Refix DD, DT 60 - 500 with Flowjet flow fitting

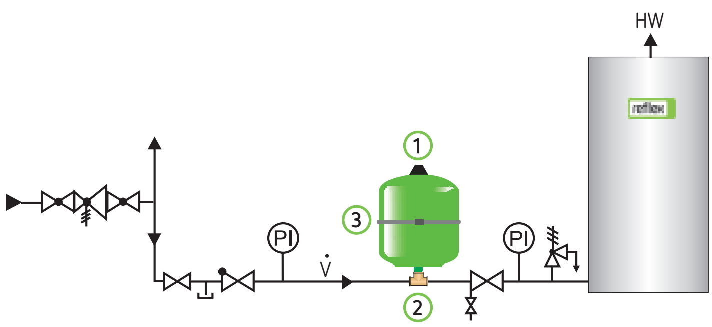


The **complete solution** with Flowjet flow fitting

Advantages: With Flowjet, mounting is simple and according to DIN. A shut-off facility, an emptying facility and flow are guaranteed for Refix.

1. Refix DD or Refix DT 60 - 500'
2. Flowjet flow fitting
   as optional accessory for Refix DD:
   Standard with T-piece Rp ¾, $V \le 2.5\ m^3/h$
   for T-piece Rp 1, $V \le 4.2\ m^3/h$
   for Refix DT 60 - 500' with Flowjet:
   Standard with Rp 1¼, $V \le 7.2\ m^3/h$
3. Reflex wall bracket for 8-25 litres
   (33 l with brackets, DT with feet)
4. A safety valve may be installed in the flow direction before Refix DD or DT5 with Flowjet, provided that the nominal diameter of the required SV is ≤ the subsequent tank feed.

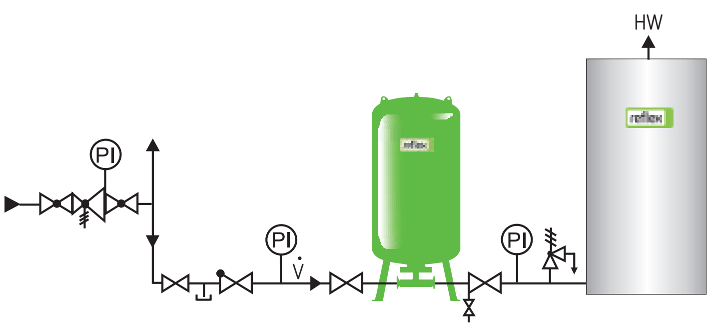
Refix DD without Flowjet flow fitting



During maintenance, if a Flowjet flow fitting is not provided, the feed to the water heater must be shut off and the Refix DD emptied using a fitting provided by the customer.

1. Refix DD
2. T-piece Rp ¾ — $V \le 2.5\ m^3/h$
   for T-piece Rp 1 — $V \le 4.2\ m^3/h$
3. Reflex wall bracket for 8–25 litres
   (33 l with brackets)

Refix DT with duo connection



- Additional fittings are necessary for shutting off and emptying the Refix DT with duo connection.
- The safety valve should be installed at the cold water inlet of the storage tank such that it cannot be shut off.

Pressure booster systems (PBS)

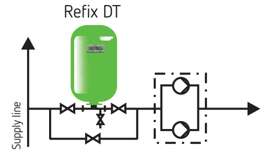
Calculation
According to DIN 1988 T5: Technical rules for potable water installations, pressure increase and reduction.
→ see form on p. 43

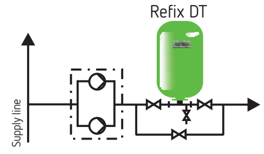
Configuration
On the input pressure side of a PBS, Refix expansion vessels relieve the connection line and the supply network.. The use of these must be agreed with the relevant water utility company.

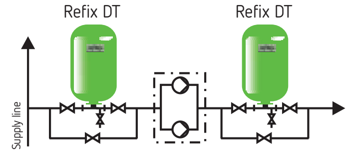
On the follow-up pressure side of a PBS, Refix vessels are installed to reduce the switch frequency, particularly in the case of cascade control systems.

Installation on **both sides** of the PBS may also be necessary.

Input pressure p_{fil}, input pressure p_i
The minimum operating pressure or input pressure p_0 in the Refix vessel must be set approx. 0.5 to 1 bar below the minimum supply pressure on the suction side and 0.5 to 1 bar below the switch-on pressure on the pressure side of a PBS.
Since the initial pressure p_i is at least 0.5 bar higher than the input pressure, a sufficient water seal is always ensured; this is an important prerequisite for low-wear operation.
In potable water systems according to DIN 1988, only water-carrying Refix vessels meeting the specifications of DIN 4807 T5 must be used. In the case of non-potable water systems, Refix units with a single connection are sufficient.







Enter set input pressure on name plate

Refix in pressure booster systems (PBS)

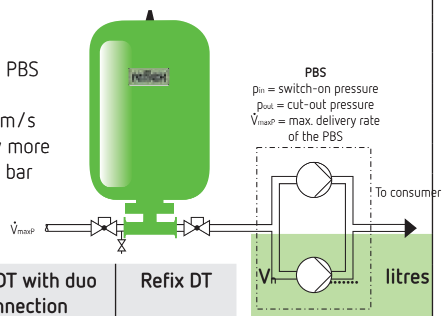
Object:

Configuration: Refix on input pressure side of PBS

Installation: As agreed with the relevant water utility company (WUC)

Necessity: Applies if the following criteria are not met

- In the event of the failure of a PBS pump, the flow rate in the PBS connection line must not change by more than 0.15 m/s
- If all pumps should fail, it must not change by more than 0.5 m/s
- During pump operation, the supply pressure must not drop by more than 50 % of the minimum value p_{minS} and must be at least 1 bar



Initial data:

min. supply pressure p_{minS} = ... bar
Max. delivery rate $\dot{V}_{maxP}$ = ... m³/h

Selection according to DIN 1988 T5

max. delivery rate $\dot{V}_{maxP}$ / m³/h	Refix DT with duo connection V_n/litres	Refix DT V_n/litres
≤ 7	300	300
> 7 ≤ 15	500	600
> 15	---	800

V_n = ... litres

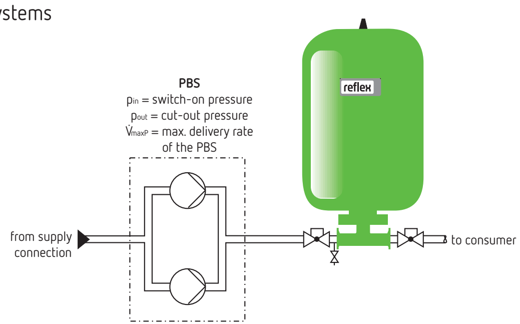
Input pressure p_0 = min. supply pressure − 0.5 bar
p_0 = ... − 0.5 bar = ... bar

p_0 = ... bar

Configuration: Refix on follow-up pressure side of PBS

- To restrict the switch frequency of pressure-controlled systems

Max. delivery head of PBS H_{max} = ... mWs
Max. supply pressure p_{maxS} = ... bar
Switch-on pressure p_{in} = ... bar
Cut-out pressure p_{out} = ... bar
Max. delivery rate $\dot{V}_{maxP}$ = ... l/h
Switch frequency s = ... 1/h
Number of pumps n = ...
Electrical power of most powerful pump P_{el} = ... kW



s - switch frequency	1/h	20	15	10
Pump output	kW	≤ 4.0	≤ 7.5	≤ 7.5

Nominal volume $V_n = 0.33 \times \dot{V}_{maxP} \dfrac{p_{out} + 1}{(p_{out} - p_{in}) \times s \times n}$

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

V_n = ... litres

- - To store the minimum supply volume V_e between activation and deactivation of the PBS

Switch-on pressure p_{in} = ... bar
Cut-out pressure p_{out} = ... bar
Input pressure Refix p_0 = ... bar → Reflex recommendation: $p_0 = p_{in}$ - 0.5 bar
Storage capacity V_e = ... l

p_0 = ... bar

Nominal volume $V_n = V_e \dfrac{(p_{in} + 1)\ (p_{out} + 1)}{(p_0 + 1)\ (p_{out} - p_{in})}$

V_n = ... x .... = ... litres
Selection according to brochure = ... litres

V_n = ... litres

Check of max. excess operating pressure

$p_{max} \leq 1.1\ p_{max} \dfrac{H_{max}\ [mWs]}{10}$

$p_{max} = p_{maxS}$ + bar = ... = ... bar

p_{max} = ... bar

Result summary

Refix DT .... litres	10 bar	☐	Nominal volume	V_n	.... litres
With duo connection DN 50 .... litres	10 bar	☐	Usable volume	V_0	.... litres
Refix DT .... litres	16 bar	☐	Input pressure	p_0	.... litres

Make-up and degassing systems can automate system operation and make a significant contribution to operational reliability. While Variomat pressure-maintaining stations are supplied with integrated make-up and degassing functions, additional units are required in the case of Reflex diaphragm expansion vessels as well as Reflexomat and Variomat Giga pressure-maintaining stations.
Fillcontrol make-up stations ensure that there is always sufficient water in the expansion vessel – an elementary prerequisite for system function. They also meet the requirements of DIN EN 1717 and DIN 1988 for safe make-up from potable water systems.
Reflex Servitec degassing stations can not only make up water; they can also be used for central venting and degassing of systems. Our joint research with the Technical University of Dresden has underlined the essential nature of these functions, particularly in the case of closed systems. Measurements of supply water, for example, produced nitrogen concentrations between 25 and 45 mg/litre, which is 2.5 times higher than the natural concentration of potable water. → p. 54

Overview of Reflex water make-up systems

	Water make-up fittings			Automatic water make-up systems		Automatic water make-up systems with pump	
	Fillset Compact	Fillset	Fillset Impuls	Fillcontrol Plus	Fillcontrol Plus Compact	Fillcontrol Auto Compact	Fillcontrol Auto
DVGW-approved system separation	X	X	X		X	5 litres System separation vessel	
kVS	1.5 m^3/h	1.5 m^3/h	1.5 m^3/h	1.4 m^3/h	0.4 m^3/h	0.18 m^3/h	0.18 m^3/h
Pump	–	–	–	–	–	8.5 bar	8.5 bar
Integrated shut-off	X	X	X	X	X	X	X
Wall mount		X	X	X		X	
Automatic water make-up				Based on time, cycle or total amount		Based on time, cycle or total amount	Based on time, cycle or total amount
				Level-control on pressure-main-taining systems		Level-control on pressure-main-taining systems	Level-control on pressure-main-taining systems
				Pressure-depend-ent Magcontrol	Pressure-depend-ent Magcontrol	Pressure-depend-ent Magcontrol	Pressure-depend-ent Magcontrol
Alarm message				X	X	X	X
Water meter		X	Contact water meter				
Evaluation Water softening				With contact water meter		With contact water meter	With contact water meter

Water make-up systems

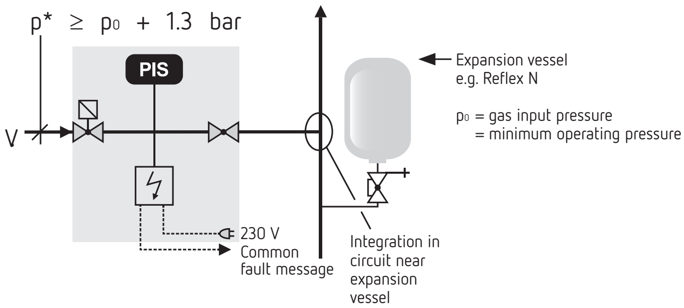
The system pressure is indicated on the display and monitored by the controller. If the pressure falls below the initial value p < p0 + 0.3 bar, controlled water make-up takes place. Faults are displayed and can be transferred via a signal contact. In the case of potable water make-up, a Reflex system must be preceded by a Reflex Fillset unit. A finished combination of both systems, with an integrated pressure reducing valve, is available in the form of Reflex Fillcontrol for smaller make-up volumes.
The pressure immediately before the water make-up must be at least 1.3 bar higher than the input pressure of the expansion vessel. The make-up volume V can be determined from the k_{VS} value.


Fillset

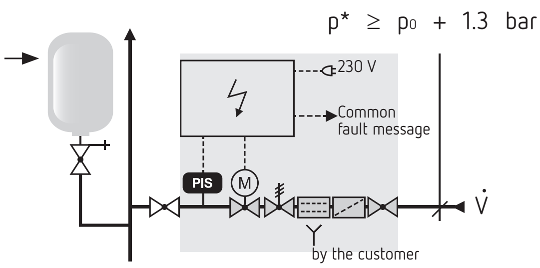

Fillcontrol Plus


Fillcontrol Plus Compact

Fillcontrol Plus diagram



Fillcontrol Plus Compact diagram



Make-up volume

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

Setting values
p_0 = ... bar
p_{SV} = ... bar

	k_{VS}
Fillcontrol	0.4 m³/h
Fillcontrol Plus	1.4 m³/h
Fillcontrol Plus + Fillset	0.7 m³/h

* p = excess pressure immediately before make-up station in bar

Fillcontrol Auto

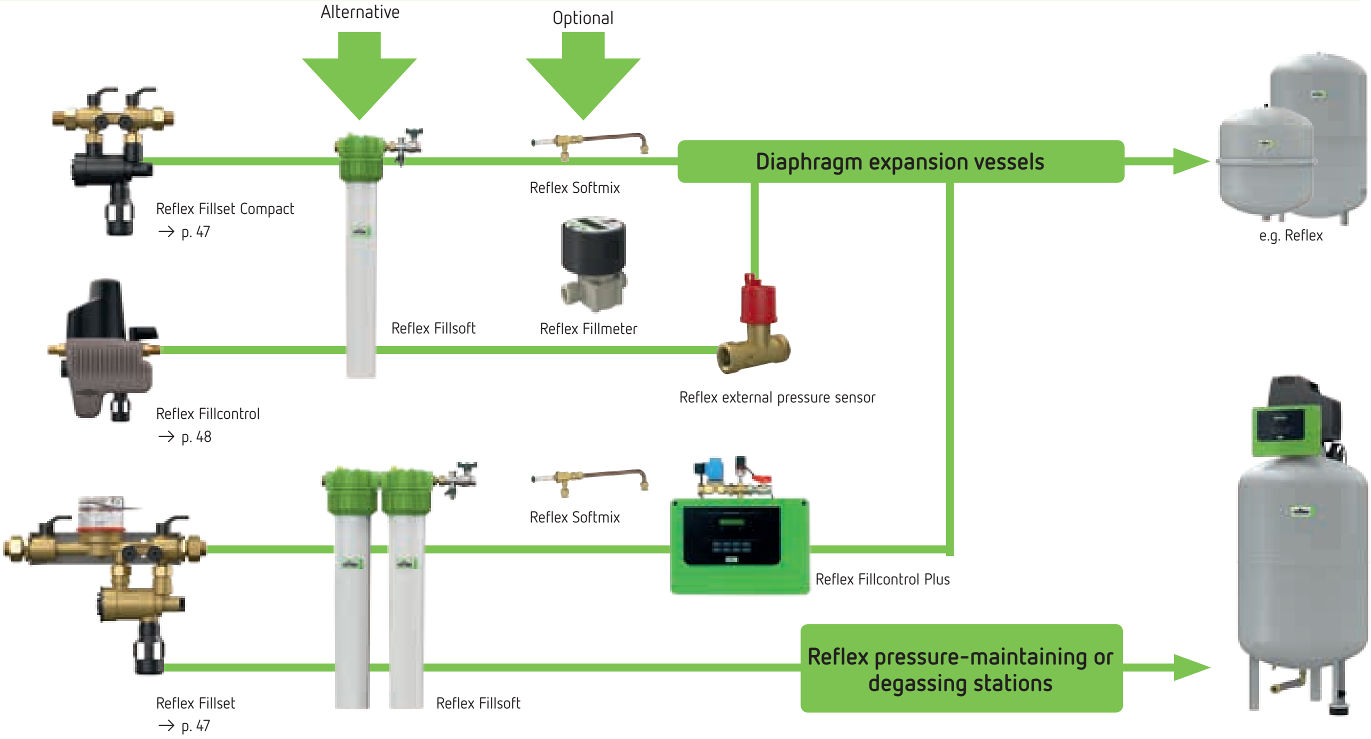
Fillcontrol Auto is a make-up station with a pump and open reservoir (system separation vessel) as a means of isolation from the potable water system according to DIN 1988 or DIN EN 1717.

Fillcontrol Auto is generally used when the fresh water supply pressure p is too low for direct make-up without a pump or when an intermediate vessel is required for separation from the potable water system.

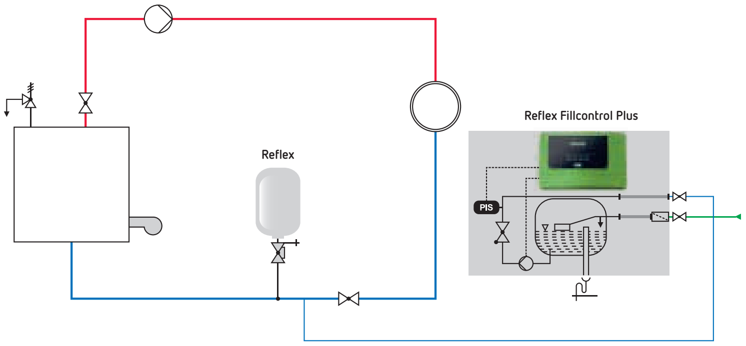
The delivery rate is between 120 and 180 l/h at a max. delivery head of 8.5 bar.


Fillcontrol Auto

Combination variants (notes for the installer)

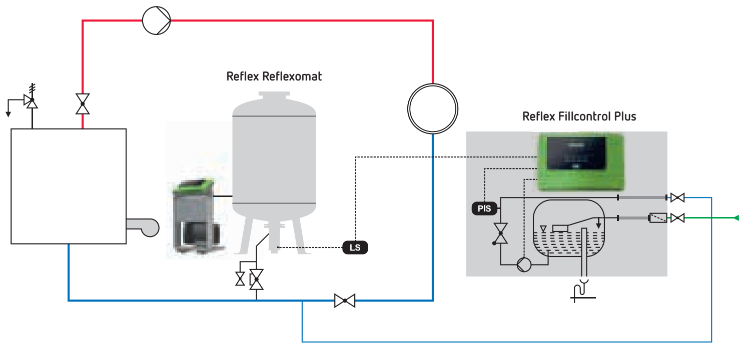


Reflex Fillcontrol Auto Compact with pressure-dependent control in a system with an expansion vessel



- Reflex Fillcontrol Auto Compact is set to "level-dependent control" in systems with pressure expansion vessels, e.g. Reflex. Make-up then takes place at filling pressure or if the initial pressure in the expansion vessel is too low. The make-up line must be integrated in the proximity of the expansion vessel.
- DN 15 up to 10 m connection line
  DN 20 over 10 m connection line

Reflex Fillcontrol Auto Compact with level-dependent control in a system with compressor pressure maintenance



- Reflex Fillcontrol Auto Compact is set to "level-dependent control" in systems with pump or compressor-controlled pressure-maintaining stations, e.g. Reflex Gigamat, Reflex Reflexomat. Make-up is then performed based on the filling level **LS** in the expansion vessel of the pressure-maintaining station. A 230 V input on the Fillcontrol Auto is available for this.
- DN 15 up to 10 m connection line
  DN 20 over 10 m connection line

The circuits must be adjusted to suit local conditions.

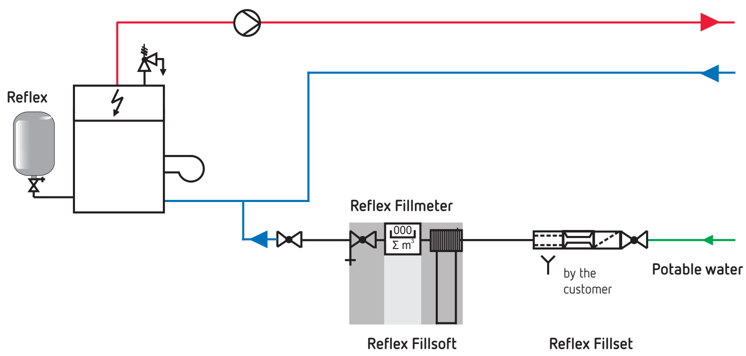
Reflex Fillsoft softening device (technical data / notes for the installer)

Reflex Fillsoft perfectly complements Reflex make-up systems so that filling and make-up water is checked and prepared before being fed into the system. The VDI 2035 Part 1 requirements, "Prevention of damage in water heating installations" are fulfilled using a highly efficient Na-ion exchanger. The pH value is not influenced by this procedure.

Technical data

Max. excess operating pressure		: 8 bar
Max. operating temperature		: 40°C
Capacity		
- Fillsoft I		: 6000 l x °dGH
- Fillsoft II		: 12,000 l x °dGH
Connection	Inlet	: Rp ½
	Outlet	: Rp ½
Weight		
- Fillsoft I		: 4.1 kg
- Fillsoft II		: 7.6 kg

Reflex Fillsoft with **Reflex Fillmeter** in a system with a pressure expansion vessel



Notes for the installer

- Reflex Fillmeter with run time monitoring makes a system log book unnecessary.
- Reflex Softmix for achieving the desired degree of water hardness.
- Reflex GH hardness testing kit for determining regional degree of water hardness.

The circuits must be adjusted to suit local conditions.

Water hardness

The need to protect heat generation systems (boilers and heat exchangers) from calcification is dictated, among other things, by the total water hardness of the filling and make-up water.
In this context, measurements are primarily based on VDI 2035, page 1, as well as the specifications of the relevant manufacturers.

Necessity: VDI 2035, page 1: Requirements of filling and make-up water
Due to the compact design of modern heat generators, the need to prevent calcification is ever growing. The current trend is for large heating outputs with small water volumes. VDI 2035, page 1, was revised in December 2005 to address this matter in a more focused manner and provide recommendations for damage prevention.

Calcification: $Ca^{2+} + 2HCO_3^- \rightarrow CaCO_3 + CO_2 + H_2O$
The ideal location to implement necessary measures is in the filling and make-up line of the heating system. Appropriate systems for automatic water make-up are simply to be added in line with requirements.

Group	Total heating output	Total hardness [dGH] Based on spec. system volume v_s (system volume/lowest individual heating output)		
		< 20 l/kW	≥ 20 l/kW and < 50 l/kW	≥ 50 l/kW
1	< 50 kW	≤ 16.8 °dGH for circulation heaters	≤ 11.2 °dGH	< 0.11 °dGH
2	50 - 200 kW	≤ 11.2 °dGH	≤ 8.4 °dGH	< 0.11 °dGH
3	200 - 600 kW	≤ 8.4 °dGH	≤ 0.11 °dGH	< 0.11 °dGH
4	> 600 kW	< 0.11 °dGH	< 0.11 °dGH	< 0.11 °dGH

Initial data
Output-specific system volume for heat output
Output-specific heat generator content

Circulating water heaters or devices with electric heating elements
vC < 0.3 l/kW

Total heating output
This is the total of all individual heat generator outputs.

Lowest individual heating output
This represents the smallest individual heating output of a single heat generator forming part of a heat generator network.

Output-specific system volume
This represents the entire water content of the system incl. heat generators relative to the smallest individual heating output.

Output-specific boiler volume
This is the characteristic value of the heat generator content relative to its heating output. The lower the value, the thicker the limescale deposits that can be expected in the case of calcification in the heat generator.

Regional total water hardness
In many cases, the most practical solution is to feed potable water from the public supply network into the systems as filling or make-up water. The local lime content or regional water hardness can vary greatly, sometimes even fluctuating within the same region. The regional water hardness can be checked with the relevant water provider or established on-site by means of a test (Reflex GH hardness testing kit). The relevant measures can then be derived on this basis. Water hardness is generally measured in dGH (degrees of general hardness). 1 dGH equates to 0.176 mol/m³, while 1 mol/m³ converts to 5.6 dGH.

Reflex GH hardness testing kit for independent measurement of local water hardness

Softening processes

There a number of methods for eliminating or disabling hard water minerals:

Cation exchangers
With cation exchange, the calcium and magnesium ions in the filling water are replaced with sodium ions, while the calcium and magnesium is retained in the cation exchanger. This prevents the hard water minerals from entering the heating system. This procedure has no influence on the pH value of the filling water, and the permeability also remains unchanged.

In the cation exchanger, the filling and make-up water is simply passed over sodium ion-enriched plastic, after which the chemical ion exchange process is performed automatically.

Decarbonisation
With decarbonisation, the hydrogen carbonate ions are removed or carbon dioxide is produced in conjunction with a hydrogen ion. The hardening cations in the magnesium and calcium are bound to the cation exchanger mass and thus removed. Due to the generated carbon dioxide, the pH value of the water is changed and the salt content reduced. A base exchanger is then added to compensate for this.

Decarbonisation works on the basis of the ion exchange principle and is used wherever a definite need exists to reduce the salt content of the water (e.g. steam generators).

Desalination
As the name suggests, desalination involves the removal of parts of the salt-forming anions and cations. In the case of full desalination, all these ions are effectively removed (demineralised water). There are two main methods used for desalination. On the one hand, the ion exchange process is again employed, in this case in a mixed bed exchanger. The other method is reverse osmosis, in which the salts are removed from the water by means of a diaphragm. This procedure is both technically demanding and highly energy-intensive and more suited to large water volumes. When using demineralised water, a pH adjustment function must be implemented in the system.

Hardness stabilisation
Hardness stabilisation is a water treatment that influences the calcium precipitation to the point that no scale formation occurs. Two specific procedures are employed. The first involves the addition of polyphosphate, thus suppressing the calcification though not fully eliminating it. Slurry formation can occur (calcium precipitation in the water), as the carbonate ion concentration is not reduced. This procedure requires chemical understanding, monitoring and regularity. The other procedure to be included under the general heading of physical water treatment involves the formation of stabilising crystal seeds, e.g. using magnetic fields, thus avoiding the need for chemicals or chemical processes. The effectiveness of the latter solution remains a matter of great dispute.

Practical water softening

For heating systems in the low to medium output range, cation exchangers are the ideal means of preventing calcification in heat generators. This cost-effective solution is simple to implement and best suits the specific requirements.

Water softening with cation exchangers in the filling and make-up line
Using the appropriate Reflex Fillsoft cation exchanger, fully or partially demineralised water can be produced to exact requirements.

Filling and make-up water
This term from VDI 2035, page 1, represents the water and specific volume that is required to completely refill a system or must be added during operation.

Soft water
This is water that has been completely freed of the hard water minerals calcium and magnesium thus eliminating the possibility of calcification. A specific characteristic value for the amount of soft water that a softening system can produce is the soft water capacity K_w [l*°dGH]. The filling and make-up water is not always to be fully demineralised, nor does it always have to be. Water that has not been completely freed of hardening minerals is also referred to as partially demineralised water.

Type	Soft water capacity K_w [l* °dGH]	k_{vs} [m³/h]	$\dot{V}_{max}$ [l/h]
Fillsoft I	6000	0.4	300
Fillsoft II	12,000	0.4	300

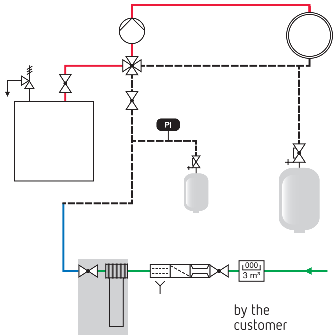


Diagram for Fillsoft I + Fillset Compact

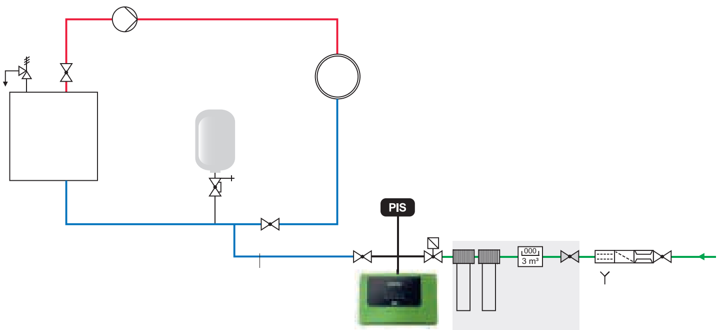


Diagram for
Fillcontrol Plus + Fillsoft II + Fillmeter + Fillset Compact

Soften your water with the Reflex Fillsoft cation exchanger


Fillsoft I


Fillsoft II


FS Softmix

Reflex Softmix produces partially demineralised water.


Fillmeter

Reflex Fillmeter monitors the capacity of the Fillsoft.

Reflex Fillsoft

Object:

Initial data

Heat generator		1	2	3	4	
Heat output	$\dot{Q}_K$	= .... kW	.... kW	.... kW	.... kW	$\dot{Q}_{tot}$ = ... kW $\dot{Q}_{min}$ = ... kW
Water content	V_W	= .... litres	 l	 l	 l	
Water content known	V_s	= .... litres	→ p. 6	Approximate water content $v_s = f(t_F, t_R, \dot{Q}_{tot})$		V_s = ... litres

Specific characteristic values

Output-specific boiler water content	v_C	$= \frac{V_C}{\dot{Q}_K}$ = ________	= .... l/kW	v_C = ... l/kW
Output-specific system content	v_s	$= \frac{V_s}{\dot{Q}_{min}}$ = ________	= .... l/kW	v_s = ... l/kW

Water hardness

Regional total water hardness	GH_{act}	= .... dGH	Information from water provider or self-measurement → p. 30	GH_{act} = ...°dGH
Target total water hardness	GH_t	= .... dGH	→ Table on p. 30 and details from relevant manufacturer	GH_t = ...°dGH
Soft water capacity of:				
Fillsoft I	K_W	= 6000 l * °dGH		K_W = ... l*°dGH
Fillsoft II	K_W	= 12,000 l * °dGH		
Fillsoft FP	K_W	= 6000 l * °dGH/unit		

Possible filling and make-up water volumes

Possible filling watervolume (mixed)	V_F	$= \frac{K_W}{(GH_{act} - GH_t)} =$ = ________ = ...	For $GH_{act} > GH_t$	V_F = ... litres
Possible make-up water volume	V_m	$= \frac{K_W}{(GH_{act} - 0.11\ °dGH)}$ = ________ = ...	For $GH_{act} > 0.11$ °dGH	V_m = ... litres
No. of cartridges required to fill system	n	$= \frac{V_s\ (GH_{act} - GH_t)}{K_W} =$ = ________ = ...		n[1] = ... litres
Possible residual make-up volume after filling	V_m	$= \frac{n * 6000\ l\ °dGH - (V_s * (GH_{act} - GH_t))}{(GH_{act} - 0.11\ °dGH)}$ = ________ = ...	For $GH_{act} > 0.11$ °dGH	V_m = ... litres

Result summary

Fillsoft	Type	System content V_s	.... litres
FP replacement cartridge	Number	Possible filling water volume (partially/fully demineralised)	.... litres
Softmix	☐ Yes ☐ No	Possible residual make-up volume (fully demineralised)	.... litres
Fillmeter	☐ Yes ☐ No	Possible residual make-up volume (partially demineralised)	.... litres
Hardness testing kit	Number		

▸ $\dot{Q}$min = lowest value of $\dot{Q}$b

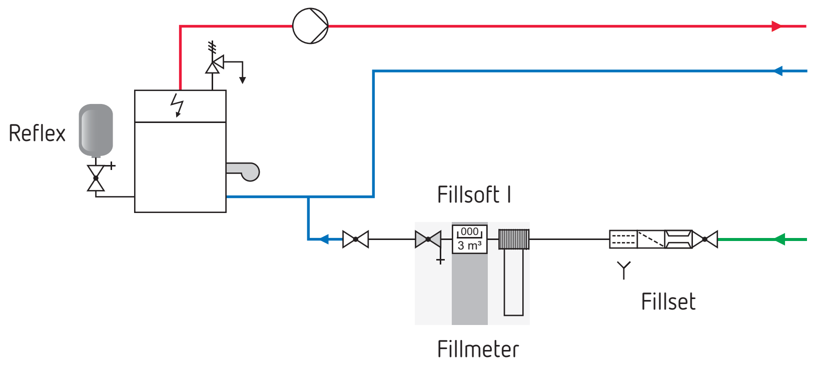
▸ Checks whether the unit is a circulating water heater (< 0.3 l/kW)

▸ Water softening is required when GHact > GHt

▸ [1] Round cartridge no. n to the nearest whole number

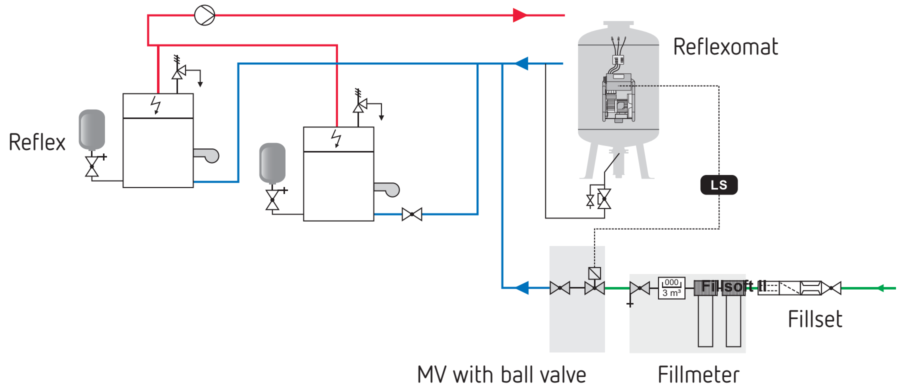
Reflex Fillsoft installation examples (notes for the installer)

Reflex Fillcontrol Auto Compact with level-dependent control in a system with compressor pressure maintenance



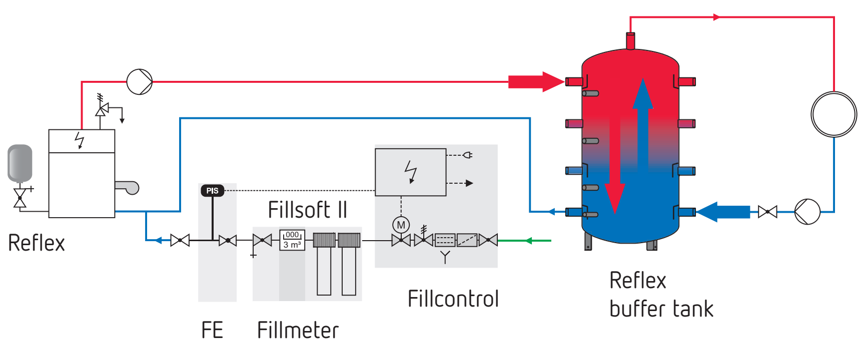
- For small single-boiler systems that are fitted, in some cases, with a wall mount device, softening may be necessary for as little as < 50 kW.
- The simplest way to integrate Fillsoft: manual water make-up with the fill meter as capacity monitoring. Don't forget the Fillset for make-up from the potable water system.

Reflex Fillcontrol Auto Compact with level-dependent control in a system with compressor pressure maintenance



- For multi-boiler systems, the output-specific water content is multiplied by 2 or more and is likely to increase the requirements according to VDI 2035 page 1.
- Essential requirements for the make-up function have already been provided in conjunction with the Reflex system technology. For make-up from the potable water system, also combine Fillsoft with Fillset.

Reflex Fillcontrol Auto Compact with level-dependent control in a system with compressor pressure maintenance



- In relatively small networks, installations with buffer tanks usually lead to a requirement for full softening according to VDI 2035 Part 1. The Fillsoft is pre-equipped for this.
- Don't forget the Fillsoft FE external pressure sensor in combination with a Fillcontrol make-up station.

Degassing stations

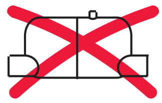
In most cases, a single sample in a glass vessel is sufficient to identify excess gas accumulation in closed systems. Upon relaxation, the sample takes on a milky appearance due to the formation of micro-bubbles.

Gas-rich, cloudy sample

Servitec in Fillcontrol Plus mode for Reflex and other expansion vessels
The pressure is indicated on the display and monitored by the controller (min/max fault message). If the pressure falls below the initial value ($p < p_0 + 0.3$ bar) the necessary checks are performed and degassed water made up by means of leakage volume monitoring. This also enables refilling of systems during manual operation. This helps to minimise the amount of oxygen injected into the system.
The additional cyclical degassing of the circulating water removes accumulating excess gases from the system. This central "deaeration" makes circulation problems due to free gases a thing of the past.
The combination of Servitec and Reflex expansion vessels is technically equivalent to Variomat pressure-maintaining stations and represents a cost-effective alternative. particularly in the sub-500 kW output range.

→ Reflex calculation for diaphragm expansion vessels page 9
→ Servitec as per table below

Setting values
p_0 = ... bar
p_{SV} = ... bar



Traditional air separators are not required, thus saving installation and maintenance costs.

Servitec in Levelcontrol Plus mode for Variomat and Variomat Giga
The functionality is similar to that of Servitec in Fillcontrol Plus mode, except that the water is made up on the basis of the water level in the expansion vessel of the pressure-maintaining station. For this purpose, a corresponding electrical signal (230 V) is required from this station. The pressure monitoring is either dispensed with or is performed by the pressure-maintaining station.

Make-up volume, system volume
The throughput volumes of the Servitec system depend on the pumps employed and the settings of the corresponding pressure reducing and overflow valves. In the case of standard systems with default factory configuration, the values in the table apply on a type-specific basis. The recommended max. system volumes are subject to the condition that partial flow degassing of the network volume takes place at least once every two weeks. In our experience, this is sufficient even for networks with extremely high loads.

Note that Servitec can only be used within the specified operating pressure range – i.e. the specified operating pressures must be maintained at the Servitec integration point. In the case of deviating conditions, we recommend the use of special systems.

Degassing of water-/glycol mixtures is a more elaborate process, a fact that is underlined by the special technical equipment used for the glycol variants.

Reflex Servitec
vacuum spray tube degassing unit

Type	System volume V_s*	Water make-up rate	Working pressure
For water up to 70 °C			
Servitec 25	up to 2 m³	Up to 0.05 m³/h	0.5 to 2.5 bar
Servitec 35	up to 60 m³	Up to 0.35 m³/h	1.3 to 2.5 bar
Servitec 60	up to 100 m³	Up to 0.55 m³/h	1.3 to 4.5 bar
Servitec 75	up to 100 m³	Up to 0.55 m³/h	1.3 to 5.4 bar
Servitec 95	up to 100 m³	Up to 0.55 m³/h	1.3 to 7.2 bar
Servitec 120	up to 100 m³	Up to 0.55 m³/h	1.3 to 9.0 bar
For water-glycol mixtures up to 70 °C			
Servitec 25/gl	up to 2 m³	Up to 0.05 m³/h	0.5 to 2.5 bar
Servitec 60/gl	up to 20 m³	Up to 0.55 m³/h	1.3 to 4.5 bar
Servitec 75/gl	up to 20 m³	Up to 0.55 m³/h	1.3 to 4.9 bar
Servitec 95/gl	up to 20 m³	Up to 0.55 m³/h	1.3 to 6.7 bar
Servitec 120/gl	up to 20 m³	Up to 0.55 m³/h	1.3 to 9.0 bar

▶ The working pressure must lie within the working range of the pressure maintenance = p_i to p_f.

* V_s = max. system volume for continuous degassing over 2 weeks

Servitec units for higher system volumes and temperatures up to 90 °C are available on request.

From our joint research with the Technical University of Dresden

Many heating systems suffer from "air problems". Intensive research in conjunction with the Energy Technology Institute of the Technical University of Dresden has shown that nitrogen is one of the main causes of circulation problems. Measurements on existing systems produced nitrogen concentrations between 25 and 50 mg/l, much higher than the natural concentration of potable water (18 mg/l). Our Servitec system rapidly reduces the concentration to near 0 mg/l.

Figure 1:
Servitec test system in a heat transfer station of the Halle energy utility

Heat output:	14.8 MW
Water content:	approx. 100 m³
Return temperature:	≤ 70 °C
Return pressure:	approx. 6 bar

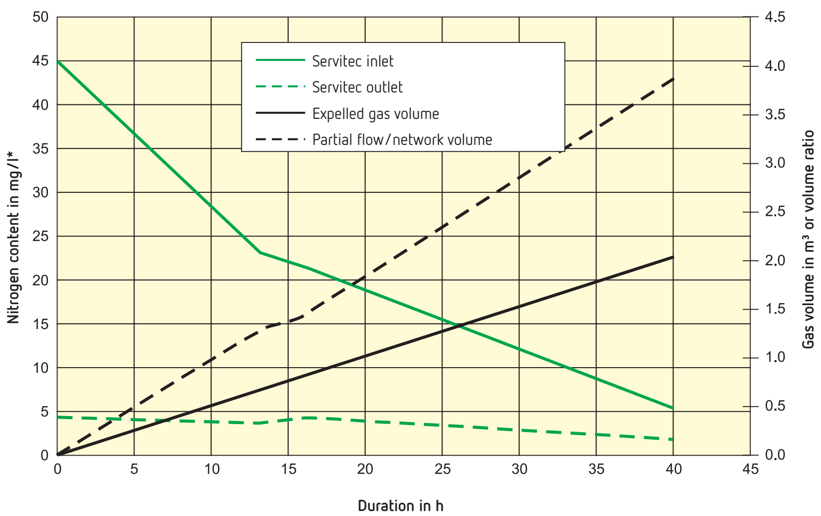


Figure 2:
Nitrogen reduction using Servitec partial flow degassing in a test system of the Halle energy utility

* Natural concentration of potable water = 18 mg/l N_2

Nitrogen-rich, cloudy sample

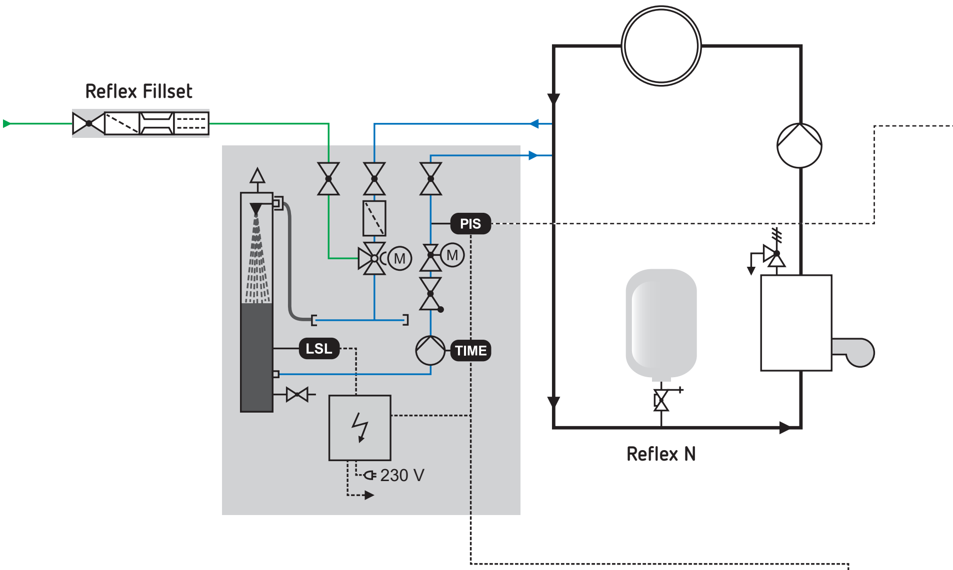
Clear, translucent sample

Both samples are virtually oxygen-free

In 40 hours, Servitec reduced the N_2 content to almost 10 % of the initial value, thereby eliminating 4 m³ of nitrogen. The air problems in the high-rise buildings were successfully eradicated.

Reflex Servitec – installation examples

Reflex Servitec in Magcontrol mode for systems with diaphragm pressure expansion vessels



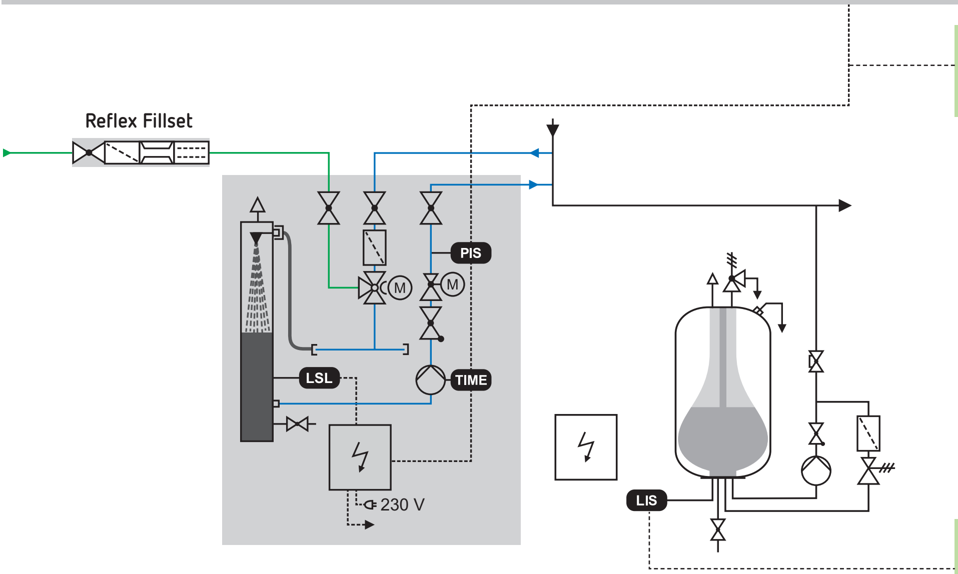
PIS **Filling – make-up, pressure-dependent – Magcontrol**

- The pressure is shown on the display
- Excess and insufficient pressure levels are signalled
- Automatic, controlled make-up in the event that the system **fails to reach the filling pressure** of 0.2 bar
- Servitec degassing of the make-up and filling water

Reflex Servitec in Levelcontrol mode for systems with pump- or compressor-controlled pressure-maintaining stations

TIME **Degassing**

- Vacuum degassing of a part flow of the circuit water takes place according to an optimised schedule using a selectable degassing mode
  - Continuous degassing (after start-up)
  - Interval degassing (automatically activated after continuous degassing)



LIS **Make-up, level dependent – Levelcontrol**

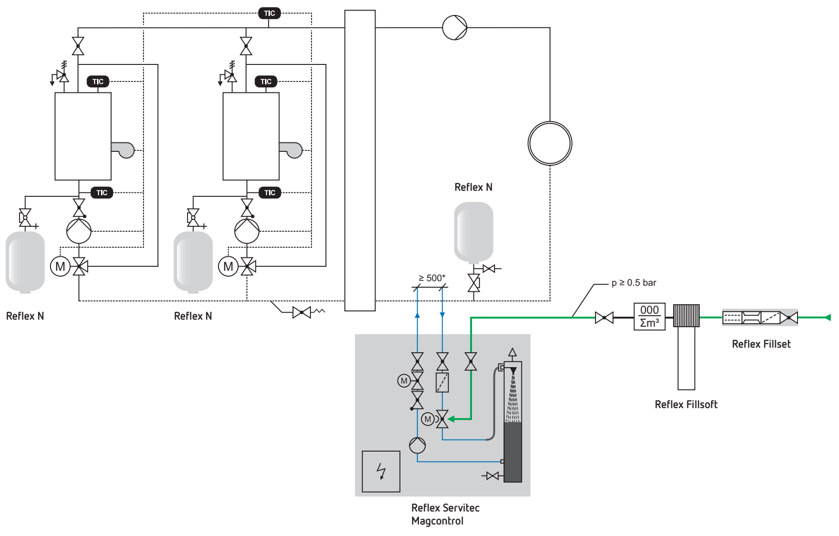
- Automatic, controlled make-up if the minimum water level is not reached in the expansion vessel of the pump- or compressor-controlled pressure-maintaining station
- Servitec degassing of make-up water

Reflex Servitec installation examples (notes for the installer)

Reflex Servitec degassing stations solve "gas problems" in three ways:

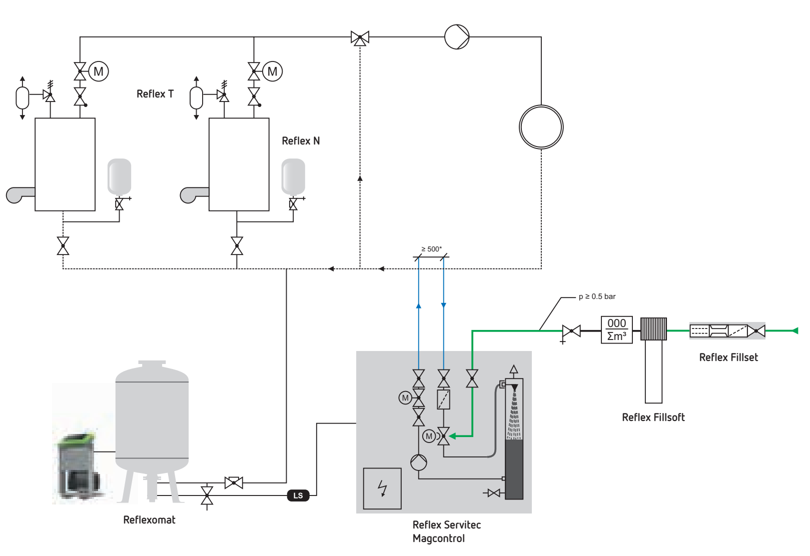
- No direct drawing in of air, thanks to monitored pressure maintenance
- No circulation problems from bubbles in the circuit water
- Reduction of corrosion risk thanks to the removal of oxygen from the filling and make-up water

Reflex Servitec in Magcontrol mode in a multi-boiler system with a hydraulic point and expansion vessel



- Preferably install the Servitec unit on the system side so that the temperature load remains ≤ 70 °C.
- When using softening systems, they should be installed between the Fillset and Servitec units.
- If the shut-off at the integration point of Servitec is closed when decommissioning the circulating pumps, the part flow degassing remains functional.

Reflex Servitec in Levelcontrol mode and compressor pressure maintenance – an ideal combination



The circuits must be adjusted to suit local conditions.

- The combination of Servitec with compressor-controlled pressure-maintaining stations (for example Reflexomat) is especially recommended. The system uncompromisingly degassed by the Servitec is softly cushioned by the Reflexomat.
- The water level in the expansion vessel is monitored by the control unit of the pressure-maintaining station. The 230 V make-up signal supplied by the pressure-maintaining station triggers the make-up process with degassing.
- Optimum degassing is ensured by integrating Servitec in the main volumetric flow of the circuit water.
- When combining pump-controlled pressure-maintaining stations with a Servitec unit, we always recommend individual boiler protection using a diaphragm pressure expansion vessel (for example Reflex).

Heat exchangers

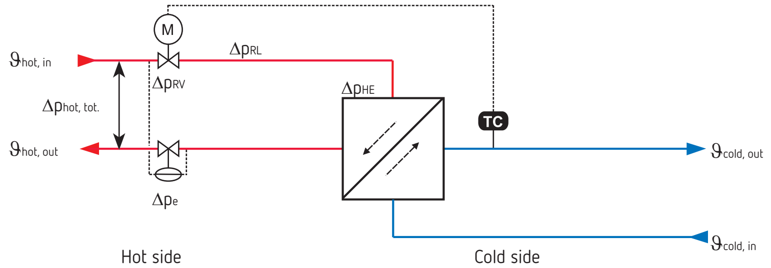
Heat balances

The role of a heat exchanger is to transfer a specific heat quantity from the hot to the cold side. The transfer capacity is not only device-specific but also dependent on the required temperatures. As a result, we do not speak of … kW heat exchangers, but rather that a device can transfer … kW with the specified heat spreads.

Applications

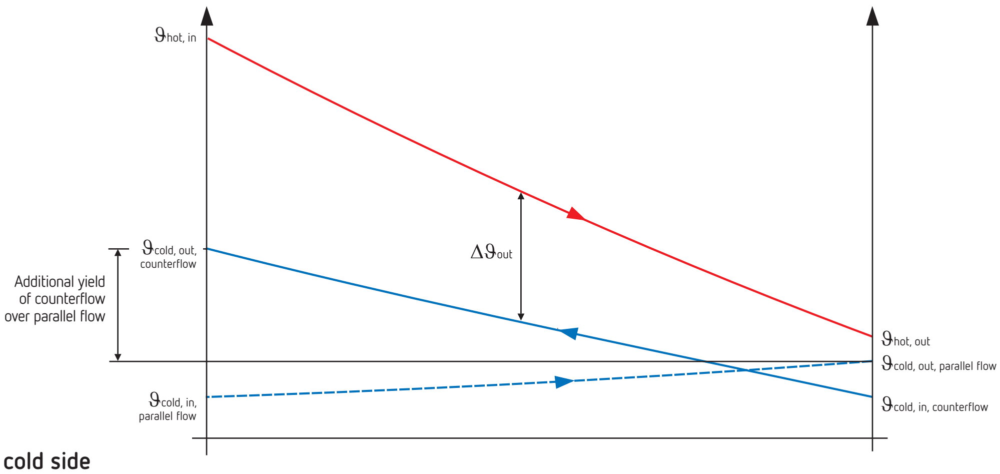
- As a system separator from media that must not be mixed, e.g.
  - Heating and potable water
  - Heating and solar system water
  - Water and oil circuits
- For separating circuits with different operating parameters, e.g.
  - Excess operating pressure of page 1 exceeds the max. excess operating pressure of page 2
  - Water content of page 1 is significantly higher than that of page 2
- To minimise interference between the two circuits

Example applications:
- Indirect district heating connections
- Floor heating
- Potable water heating
- Solar energy systems
- Machine cooling



Counterflow

As a rule, heat exchangers should always be connected on the basis of the counterflow principle as only this will ensure that they can deliver their full capacity. In the case of parallel flow connections, significant performance losses can be expected.



Hot and cold side

The allocation of the two system circuits as the primary and secondary side varies by individual application. In the case of heating systems, the hot side is usually described as the primary side, whereas the cold side is the primary side in cooling and refrigerating systems. The differentiation between hot and cold sides is both clearer and non-application-specific.

Inlet/outlet

When configuring heat exchangers, problems are often encountered with the terms 'advance' and 'return' as the calculation software requires accurate designation of the inlet and outlet. A clear distinction must be made between the hot heating advance on the outlet side of the heat exchanger and the inlet into the plate heat exchanger delivered from the heating system in a cooled state. In the Reflex calculation software, 'inlet' always refers to the supply to the plate heat exchanger, while the 'outlet' is defined correspondingly.

Heat exchangers

Thermal length

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

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

The term "thermal length" is often used as a qualitative description of the heat exchanger's performance. This is a device-specific property that depends on the structure of the heat exchanger plates. Increased profiling and narrower channels raise the flow turbulence between the plates. The "thermal length" of the device is increased thus raising its performance and allowing it to better align the temperatures of both media.

Log mean temperature difference

A measure of the driving force of the heat transfer is the temperature difference between the hot and cold medium. Since this constitutes a non-linear transition, the driving force is linearised under the term "log mean 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 lower this driving temperature difference, the greater the surface area to be provided; this can result in very large systems for cold water networks in particular.

Terminal temperature difference

The terminal temperature difference is of central importance to the configuration of heat exchangers. It states to what extent the outlet temperature on side 2 is aligned with the inlet temperature on side 1. The smaller this temperature difference, the greater the transfer area that must be provided, and this in turn dictates the price of the system. For heating systems, an appropriate terminal temperature difference of ≥ 5 K is assumed. In the case of cooling systems, terminal temperature differences of 2 K are sometimes required, which can only be implemented with very large systems. A critical assessment of the terminal temperature difference can thus have a significant impact on overall costs.

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

Pressure losses

An important criterion for the configuration of heat exchangers is the permissible pressure loss. Similarly to the terminal temperature difference, a very low pressure loss is generally only possible with very large heat exchangers. In such cases, increasing the temperature spread can help to reduce the volume flow to be circulated and thus also the pressure loss experienced by the heat exchanger. If a higher pressure loss is available in a system, e.g. in the case of district heating networks, it may be expedient to permit a slightly higher pressure loss in order to significantly reduce the size of the system.

Flow properties

The size of a heat exchanger is also greatly dictated by the flow properties of the media. The greater the turbulence with which the heat transfer media pass through the system, the higher not only the transferable output but also the pressure losses. This interrelation between output, system size and flow properties is described by the heat transfer coefficient.

Surface reserve

To determine the size of a heat exchanger, the first step is to establish the required transfer area on the basis of the boundary conditions. When applying a maximum pressure loss, for example, this can result in devices with a significant excess surface area. This surface reserve is a theoretical value. When operating the plate exchanger, the temperatures of the two heat transfer media are aligned to the point that the excess surface area no longer exists. In a heating circuit, the target temperature is generally specified via the regulator. A theoretical surface reserve is removed by reducing the heating mass flow via the regulator. The temperature on the outlet side of the hot medium is thus reduced correspondingly. When sizing the control fittings, the reduced mass flow must be taken into account to avoid overdesigning.

Physical principles

Heat balances
Heat emission and absorption of heat transfer media:

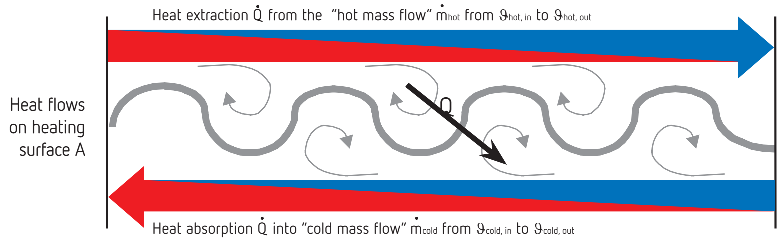
$$\dot{Q} = \dot{m} \times c \times (\vartheta_{in} - \vartheta_{out})$$

Based on the specified temperature spread and the circulated mass, the above formula can be used to calculate the capacity to be transferred.

Heat transport via heat exchanger plates:

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

The heat transfer coefficient k [W/m²K] is a medium- and device-specific variable comprising the flow properties, nature of the transfer surface and type of the heat transfer media. The more turbulent the flow, the higher the pressure loss and thus also the heat transfer coefficient. The log mean temperature difference $\Delta\vartheta_{ln}$ is a pure system variable resulting from the established set temperatures.
Using a complicated calculation algorithm, the heat transfer coefficient is first established on the basis of the boundary conditions, after which the necessary system size is determined on the basis of the required transfer surface area.



Initial data
The following values must be known to be able to configure a heat exchanger:
- Type of media (e.g. water, water/glycol mixture, oil)
- Properties of any media other than water (e.g. concentrations, density, heat conductivity and capacity, viscosity)
- Inlet temperatures and required outlet temperatures
- Capacity to be transferred
- Permitted pressure losses

If the systems are operated under very different (e.g. seasonal) conditions, as in the case of district heating networks for instance, the heat exchangers must also be configured to suit these conditions.

Calculation program
Computer-based calculations of pressure-maintaining systems and heat exchangers can be performed via our **Reflex Pro calculation program** which is available for use or download at www.reflex.de. Another option is to use our Reflex Pro app!
Both tools represent a quick and simple means of finding your ideal solution.

System equipment

Safety technology

Applicable standards for the safety equipment of heat exchangers as indirect heat generators include:

- DIN 4747 for district heating substations
- DIN EN 12828 for water heating systems; see section "Safety technology" from p. 63
- DIN 1988 and DIN 4753 potable water heating systems

The following information on system equipment is to support you with your system configuration and help to avoid frequent problems with system operation and device failures during the planning phase.

Regulating valve

The configuration of the regulating valve is of utmost importance to the stable operation of a heat exchanger. It should not be oversized and must ensure stable regulation even under low loads.

One particular selection criterion is the valve authority. It describes the ratio between the pressure losses with a fully opened regulating valve and the maximum available pressure loss with the valve closed. If the valve authority is too low, the regulating effect of the valve is insufficient.

$$\text{Valve authority} = \frac{\Delta p_{RV}\ (100\ \%\ \text{stroke})}{\Delta p_{hot,\ tot.}} \geq 30 \text{ to } 40\ \%$$

Once the pressure loss via the regulating valve has been determined, the k_{VS} value can be established. It must be based on the actual mass flow of the circuit to be regulated.

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

▶ Regulating valve must not be oversized

The k_{VS} value of the selected regulating valve should not be significantly higher than the calculated value (do not use safety margins!). Otherwise, there is a risk of system instability and frequent switching, particularly under weak or partial loads, and this is one of the most frequent failure causes of plate heat exchangers.

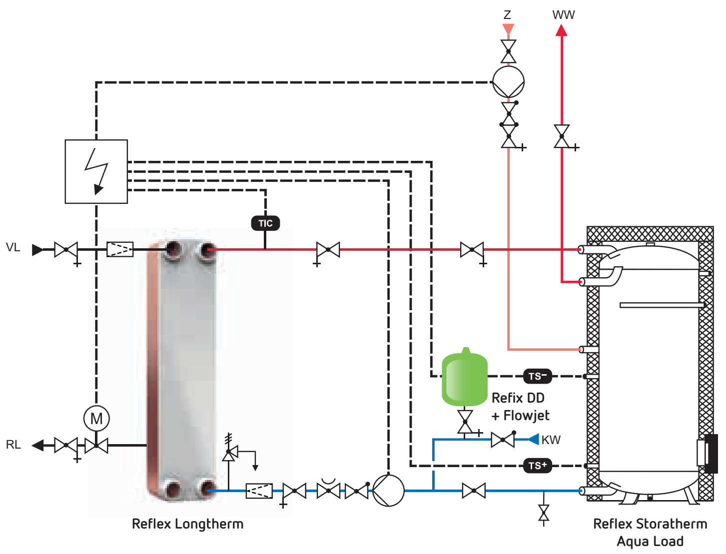
Temperature sensor, temperature regulator

The temperature sensors must be fast and virtually inertia-free and must always be fitted in the immediate vicinity of the plate heat exchanger outlet to ensure quickest possible actuation of the regulation to respond to changing conditions or variables. If slow sensors and regulators are used and situated far from the plate heat exchanger, there is a risk of periodic overshooting of the set point value temperatures and, consequently, frequent switching of the controls. Such unstable control behaviour can result in the failure of the plate heat exchanger. If additional control circuits are connected downstream of the heat exchanger control circuit, e.g. for secondary heating circuit regulation, they must communicate with one another.

Important!
Great care must be taken when selecting regulators and regulating valves. An incorrect configuration can result in unstable operation, which in turn leads to excessive dynamic stress on materials.

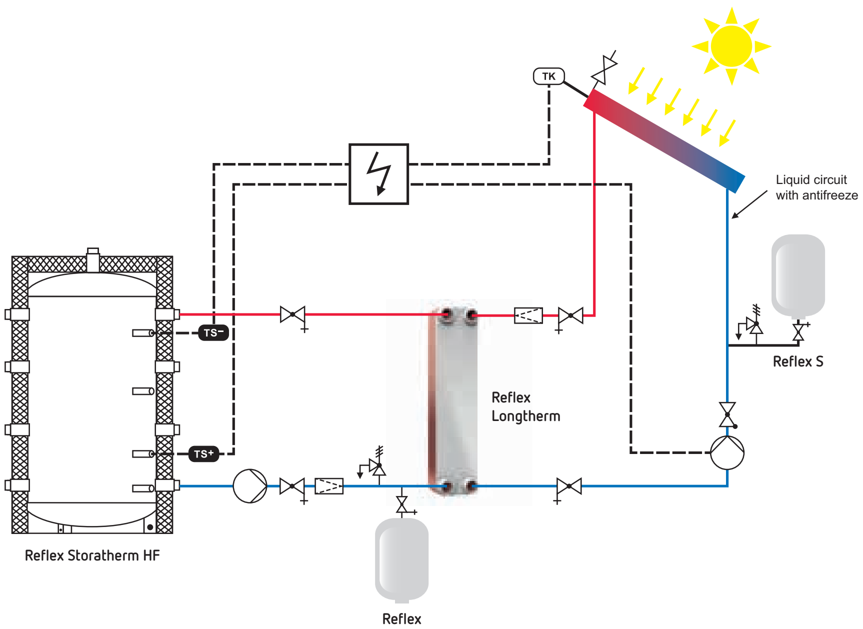
Reflex Longtherm installation examples (notes for the installer)

Reflex Longtherm in a storage/charging system for the heating of potable water



- Preferably select potable water outlet temperature as ≤ 60 °C, in order to reduce the risk of calcification (heating medium temperature ≤ 70 °C).
- In the case of constant flow on the potablewater side, the risk of calcification is lower; where necessary, connect the circulation line on the cold water side behind the charge pump.
  Important: For the configuration of the heat exchanger, the total maximum potable water volume flow ($\dot{V}_{charge}$) and the circulation volume flow ($\dot{V}_{circ}$) must be recorded.
- When used as a flow limiter without a downstream tank, a fast regulator must be used.

Reflex Longtherm in a solar energy system with buffer tank

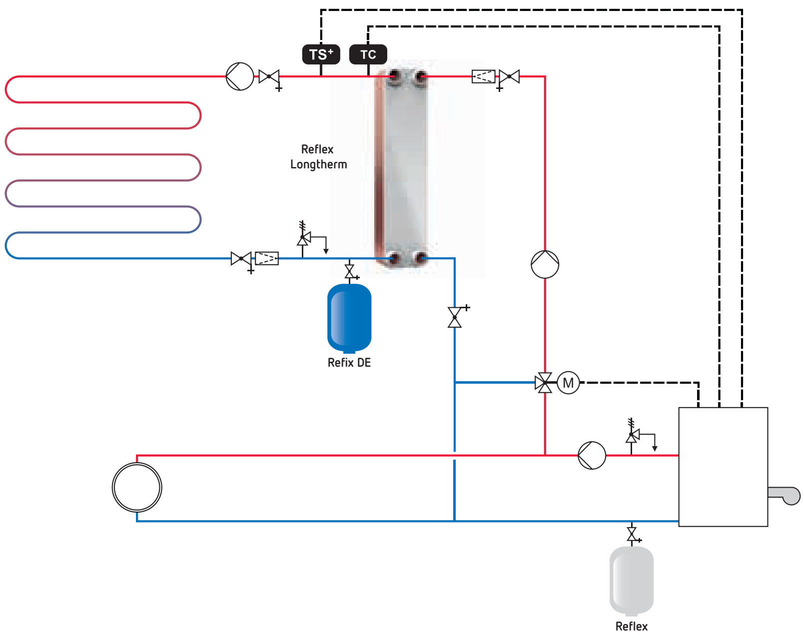


- **Configuration data**
  For flat collectors, the heat exchanger should be designed for a transfer capacity of 500 W/m² collector surface area (opt. efficiency 65 % with global radiation of 800 W/m²).
  Pure potable water heating
  Collector temperature: 55/35 °C
  (antifreeze proportion acc. to the following values), TW temperature: 10/50 °C
  Heating the buffer tank
  Collector temperature: 55/35 °C
  (antifreeze proportion acc. to the following values), HW temperature: 30/50 °C
- **Antifreeze** (propylene glycol)
  in connection with potable water or foods
  25 % frost-proof to -10 °C
  38 % frost-proof to -20 °C
  47 % frost-proof to -30 °C
  Antifreeze (ethylene glycol)
  in hot water heating systems or technical cooling systems
  25 % frost-proof to -13 °C
  34 % frost-proof to -20 °C
  50 % frost-proof to -36 °C
  Please observe the minimum dosage quantities from the manufacturer!

The circuits must be adjusted to suit local conditions.

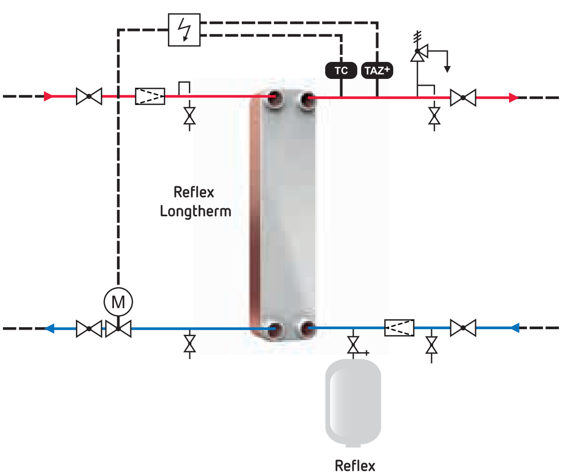
Reflex Longtherm installation examples (notes for the installer)

Reflex Longtherm for system separation in a system with floor heating



- When retrofitting Reflex Longtherm for system separation in "old" systems, the floor and boiler circuits must be flushed beforehand.
- Boiler regulation enables low return temperatures for utilisation of condensing technology.
- Use corrosion-protected expansion vessel Refix DE in the floor heating circuit.

Reflex Longtherm for system separation in a district heating transfer station



- The specific technical connection conditions of the heat source must be observed.
- Due to the often high temperature and pressure requirements and the changing operating mode, it is imperative that the assembly, operating and maintenance instructions are adhered to precisely.
- When connecting the contact heat consumers (e.g. potable water heating, industry requirements), the summer temperatures for the district heating system must be observed precisely.

The circuits must be adjusted to suit local conditions.

Within the meaning of the guidelines and regulations, equipment is defined as all pieces of equipment that are required for operation and safety, such as connection lines, fittings and control devices.
Safety equipment is defined in standards. The main pieces of equipment are described below. Pages 70-73 provide an overview of heat generation systems with operating temperatures up to 105 °C according to DIN EN 12828 and hot water systems according to DIN 4753.

Safety valves (SV)

Safety valves protect heat and cold generators, expansion vessels and the entire system against impermissible excess pressures. When configuring safety valves, potential loading conditions (e.g. heat supply in the case of shut off heat generators, pressure increases caused by pumps) must be taken into account.

Hot water generators
DIN EN 12828: "Each heat generator in a heating system must be secured against exceeding the maximum operating pressure by at least one safety valve."
To ensure that they can discharge safely and adequately, safety valves on directly heated heat generators must be configured for saturated steam in relation to the nominal heat output $\dot{Q}$. In heat generators with an output of over 300 kW, an expansion trap should be connected for the phase separation of steam and water. In the case of indirectly heated heat generators (heat exchangers), sizing for water outflow is possible if the emission of steam is excluded by the temperature and pressure conditions. Based on experience, dimensioning can be performed on the basis of a fluid outflow of 1 l/(hkW).
According to DIN EN 12828, when using more than one safety valve, the smaller one must be configured for at least 40 % of the total discharge volume flow.
The technical specifications below are based on the rules already applied. The European standards to be applied in the future, e.g. EN ISO 4126-1 for safety valves had not been accepted at the time of printing this brochure. For the time being, we will therefore focus solely on the use of currently available and commonplace valves and their calculation criteria. As safety-relevant components, all valves must bear a CE mark according to the Pressure Equipment Directive 97/23/EC (DRGL) and should be component tested. The descriptions of safety valves below relate to valves that are currently available on the market. In the medium term, valves will be rated and identified according to DIN ISO 412, and dimensioning will have to be carried out accordingly.

SV code letter H
These safety valves are known generally as "diaphragm safety valves" with response pressures of 2.5 and 3.0 bar. In accordance with TRD 721, in Germany H valves can be used up to a maximum response pressure of 3 bar. The performance is defined independently of the brand. For the purposes of simplification, the blow-off steam and water are equated, irrespective of the response pressure (2.5 or 3.0 bar).

SV code letter D/G/H
If the response pressures deviate from 2.5 and 3.0 bar or if an output of 900 kW is exceeded, D/G/H safety valves are used. The blow-off rates are specified for each specific brand according to the allocated outflow numbers.

Hot water systems
In hot water systems according to DIN 4753, only safety valves with the code letter W are permitted. In some cases, combined valves W/F (F - fluids) are offered. The performance values are defined in TRD 721.

Solar energy systems
Solar energy systems according to VDI 6002 are to be fitted with H or D/G/H safety valves, while intrinsically safe systems should also be fitted with F safety valves (outflow for fluids only). Solar energy systems that are calculated according the specifications in this documentation are deemed intrinsically safe.

Cooling water systems
For cooling water systems in which evaporation can be excluded, F safety valves can be used according to the manufacturer. The loading conditions must be calculated specifically.

Expansion vessels
If the max. excess operating pressure of expansion vessels is below the permissible operating pressure of the system, intrinsic safeguarding is required. The loading conditions must be calculated specifically. Suitable valves are H, D/G/H and safety valves according to the AD data sheet A2 (e.g. F).
Although Reflex expansion vessels for pump-controlled pressure-maintaining stations are depressurised in normal operation, pressurisation can be expected in the event of incorrect operation. They are therefore protected with F valves via the control unit. At blow-off pressure (5 bar) the maximum possible volume flow is to be discharged. This generally works out as 1 l/(hkW) relative to the connected overall heat output.

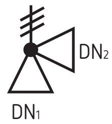
* The Reflex product range does not include safety valves.

Safety valves on heat generators according to DIN EN 12828, TRD 721***
Code letter H, blow-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
Blow-off rate for steam and water/kW	≤ 50	≤ 100	≤ 200	≤ 350	≤ 600	≤ 900

Code letter D/G/H, e.g. LESER, type 440*

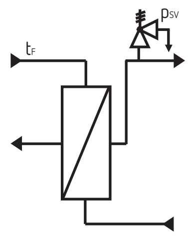
DN1/DN2	20x32	25x40	32x50	40x65	50x80	65x100	80x125	100x150	125x200	150x250	20x32	25x40
p_{SV}/bar	Steam outflow ← Blow-off rate/kW →										Water outflow	
2.5	198	323	514	835	1291	2199	3342	5165	5861	9484	9200	15,100
3.0	225	367	583	948	1466	2493	3793	5864	6654	10824	10200	16600
3.5	252	411	652	1061	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 tF to prevent 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_F/°C	≤ 138	≤ 143	≤ 147	≤ 151	≤ 155	≤ 158	≤ 161	≤ 164	≤ 170	≤ 175	≤ 179	≤ 184

The water outflow table can be applied for **heat exchangers** provided that the conditions opposite are met.



Safety valves on water heaters according to DIN 4753 and TRD 721
Code letter W, blow-off pressure p_{SV} 6, 8, 10 bar, e.g. SYR type 2115*

Inlet connection G	Tank volume litres	Max. heating capacity kW
½	≤ 200	75
¾	> 200 ≤ 1000	150
1	> 1000 ≤ 5000	250
1¼	> 5000	30000

Safety valves in solar energy systems according to VDI 6002, DIN 12976/77, TRD 721
Code letter H, D/G/H, F (intrinsically safe systems)

Inlet port	DN	15	20	25	32	40
Collector inlet surface	m²	≤ 50	≤ 100	≤ 200	≤ 350	≤ 600

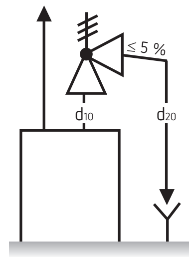
When making a selection, the system-specific conditions should be compared with the manufacturer specifications for the valves (e.g. temperature load).

Safety valves in cooling systems and on expansion vessels
Code letter F (only with guaranteed fluid outflow), e.g. SYR, type 2115*

Connection Inlet	½	¾	1	1¼	1½	2
p_{SV}/bar	Blow-off rate/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

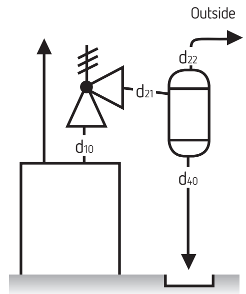
* Contact the manufacturer for up-to-date values
** Protection of Reflex expansion vessels in pressure-maintaining stations
Vessels up to 1000 litres, Ø 740 mm, G ½ = 3100 kW = 3100 l/h
as of 1000 litres, Ø1000 mm, G 1 = 10,600 kW = 10,600 l/h
*** If safety valves according to DIN ISO 4126 are used, an appropriate calculation base must be applied.

Exhaust lines from safety valves, expansion traps



Exhaust lines must meet the conditions of DIN EN 12828, TRD 721 and – in the case of solar energy systems – VDI 6002. In accordance with DIN EN 12828, safety valves are to be fitted in such a way that the pressure loss in the connection line to the heat generator does not exceed 3 % of the nominal pressure of the safety valve and the pressure loss in the blow-off line does not exceed 10 % of the nominal pressure of the safety valve. On the basis of the withdrawn standard DIN 4751 T2, these requirements have been compiled in a number of tables for simplification purposes. Mathematical verification may be required in individual cases.

Expansion traps, installation
Expansion traps are installed in the exhaust lines of safety valves as a means of phase separation of steam and water. A water discharge line must be connected at the lowest point of the expansion trap, which discharges heating water in a safe and observable manner. The steam exhaust line must be routed from the high point of the expansion trap to the outside.



Necessity
In accordance with DIN EN 12828 for heat generators with a nominal heat output of > 300 kW. In the case of indirectly heated heat generators (heat exchangers), expansion traps are not required if the safety valves can be dimensioned for water outflow, i.e. if there is no risk of steam formation on the secondary side.

→ Safety valves on heat generators, see page 64

Exhaust lines and Reflex expansion traps in systems according to DIN EN 12828

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

			SV without T expansion trap			SV with or without T expansion trap				SV with T expansion trap						
Safety valve		Nominal output Heat generator	Exhaust line			SV supply				SV – T line			Exhaust line			Water discharge line
d_1 DN	d_2 DN	Q kW	d_{20} DN	Length m	No. of bends	d_{10} DN	Length m	No. of bends	Type T	d_{21} DN	Length m	No. of bends	d_{22}* DN	Length m	No. of bends	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	270	65	≤ 5	≤ 2	80	≤ 15	≤ 3	65
			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	≤	≤ 3	100
			80	≤ 4	≤ 3											

Safety valves with code letter D/G/H, blow-off pressure $p_{SV} \leq 10$ bar

		SV without T expansion trap				SV with or without T expansion trap					SV with T expansion trap						
Safety valve		Exhaust line				SV supply					SV – T line			Exhaust line			Water discharge line
d_1 DN	d_2 DN	d_{20} DN	Length m	No. of bends	Blow. press. bar	d_{10} DN	Length m	No. of bends	Type T	Blow. press. bar	d_{21} DN	Length m	No. of bends	d_{22}* DN	Length m	No. of bends	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

* When combining several lines, the cross-section of the collecting main must be at least the same as the sum of the cross-sections of the individual lines.

Pressure limiters

Pressure limiters are electromechanical switchgears, and according to the Pressure Equipment Directive 97/23/EC (DGRL) are defined as pieces of equipment that perform a safety function. The limiters used must therefore carry a CE symbol and be component tested. In the event of exceeding or not reaching the correct pressure, the heating will be switched off immediately and locked.

The Reflex product range does not include pressure limiters.

Maximum pressure limiter PL_{max}
DIN EN 12828: "All heat generators with a nominal heat output of PL_{max} more than 300 kW must be fitted with a safety pressure limiter."

As a general rule, pressure limiters are set 0.2 bar below the safety valve actuation pressure.

Pressure limiters are not required for heat exchangers (indirect heating).

Minimum pressure limiter PL_{min}

DIN EN 12828, the standard for systems with operating temperatures PL_{min} ≤ 105 °C does not require a minimum pressure limiter in all cases. It is only required as a replacement measure for the water level limiter on directly heated heat generators.

A minimum pressure limiter can also be used to monitor function in systems with pressure-maintaining systems that are not supported by an automatic make-up system.

Expansion lines, shut-offs, draining

Expansion lines, heat generators up to 120 °C
DIN EN 12828: "Expansion lines must ... be dimensioned such that their flow resistance Δp ... can only bring about a pressure increase ... to which the pressure limiters (PL_{max}) and safety valves (p_{SV}) do not respond."

The base volume flow to be applied is 1 litre/(hkW) relative to the nominal heat output of the heat generator $\dot{Q}$.

In the case of suction pressure maintenance, the permissible pressure loss Δp results mainly from the difference between the safety valve actuation pressure p_{SV} or set pressure of the pressure limiter PL_{max} and the final pressure p_f, minus a specific tolerance. The pressure loss is mathematically verified by the following relationship:

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

Verification is not necessary if the following table values are used. In the case of Reflex Variomat pressure-maintaining stations, the expansion lines are also dimensioned according to the degassing performance. → 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

Reflex N

Reflex G

Incidentally, it is both permissible and common for expansion lines on expansion vessel or pressure-maintaining station connections to be "contracted" to smaller dimensions.

Potable water installations
In hot water and pressure booster systems, the connection lines for water-carrying vessels are determined on the basis of the peak volume flow Vp as per the specifications of DIN 1988 T3. For Refix DT5 from 80 litres, the bypass lines for repair purposes (closed during operation) should generally be one dimension smaller than the main line. Refix DT units with flow fittings are pre-equipped with an integrated bypass (open during operation). Special calculations are required when using Refix units for pressure surge damping.

Shut-offs, draining
To be able to perform maintenance and inspection work in a correct and professional manner, the water spaces of expansion vessels must be configured such that they can be shut off from those of the heating/cooling system. The same applies for expansion vessels in potable water systems. This facilitates (and, in some cases, enables) the annual inspection of the pressure-maintaining system (e.g. gas input pressure check on expansion vessels).

In accordance with DIN EN 12828, cap ball valves with socket fittings as well as integrated drainage and quick couplings are provided; these components are subject to minimal pressure loss and are protected against inadvertent closing.

Refix DT with flow fitting

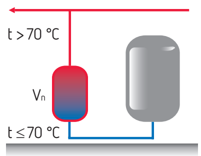
Refix DD with T-piece

In the case of Refix DT 60-500 litres, a Flowjet flow fitting Rp 1¼ is supplied for on-site installation, which combines the shut-off function, draining and bypass in a single unit.
For Refix DD 8-33 litres, our Flowjet flow fitting Rp ¾ with protected shut-off and draining is available as an optional accessory. The T-piece for the water flow is supplied with the Refix DD unit, in this case in Rp ¾ format. Larger T-pieces must be provided by the customer.
In the case of Refix DT 80–3000 litres, the required fittings must be procured by the customer. In this case we recommend that the supplied fittings be used for installation.

Intermediate vessels

Intermediate vessels protect the diaphragms of expansion vessels from impermissible temperature loads. According to DIN 4807 T3 and EN 13831, the continuous temperature on the diaphragms must not exceed 70 °C. In a cooling water systems, temperatures ≤ 0 °C should be avoided.

In heating systems
As a rule, heating systems are operated at return temperatures of ≤ 70 °C. The installation of intermediate vessels is not necessary. In the case of older systems and industrial plants, return temperatures > 70 °C are sometimes unavoidable.



No general formula exists for calculating the intermediate vessel. The decisive factor is the water quantity heated to over 70 °C. This will generally be around 50 % of the system volume. For systems with heat reservoirs, up to 100 % is possible.

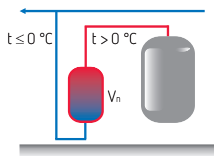
$$V_n = \frac{\Delta n}{100} V_s \text{ (0.5 to 1.0)}$$

- 0.5 if return 50 % of V_s
- 1.0 in case of heat reservoir with 100 % V_s
- Use factor 1 for safety reasons

→ Δn see 'Properties and auxiliary variables' p. 6
→ V_s system volume

In cooling circuits
If the temperature drops to ≤ 0 °C, we recommend that the intermediate vessel be dimensioned as follows.

$$V_n = 0.005\ V_s$$

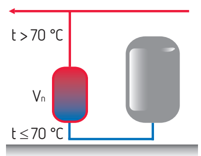


In solar energy systems
Without evaporation

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

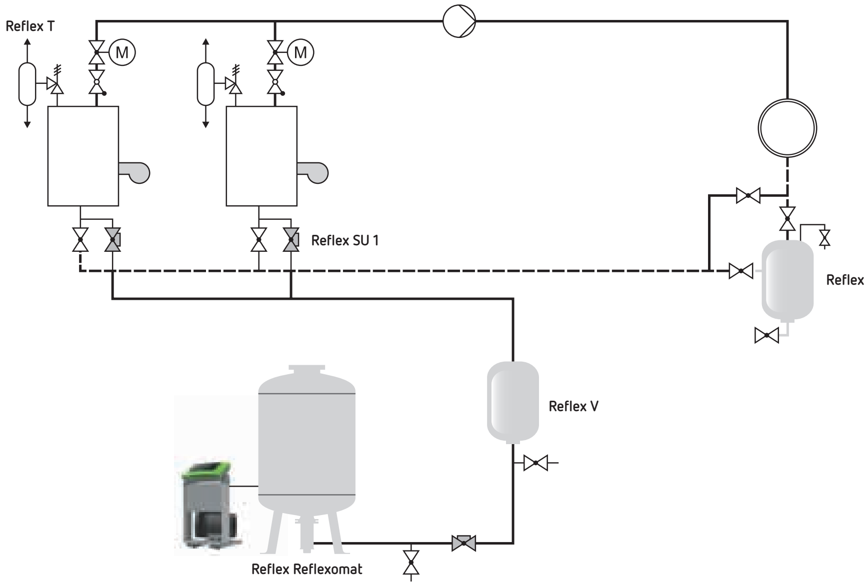
With evaporation

$$V_n = \frac{\Delta n}{100} \quad V_s + V_C$$



Reflex accessory installation examples (notes for the installer)

Reflex accessory in a heating system with return temperature > 70 °C and individual boiler output > 300 kW



DIN EN 12828:

- All expansion vessels must be arranged such that they can be shut off from the heating system.
  → Reflex expansion vessel connection assembly
  Reflex SU quick coupling

  "It must be possible to drain the water space ... in expansion vessels."
  → Reflex expansion vessel connection assembly and Reflex SU quick coupling have integrated drainage

  Heat generators with a nominal heat output of more than 300 kW must have an expansion trap in the immediate vicinity of each safety valve.
  → Reflex T expansion trap

- DIN 4807 Part 3:

  "In continuous operation, the temperature on the diaphragm must not exceed 70 °C."
  → Install Reflex V intermediate vessel upstream of the expansion vessel

- We recommend installation of a Reflex EB dirt collector, particularly for old systems.

- Use of an MBM II diaphragm rupture detector is possible for Reflexomat vessels and Refix DT potable water expansion vessels as an option.

Safety equipment for hot water heating systems

in acc. with DIN EN 12828, operating temperatures up to 105 °C

	Direct heating (heated with oil, gas, coal or electric energy)		**Indirect heating** (heat generators heated with liquids or steam)	
Temperature protection				
Temperature measuring device	Thermometer, display range[3] 120 % of the max. operating temperature			
Safety temperature limiter, or monitor, according to EN 60730-2-9	STL Temperature overshoot max. 10 K		STL with $t_{PR} > t_{dSec}$ (p_{SV}), STL not required if primary temperature ≤ 105 °C or use of STM if $t_{PR} > t_{Smax}$ [1]	
Temperature regulator[2]	As of heating medium temperatures > 100 °C, setpoint value ≤ 60 °C, maximum value 95 °C (not applicable for gr. I)			
Low-water protection - Low boiler level	$\dot{Q}_n \leq 300$ kW Not required if no permissible heating with low water level	$\dot{Q}_n > 300$ kW WMS or SPL_{min} or flow restrictor	To preserve controllability, a **minimum volume flow** via the heat exchanger must be ensured.[3]	
- Boilers in roof-mounted systems	WMS or SPL_{min} or flow restrictor or suitable device		---	
- Heat generator with heating that is unregulated or cannot be quickly deactivated (solid fuel)	Emergency cooling (e.g. thermal discharge safety device, safety heat consumer) with safety temperature limiter to take effect if max. operating temperature exceeded by more than 10 K		---	
Pressure protection				
Pressure measuring system	Pressure gauge, display range ≥ 150 % of max. operating pressure			
Safety valve in acc. with prEN 1268-1 or prEN ISO 4126-1, TRD 721	Calculation for steam outflow		$t_{PR} > t_{dSec}$ (p_{SV}) [3] Calculation for steam outflow with $\dot{Q}_n$	$t_{PR} \leq t_{dSec}$ (p_{SV}) [3] Water outflow 1 l/(hkW)
Expansion trap per SV	T for $\dot{Q}_n > 300$ kW, substitute 1 STL + 1 SPL_{max}			---
Pressure limiter max. TÜV-tested	Per heat generator for $Q_n > 300$ kW, $SPL_{max} = p_{SV}$ - 0.2 bar		---	---
Pressure maintenance Expansion vessel	- Pressure regulation within boundaries of p_i ... p_f as expansion vessel or expansion vessel with external pressure generation - Protected shut-off and draining of expansion vessels should be possible for maintenance purposes			
Filling systems	- Assurance of operational min. water seal VWS, autom. make-up with water meter - Connections to potable water systems must comply with prEN 806-4, or DIN 1988 or DIN EN 1717			
Heating				
			Primary shut-off valve, if $t_{PR} > t_{dSec}$ (p_{SV}) Recommendation: Primary shut-off valve also for $t_{PR} > t_{per\ sec}$	

[1] STL recommended, as STM automatically releases heating when temperature drops below limit, thus “sanctioning” the failure of the regulator.

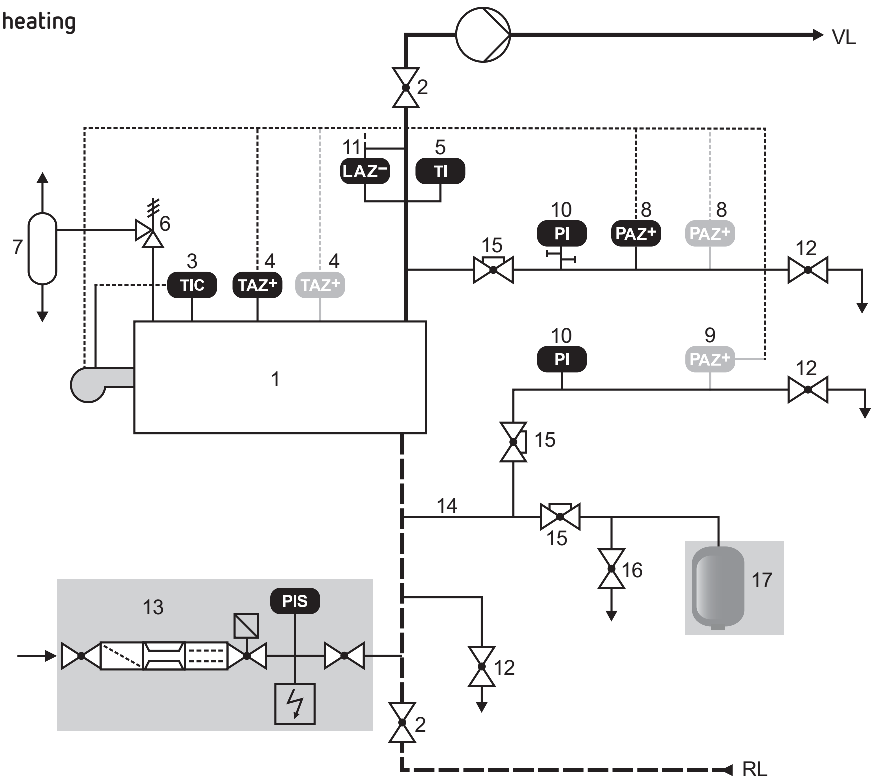
[2] If the temperature regulator is not type-tested (e.g. DDC without structure shut-off for max. target temperature), an additional type-tested temperature monitor must be provided in the case of direct heating.

[3] Based on invalid DIN 4751 T2

Safety equipment for hot water heating systems

in acc. with DIN EN 12828, operating temperatures up to 105 °C

Example: direct heating



Key

1	Heat generator
2	Shut-off valves, advance/return
3	Temperature regulator
4	Safety temperature limiter, STL
5	Temperature measuring device
6	Safety valve
7	Expansion trap (T) > 300 kW[1) 2)]
8	SPL_{max}[1)], Q > 300 kW
9	SPL_{min}, as optional substitute for low-water protection
10	Pressure gauge
11	Low-water protection, up to 300 kW also as substitute for SPL_{min} or flow monitor or other permitted measures
12	Filling/draining system (filling/draining tap)
13	Automatic water make-up (Fillcontrol Plus + Fillset + Fillcontrol)
14	Expansion line
15	Protected shut-off valve (SU quick coupling, MK cap ball valve)
16	Deaeration/draining before expansion vessel
17	Expansion vessel (e.g. Reflex N)

▶ Code letters, symbols → page 79

Optional components

Reflex product programme

[1)] Not required for indirect heating, if SV can be calculated for water outflow (→ p. 39)

[2)] Not required if additional STL and SPL $_{max}$ fitted

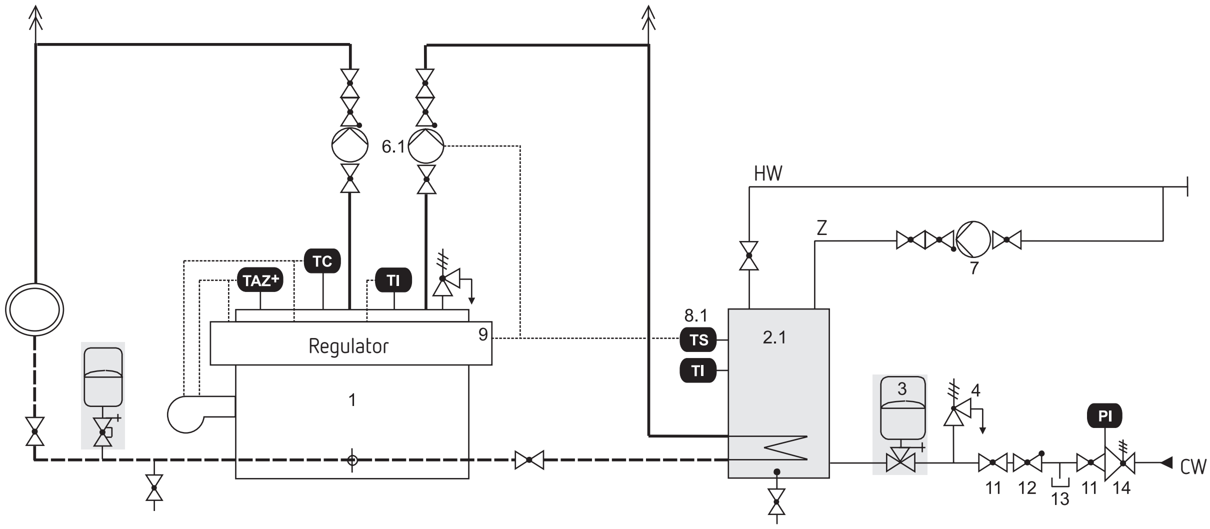
Safety equipment of hot water systems according to DIN 4753 T1

Requirements of potable water systems
Potable water heater closed, indirect heating
Grouping according to DIN 4753 T1: Gr. I p x I ≤ 300 bar x litre whereby $\dot{Q}$ ≤ 10 kW or V ≤ 15 l and $\dot{Q}$ ≤ 50 kW
Gr. II if gr. I thresholds exceeded

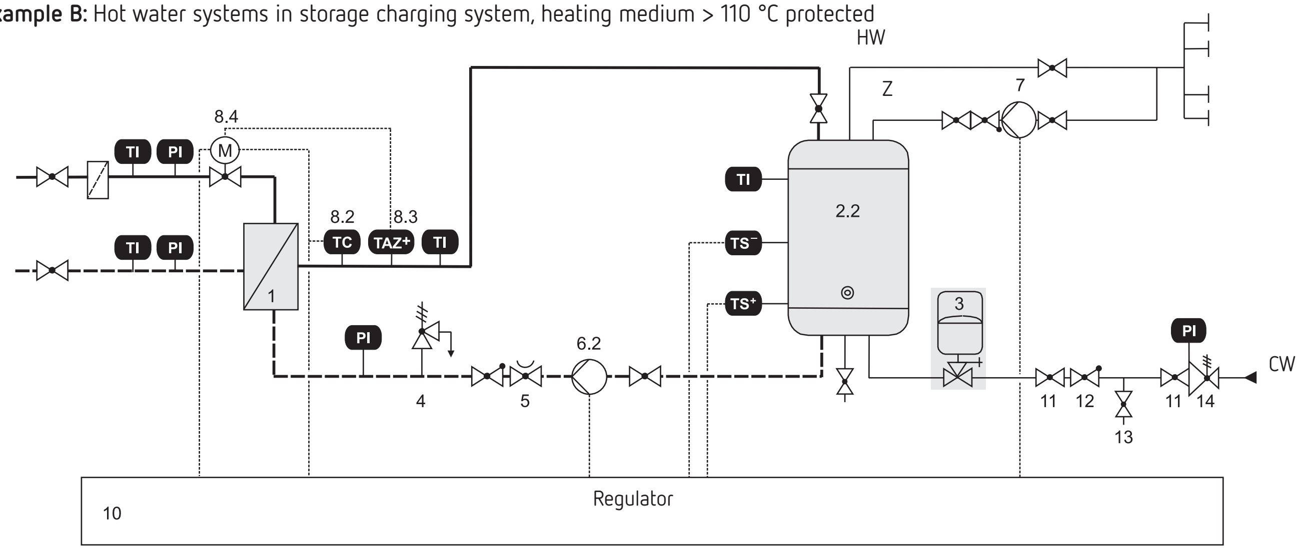
Temperature protection	DIN 4753 T1, DIN 4747
Thermometer	May be part of regulator, not required for gr. I
Temperature regulator type-tested	As of heating medium temperatures > 100 °C, setpoint value ≤ 60 °C, maximum value 95 °C (not applicable for gr. I)
Safety temperature limiter According to DIN 3440	As of heating medium temperatures > 110 °C, setpoint value ≤ 95 °C, maximum value 110 °C for V < 5000 l and Q ≤ 250 kW no intrinsic safety required according to DIN 3440; for district heating systems, actuator valve with safety function according to DIN 32730
Pressure protection	DIN 4753 T1
Pressure gauge	Required for tanks > 1000 l; general installation near safety valve, recommended for cold water systems
Safety valve	- Installation in cold water line - No shut-offs or impermissible narrowing between water heater and safety valve
	Nominal content of water space / Max. heating output / Connection nominal diameter ≤ 200 l / 75 kW / DN 15 ≤ 1000 l / 150 kW / DN 20 ≤ 5000 l / 250 kW / DN 25 > 5000 l / Selection according to max. heating capacity
Pressure reducing valve DVGW-approved	Required: - If the pressure for the cold water supply > 80 % of the safety valve actuation pressure - In case of installation of diaphragm expansion vessels (expansion vessel-W according to DIN 4807 T5) to ensure a constant normal pressure level before the vessel
Diaphragm expansion vessels Expansion vessel-W according to DIN 4807 T5	- Requirements of DIN 4807 T5: Water flow under defined conditions Green colour Diaphragms and non-metallic parts according to KTW-C as a minimum Installation of pressure reducing valve Protected shut-off of expansion vessel - Input pressure set to 0.2 bar below pressure reducing valve
Potable water protection	DIN 1988 T2, T4 or DIN EN 1717
Backflow preventer DVGW-approved	Prescribed for potable water heaters > 10 litres, shut-off on both sides, test system to be implemented after first shut-off
Design type of potable water heaters According to DIN 1988 T2 for heating water complying with category 3 of DIN EN 1717 (absence or minimal amount of toxic additives (e.g. ethylene glycol, copper sulphate solution); see DIN for other media and designs	**Design type B**, corrosion-resistant heating surfaces and linings (copper, stainless steel, enamelled) e.g. Reflex Longtherm plate heat exchanger Permissible for max. operating pressure on heating side ≤ 3 bar
	Design type C = B + no detachable connections; quality of non-detachable connections must be verified by means of a procedure inspection (e.g. AD data sheets, HP series), e.g. tube heat exchanger Also permissible for max. operating pressure on heating side > 3 bar

Safety equipment of hot water systems according to DIN 4753 T1

Example A: Hot water systems in storage system, boiler protection ≤ 100 °C



Example B: Hot water systems in storage charging system, heating medium > 110 °C protected



Key

1	Heat generator (boiler, heat exchanger)
2.1	HW tank with integrated heating surface
2.2	HW tank without heating surface
3	Diaphragm expansion vessel for potable water (see also p. 24-25)
4	Diaphragm SV, code letter W
5	Volume adjusting valve
6.1	Charge pump, heating side
6.2	Charge pump, potable water side
7	Circulating pump
8.1	Thermostat for activating charge pump 6.1
8.2	Type-tested temperature regulator
8.3	Type-tested temperature limiter
8.4	Control valve with safety function
9	Boiler regulation with actuation of hot water supply
10	Heating regulation with actuation of storage charging system
11	Shut-off valve
12	Non-return valve
13	Test system
14	Pressure reducing valve

11–14: Also possible as combined fitting with safety valve 4

▶ Code letters, symbols → page 79

Inspection and maintenance of systems and pressure vessels

What is tested and why

Diaphragm expansion, in-line and blow-off vessels as well as heat exchangers and boilers are all examples of pressure vessels. They all possess a risk potential resulting mainly from the pressure, volume, temperature and the medium itself.

Specific legal requirements apply for the manufacture, start-up and operation of pressure vessels and complete systems.

Manufacture according to DGRL
Since 01/06/2002, the production and **initial inspection** of pressure vessels by the manufacturer, as well as their placing on the market, has been governed throughout Europe by the Pressure Equipment Directive 97/23/EC (DGRL). Only pressure vessels complying with this Directive may be brought into circulation.

CE Reflex diaphragm expansion vessels meet the requirements of Directive 97/23/EC and are marked with the number0045.

"0045" represents TÜV Nord as the named inspection authority.

A new feature is that the manufacturer certification previously issued on the basis of the steam boiler or pressure vessel ordinance is now being replaced with a **declaration of conformity**. → page 78

In the case of Reflex pressure vessels, the declaration of conformity is part of the supplied assembly, operating and maintenance instructions.

Operation according to BetrSichV
Within the meaning of the ordinances, the term 'operation' refers to the assembly, use, **pre-commissioning inspection** and **recurring inspection** of systems requiring monitoring. The steam boiler and pressure vessel ordinances previously applicable in Germany were replaced by the **Ordinance on Industrial Safety and Health (BetrSichV)** on 01/01/2003.

With the introduction of the Ordinance on Industrial Safety and Health and the Pressure Equipment Directive, the previously applicable steam boiler and pressure vessel ordinances were finally replaced with a standardised set of regulations on 01/01/2003.

The necessity of inspections prior to start-up and that of recurring checks, as well as the relevant inspecting authority are defined on the basis of the risk potential according to the specifications of the **DGRL** and **BetrSichV**. For this purpose, the categories medium (fluid), pressure, volume and temperature are applied according to the conformity assessment diagrams in Appendix II of the **DGRL**. A specific assessment for the Reflex product range can be found in tables 1 and 2 (→ p. 76). The applicability of the specified maximum intervals is subject to compliance with the measures in the relevant Reflex assembly, operating and maintenance instructions.

During the conformity assessment on the part of the **manufacturer according to DGRL**, the maximum permissible parameters for the vessel apply, while the **operator's assessment according to BetrSichV** can be based on the maximum actual parameters for the system. Therefore, when assessing and categorising the pressure PS, the maximum possible pressure must be applied that can occur even in the case of extreme operating conditions, malfunction and operating errors on the basis of the pressure protection of the system or system component. The fluid group is selected according to the actual medium employed.

Inspection and maintenance of systems and pressure vessels

§ 14 Inspection prior to start-up

- Assembly, installation
- Installation conditions
- Safe function

§ 15 Recurring inspections

- Documentation and organisation check
- Technical inspection
  - External inspection
  - Internal inspection
  - Strength test

For recurring inspections, the operator must define the **inspection intervals** on the basis of a **safety evaluation** and the applicable maximum intervals.
(Tables 1 and 2, → p. 76)

If the system is to be commissioned by an authorised inspection body (AIB), the check lists created by the operator must be provided to and agreed with the relevant authority.
The safety evaluation must distinguish between the following:
- The **overall system**, which can also comprise multiple items of pressure equipment and be configured for specific safety thresholds for the system pressure and temperature – e.g. hot water boiler with expansion vessel, secured via the safety valve and the boiler's STL
- The **system components** – e.g. the hot water boiler and expansion vessel – may belong to different categories and thus be evaluated differently from a safety perspective.

If the overall system is made up solely of components that must be inspected by a qualified person (QP), the overall system can also be inspected by a QP.

In the case of external and internal checks, inspections may be replaced with other equivalent procedures, while the static pressure tests for strength tests can be substituted with comparable, non-destructive procedures.

Transition regulations
For systems comprising pressure equipment commissioned before 01/01/2003, a transitional period applied up to 31/12/2007.

Since 01/01/2008 the provisions of the BetrSichV apply unconditionally to all systems requiring monitoring.

Maintenance
While the specifications of the DGRL and BetrSichV are geared primarily towards safety aspects and health protection in particular, the purpose of maintenance work is to ensure optimum and efficient system operation while minimising faults. System maintenance is performed by a **specialist** commissioned by the operator. This may be a plumber or a Reflex service representative (→ p. 80 – 81).

Maintenance of diaphragm expansion vessels must be performed according to manufacturer specifications, among other things, and thus take place on a yearly basis. This mainly comprises the inspection and adjustment of the vessel input pressure as well as the system filling or initial pressure. → p. 9

We recommend that our pressure-maintaining, make-up and degassing systems be maintained at the same frequency as our diaphragm expansion vessels, i.e. annually.

All Reflex products are supplied with assembly, operating and maintenance instructions (→ p. 78) containing all relevant information for the plumber and operator.

Table 1:
Inspection of Reflex pressure vessels according to BetrSichV, edition dated 27/09/2002, as amended on 23/12/2004, with operation according to Reflex assembly, operating and maintenance instructions
Applicable for all
- Reflex, Refix, Variomat, Variomat Giga, Reflexomat, Reflexomat Compact vessels and the Servitec spray-tube and
- Intermediate vessels, dirt collectors and Longtherm plate heat exchangers at max. operating temperatures > 110 °C of the system (e.g. STL setting)

Classification in fluid group 2 according to DGRL - (e.g. water, air, nitrogen = non-explosive, non-toxic, not easily flammable).

Assessment/category As per diagram 2 in Appendix II of DGRL	**Pre-start-up, § 14**	**Recurring inspections, § 15**			
			Maximum intervals in years		
	Inspecting party	**Inspecting party**	**External**[1]	**Internal**[2]	**Strength**[2]
V ≤ 1 litre and PS ≤ 1000 bar PS x V ≤ 50 bar x litre	No special requirements; to be arranged by the operator based on the current state of the art and according to the specifications in the operating instructions[3]				
Reflex, Refix, in-line, dirt collector, Longtherm, Variomat, Variomat Giga, Reflexomat, Reflexomat Compact vessels					
PS x V > 50 ≤200 bar x litres	QP	QP	No maximum intervals defined[4]		
PS x V > 200 ≤ 1000 bar x litres	AIB**	QP	No maximum intervals defined[4]		
PS x V > 1000 bar x litres	AIB**	AIB**	---	5*/**	10

* Recommendation:
Max. 10 years for Reflex and Refix with bladder diaphragms as well as Variomat and Variomat Gigamat vessels, but at the very least when opening for repair purposes (e.g. diaphragm replacement) according to Appendix 5 Section 2 and Section 7(1) of BetrSichV

**

Important note:
As of 01/01/2005, the following applies for applications in heating and cooling systems:

In the case of indirectly heated heat generators (Longtherm) with a heating medium temperature no higher than 120 °C (e.g. STL setting) and expansion vessels (Reflex, Refix, Variomat, Variomat Giga, Reflexomat or Reflexomat Compact vessels) in heating and cooling/refrigerating systems with water temperatures no higher than 120 °C, the inspections may be performed by a qualified person (QP).

Table 2:
Inspection of Reflex pressure vessels according to BetrSichV, edition dated 27/09/2002, as amended on 23/12/2004, with operation according to Reflex assembly, operating and maintenance instructions
Applicable for all
- Intermediate vessels, dirt collectors and Longtherm plate heat exchangers at max. operating temperatures ≤ 110 °C of the system (e.g. STL setting)

Classification in fluid group 2 acc. to DGRL - (e.g. water = non-explosive, non-toxic, not easily flammable).

Assessment/category As per diagram 4 in Appendix II of DGRL	**Pre-start-up, § 14**	**Recurring inspections, § 15**			
			Maximum intervals in years		
	Inspecting party	**Inspecting party**	**External**[1]	**Internal**[2]	**Strength**[2]
PS ≤ 10 bar or PS x V < 10,000 bar x litres If PS ≤ 1000 bar	No special requirements; to be arranged by the operator based on the current state of the art and according to the specifications in the operating instructions[3]				
10 < PS ≤ 500 bar and PS x V > 10,000 bar x litres	AIB	QP	No maximum intervals defined[4]		

Table 3:
Inspection according to BetrSichV, edition dated 27/09/2002, as amended on 23/12/2004, for Reflex Longtherm brazed plate heat exchangers in systems with hazardous media and operation according to Reflex assembly, operating and maintenance instructions
Classification in fluid group 1 according to DGRL - (e.g. gasoline = explosive, highly flammable, toxic, oxidising). This fluid group is only permitted for Longtherm!
Applicable for permissible operating temperatures $t > t_{boiling}$ at atmospheric pressure + 0.5 bar.

Assessment/category As per diagram 1 in Appendix II of DGRL	**Pre-start-up, § 14**	**Recurring inspections**			
			Maximum intervals in years		
	Inspecting party	**Inspecting party**	**External**[1]	**Internal**[2]	**Strength**[2]
V ≤ 1 litre and PS ≤ 200 bar PS x V ≤ 25 bar x litres	No special requirements; to be arranged by the operator based on the current state of the art and according to the specifications in the operating instructions[3]				
PS x V > 25 ≤ 1000 bar x litres PS ≤ 200 bar	QP	QP	No maximum intervals defined[4]		
PS x V > 200 ≤ 1000 bar x litres PS ≤ 200 bar	AIB	QP	No maximum intervals defined[4]		
PS x V > 1000 bar x litres	AIB	AIB	---	5	10

Note: Longtherm plate heat exchangers must be classified in the higher category of the two chambers.

Note: If the "Assessment/category" column contains multiple criteria without "and" specifications, exceeding one criterion must result in the application of the next highest category.

PS Maximum possible excess pressure in bar resulting from the system configuration and operation

n Expansion coefficient for water

V Nominal volume in litres

t Operating temperature of fluid

$t_{Boiling}$ Boiling temperature of fluid under atmospheric pressure

QP Qualified person in accordance with § 2 (7) BetrSichV, who possesses the required expertise to inspect the pressure equipment on the basis of his or her training, professional experience or recent professional activity

AIB Authorised inspection body according to § 21 BetrSichV; currently TÜV

1) 2-yearly external inspections are not necessary with normal Reflex applications. Only necessary if the pressure equipment is heated by fire, waste gas or electricity.

2) In accordance with §15 (10), inspections and strength tests can be substituted with equivalent, non-destructive test procedures if their execution is not possible due to the construction of the pressure equipment or not expedient due to its mode of operation (e.g. fixed diaphragm).

3) With regard to the max. excess operating pressure of the equipment, this applies to the following products:
Reflex up to N 12 litres/3 bar, Servitec type ≤ 120
Longtherm rhc 15, rhc 40 ≤ 50 plates, rhc 60 ≤ 30 plates

4) To be defined by the operator on the basis of manufacturer information and experience with operational modes and feeds. The inspection can be performed by a qualified person (QP) according to § 2 (7) BetrSichV.

5) Irrespective of the max. operating temperature

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

reflex

Allgemeine Sicherheitshinweise

Reflex Membran-Druckausdehnungsgefäße sind Druckgeräte. Eine Membrane teilt das Gefäß in einen Wasser- und einen Gasraum mit Druckpolster. Die Konformität im Anhang bescheinigt die Übereinstimmung mit der Richtlinie 97/23/EG. Der Umfang der Baugruppe ist der Konformitätserklärung zu entnehmen. Die gewählte technische Spezifikation zur Erfüllung der grundlegenden Sicherheitsanforderungen des Anhangs I der Richtlinie 97/23/EG ist dem Typenschild bzw. der Konformitätserklärung zu entnehmen.

Montage, Betrieb, Prüfung vor Inbetriebnahme, wiederkehrende Prüfungen
nach den nationalen Vorschriften, in Deutschland nach der Betriebssicherheitsverordnung. Entsprechend sind Montage und Betrieb nach dem Stand der Technik durch Fachpersonal und speziell eingewiesenes Personal durchzuführen. Erforderliche Prüfungen vor Inbetriebnahme, nach wesentlichen Veränderungen der Anlage und wiederkehrende Prüfungen sind vom Betreiber gemäß den Anforderungen der Betriebssicherheitsverordnung zu veranlassen. Empfohlene Prüffristen siehe Abschnitt „Prüffristen". Es dürfen nur Reflex ohne äußere sichtbare Schäden am Druckkörper installiert und betrieben werden.

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

Parameter einhalten
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 (Druck, Temperatur) nicht über- bzw. unterschritten werden. Eine Überschreitung des zulässigen Betriebsüberdruckes wasser- und gasseitig, sowohl im Betrieb als auch beim gasseitigen Befüllen, ist auszuschließen.
Der Vordruck p₀ darf keinesfalls den zul. Betriebsüberdruck überschreiten. Selbst bei Gefäßen mit zul. Betriebsüberdruck größer 4 bar darf der Vordruck bei Lagerung und Transport nicht mehr als 4 bar betragen. Zur Gasbefüllung ist ein Inertgas, z.B. Stickstoff, zu verwenden.

Korrosion/Inkrustation
Reflex sind aus Stahl gefertigt, außen beschichtet und innen roh. Ein Abnutzungszuschlag (Korrosionszuschlag) wurde nicht vorgesehen. Der Einsatz darf nur in atmosphärisch geschlossenen Systemen mit nicht korrosiven und chemisch nicht aggressiven und nicht giftigen Wassern erfolgen. Der Zutritt von Luftsauerstoff in das gesamte Heiz- und Kühlwassersystem durch Permeation, Nachspeisewasser usw. ist im Betrieb zuverlässig zu minimieren. Wasseraufbereitungsanlagen sind nach dem aktuellen Stand der Technik auszulegen, zu installieren und zu betreiben.

Wärmeschutz
In Heizwasseranlagen ist bei Personengefährdung durch zu hohe Oberflächentemperaturen vom Betreiber ein Warnhinweis in der Nähe des Reflex anzubringen.

Aufstellungsort
Eine ausreichende Tragfähigkeit des Aufstellortes ist unter Beachtung der Vollfüllung des Reflex mit Wasser sicherzustellen. Für das Entleerungswasser ist ein Ablauf bereitzustellen, erforderlichenfalls ist eine Kaltwasserzumischung vorzusehen (siehe auch Abschnitt „Montage"). Bei der Berechnung der Behälter sind standardmäßig keine Querbeschleunigungskräfte berücksichtigt.

Das Missachten dieser Anleitung, insbesondere der Sicherheitshinweise, kann zur Zerstörung und Defekten am Reflex 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. They have an gas cushion. A diaphragm separates 'reflex' in a gas and a water space. The attached conformity certification certifies the compliance to the Pressure Equipment directive 97/23/EC. The scope of the subassembly can be found in the conformity declaration. The technical specification selected to fulfil the fundamental safety requirements of annex I of the directive 97/23/EC can be found on the nameplate or conformity declaration.

Mounting, operation, test before operation, regular check-up
According to the governing local regulations. The installation and the operation to be performed to the art of technique by professional installers and authorised technical personnel. Necessary tests before operation, after fundamental changes in the installation and periodic inspection have to be initiated by the user acc. to the requirements of the Operational Safety Regulation. Recommendations regarding periodic check-up: → paragraph „periodic check-up".
Only Reflex without visible external damage to the pressure body may be installed and operated.

Changes to the Reflex
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 (pressure, temperatrue) are adhered to. Exceeding the permissible operating pressure of the water and the gas systems both during operation and when filling the gas system must be excluded. On no account must the gas pre-pressure exceed the permissible

Reflex

Anhang 1
Annex 1

Konformitätserklärung für ein Druckgerät (einen Behälter / eine Baugruppe) **Declaration of conformity of a pressure equipment (a vessel / an assembly)** Angewandtes Konformitätsbewertungsverfahren nach Richtlinie für Druckgeräte 97/23/EG des Europäischen Parlaments und des Rates vom 29. Mai 1997 Applied Conformity Assessment according to Pressure Equipment Directive 97/23/EC of the European Parliament and the Council of 29 May 1997	Konstruktion, Fertigung, Prüfung von Druckgeräten Design – Manufacturing – Product Verification

Druckausdehnungsgefäße
Reflex F, N, NG, EN/R, C, S, SV, G
universell einsetzbar in Heiz-, Solar- und Kühlwassersystemen

Pressure expansion vessels
Reflex F, N, NG, EN/R, C, S, SV, G
universally applicable in heating, solar and cooling systems

Typ / type	gemäß Typenschild Behälter according to name plate of vessel	
Serien-Nr. / Serial no.	gemäß Typenschild Behälter according to name plate of vessel	
Herstellungsjahr / Year of manufacture	gemäß Typenschild Behälter according to name plate of vessel	
max. zulässiger Druck (PS) / max. allowable pressure (PS)	gemäß Typenschild Behälter according to name plate of vessel	
Prüfdruck (PT) / Test pressure (PT)	gemäß Typenschild Behälter according to name plate of vessel	
min. / max. zulässige Temperatur (TS) / min. / max. allowable temperature (TS)	gemäß Typenschild Behälter according to name plate of vessel	
max. Dauerbetriebstemperatur Voll- / Halbmembrane / max. continuous operating temperature membrane / diaphragm	gemäß Typenschild Behälter according to name plate of vessel	
Beschickungsgut Operating medium	Wasser / Inertgas oder Luft gemäß Typenschild Behälter Water / inertgas or air according to name plate of vessel	
Normen, Regelwerk Standards	Druckgeräterichtlinie, prEN 13831:2000 oder EN13831:2007 oder AD 2000 gemäß Typenschild Behälter Pressure Equipment Directive, prEN 13831:2000 or EN 13831:2007 or AD 2000 according to name plate of vessel	
Druckgerät Pressure equipment	**Reflex G:** **Baugruppe** Artikel 3 Abs. 2.2 bestehend aus: • **Behälter** Artikel 3 Abs. 1.1 a) 2. Gedankenstrich (Anhang II Diagr. 2) mit Ausrüstung Artikel 3 Abs. 1.4: Vollmembrane und Ventil • **Ausrüstung** Artikel 3 Abs. 1.4: Manometer **Reflex EN/R, C, S ≤ 40 ltr.** **Behälter** Artikel 3 Abs. 1.1 a) 2. Gedankenstrich (Anhang II Diagr. 2) mit • **Ausrüstung** Artikel 3 Abs. 1.4: Vollmembrane und Ventil **Reflex F, N, NG, S > 40 ltr., "SV"** **Behälter** Artikel 3 Abs. 1.1 a) 2. Gedankenstrich (Anhang II Diagr. 2) mit • **Ausrüstung** Artikel 3 Abs. 1.4: Halbmembrane und Ventil **Reflex G:** **Assembly** article 3 paragraph 2.2 consisting of: • vessel article 3 paragraph 1.1 a) 2. indent (Annex II table 2) with accessories article 3 paragraph 1.4: membrane and valve • accessories article 3 paragraph 1.4: manometer **Reflex EN/R, C, S ≤ 40 ltr.** Vessel article 3 paragraph 1.1 a) 2. indent (Annex II table 2) with • accessories article 3 paragraph 1.4: membrane and valve **Reflex F, N, NG, S > 40 ltr., SV.** Vessel article 3 paragraph 1.1 a) 2. indent (Annex II table 2) with • accessories article 3 paragraph 1.4: diaphragm and valve	
Fluidgruppe / Fluid group	2	
Konformitätsbewertung nach Modul Conformity assessment acc. to module	B+D	Reflex N, NG, EN/R, C, S, SV, G
	A	Reflex F
Kennzeichnung gem. Richtlinie 97/23/EG Labelling acc. to Directive 97/23/EC	CE 0045	Reflex N, NG, EN/R, C, S, SV, G
	CE	Reflex F
Zertifikats-Nr. der EG-Baumusterprüfung Certificate-No. of EC Type Approval	siehe Anhang 2 see annex 2	
Zertifikats-Nr. QS-System (Modul D) Certificate-No. QA System (module D)	07 202 1403 Z 0050/10/D0045	
Benannte Stelle für Bewertung des QS-Systems Notified Body for certification of QA System	TÜV Nord Systems GmbH & Co. KG Große Bahnstraße 31, 22525 Hamburg, Germany	
Register-Nr. der Benannten Stelle Registration-No. of the Notified Body	0045	
Hersteller Manufacturer reflex Reflex Winkelmann GmbH Gersteinstraße 19 59227 Ahlen – Germany Telefon: +49 2382 7069-0 Telefax: +49 2382 7069-588 E-Mail: info@reflex.de	Der Hersteller erklärt, dass das Druckgerät (der Behälter / die Baugruppe) die Anforderungen der Richtlinie 97/23/EG erfüllt. The manufacturer herewith declares the pressure equipment (the vessel / the assembly) to be in conformity with directive 97/23/EC. [illegible] Norbert Hülsmann · Volker Mauel Mitglieder der Geschäftsführung / Members of the Management	

Example:
Reflex assembly, operating and maintenance instructions with declaration of conformity according to DGRL

Terms

Formula letter	Explanation	See page (among others)
A_p	Working range of pressure maintenance	18
A_{SV}	Closing pressure difference for safety valves	5, 9
n	Expansion coefficient for water	6, 10, 24
n^*	Expansion coefficient for water mixtures	6, 13, 16
n_R	Expansion coefficient relative to return temperature	11
p_0	Minimum operating pressure	5, 9, 18, 23, 24
p_i	Initial pressure	5, 9, 18, 23, 24
p_e	Evaporation pressure for water	6
p_e^*	Evaporation pressure for water mixtures	6
p_f	Final pressure	5, 9, 18
p_{fil}	Filling pressure	5, 9
p_{st}	Static pressure	5, 9
p_{SV}	Safety valve actuation pressure	5, 9
p_{sup}	Minimum supply pressure for pumps	7
$p_{max.}$	Max. excess operating pressure	7
V	Compensating volume flow	19
V_s	System volume	6
v_s	Specific water content	6
V_e	Expansion volume	5, 9, 23
V_C	Collector content	12, 14, 39
V_n	Nominal volume	9, 18
V_{WS}	Water seal	5, 9
Δp_P	Pump differential pressure	7
ρ	Density	6

Code letters

T – Temperature

T	Temperature test port
TI	Thermometer
TIC	Temperature regulator with display
TAZ+	Temperature limiter, STL, STM

P – Pressure

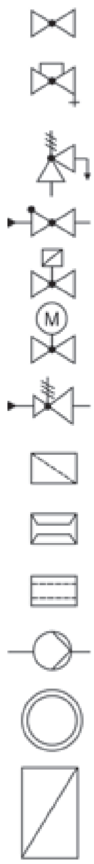
P	Pressure test port
PI	Pressure gauge
PC	Pressure regulator
PS	Pressure switch
PAZ⁻	Pressure limiter - min., SPL_{min}
PAZ+	Pressure limiter - max., SPL_{max}

L – Water level

LS	Water level switch
LS+	Water level switch - max.
LS⁻	Water level switch - min.
LAZ⁻	Water level limiter - min.

▶ Code letters according to DIN 19227 T1, "Graphical symbols and code letters for process technology"

Symbols



Shut-off valve

Fitting with protected shut-off and draining

Spring-loaded safety valve

Non-return valve

Solenoid valve

Motorised valve

Overflow valve

Dirt trap

Water meter

System separator

Pump

Heat consumer

Heat exchangers

Quick selection table for Reflex N and Reflex S

To achieve a detailed calculation, please use our calculation software **Reflex Pro,** available online or to download at **www.reflex.de** and as an app in the iTunes Store.

Heating systems: 90/70°C

Safety valve p_{sv} bar	2.5			V_n	3.0				V_n	4.0				V_n	5.0					V_n	6.0					
Input 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
Content V_s litres	65	30	---	8	85	50	19	---	8	55	30	5	---	8	55	37	16	---	---	8	75	60	41	24	7	---
	100	45	---	12	120	75	29	---	12	80	45	7	---	12	85	55	24	---	---	12	110	90	60	36	10	---
	170	85	---	18	200	130	60	17	18	140	85	28	---	18	140	100	55	8	---	18	190	150	110	70	32	---
	270	150	33	25	320	220	120	55	25	230	150	70	---	25	230	170	110	43	---	25	290	240	180	130	75	---
	410	240	80	35	470	340	200	110	33	330	240	130	25	33	360	270	180	95	5	33	440	370	290	220	140	---
	610	380	110	50	700	510	320	200	50	540	380	230	70	50	550	420	300	170	43	50	660	560	450	350	240	24
	980	500	170	80	1120	840	440	260	80	870	650	410	120	80	890	710	530	320	95	80	1060	900	750	600	430	90
	1230	620	210	100	1400	1050	540	330	100	1090	820	430	150	100	1110	890	670	420	120	100	1320	1130	940	750	560	100
	1720	870	300	140	1960	1470	760	460	140	1530	1140	610	200	140	1560	1250	940	510	170	140	1850	1580	1320	1060	790	140
	2450	1240	420	200	2800	2100	1090	660	200	2180	1630	870	290	200	2230	1780	1340	720	240	200	2640	2260	1890	1510	1130	210
	3060	1550	530	250	3500	2630	1360	820	250	2720	2040	1090	370	250	2790	2230	1670	900	300	250	3300	2830	2360	1890	1410	260
	3680	1860	630	300	4200	3150	1630	990	300	3270	2450	1300	440	300	3340	2670	2010	1080	360	300	3960	3390	2830	2260	1700	310
	4900	2480	850	400	5600	4200	2180	1320	400	4360	3270	1740	580	400	4460	3570	2670	1440	480	400	5280	4520	3770	3020	2260	410
	6130	3100	1060	500	6920	5250	2720	1650	500	5450	4080	2170	730	500	5570	4460	3340	1800	600	500	6600	5660	4710	3770	2830	520
	7350	3720	1270	600	8400	6300	3260	1980	600	6540	4900	2610	880	600	6680	5350	4010	2170	730	600	7920	6790	5660	4520	3390	620
	9800	4970	1690	800	11200	8400	4350	2640	800	8710	6540	3480	1170	800	8910	7130	5350	2890	970	800	10560	9050	7540	6030	4520	830
	12250	6210	2120	1000	13830	10500	5440	3300	1000	10890	8170	4350	1460	1000	11140	8910	6680	3610	1210	1000	13200	11310	9430	7540	5660	1030

Selection example

p_{sv} = 3 bar
H = 13 m
$\dot{Q}$ = 40 kW (plates 90/70 °C)
V_{BW} = 1000 l (V buffer tank)

Calculate:

→ V_s = 40 kW x 8.5 l/kW + 1000 = 1340 l

→ $p_0 \geq \left(\frac{13}{10} + 0.2 \text{ bar}\right) = 1.5$ bar

From the table:

With p_{sv} = 3 bar, p_0 = 1.5 bar,

V_s = 1340 litres

→ V_n = **250 litres** (for V_s max. 1360)

Selected:

1 x Reflex N 250, 6 bar → p. 4

1 x SU R1 cap ball valve

→ p. 7

Approximate water content:

Radiators	Panel-type radiators
$V_s = \dot{Q}$ [kW] x 13.5 l/kW	$V_s = \dot{Q}$ [kW] x 8.5 l/kW

Reflex recommendations:

- Select sufficiently high safety valve actuation pressure: $p_{sv} \geq p_0 + 1.5$ bar
- If possible, apply a 0.2 bar margin when calculating the gas input pressure: $p_0 \geq \frac{H\,[m]}{10} + 0.2$ bar
- Due to the required supply pressure for the circulating pumps, select an input pressure of at least 1 bar also for roof-mounted systems: $p_0 \geq 1$ bar
- In a vented system in cold conditions, set the water-side filling or input pressure at least 0.3 bar higher than the input pressure: $p_{fil} \geq p_0 + 0.3$ bar

reflex
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