reflex4experts

reflex
Thinking solutions.

Professional planning, calculation and equipment

Compact expertise for pressurisation, degassing, make-up and water treatment systems

Reflex —

A long-established well-known brand

Reflex Winkelmann GmbH - part of the Building+Industry division, is a leading provider of high-quality heating and hot-water supply technology. Under its Reflex brand, the company, which has its headquarters in Ahlen in the German region of Westphalia, develops, produces and sells not only expansion vessels, but also innovative components and integrated solutions for pressure maintenance, make-up, degassing and water treatment, hot water storage tanks and plate heat exchangers, as well as hydraulic manifold and vessel components. Reflex Winkelmann GmbH has around 2,000 employees worldwide, giving it an international presence in all major markets.

With its energy-efficient and sustainable products, the company is already doing its bit to support the environment, as evidenced by its commitment to sustainability and the climate policy goals enacted by the German Federal Government. This support is built on proven technologies and future-oriented innovations. What's more, Reflex Winkelmann GmbH works together with others as equals, always maintains its focus on the customer and offers additional services such as its own factory service centre fleet and a comprehensive range of training options.

Contents

Basic principles

This guideline is intended to provide you with the most important information for planning, calculation and equipment of Reflex pressurisation, degassing and heat transfer systems. Summarising Calculation forms have been created for selected systems. Summaries are provided in which you will find the most important auxiliary variables and material values for the calculation as well as the requirements for safety equipment.

Standards and directives

Due to the structures of the European Union (applicable to all EU - member states) standards are now drawn-up and apply in a cross-border manner. Country-specific standards have been or are being converted into internationally valid EN standards. In addition, country-specific standards or supplementary standards may be valid and applicable as long as they do not contradict or restrict the applicable EN standards (e.g. German DIN residual standards). In addition, within Germany, the Potable Water Ordinance (TrinkwV), the rules of the DVGW (German Technical and Scientific Association for Gas and Water) and the German Industrial Safety Directive (BetrSichV) apply. This manual uses the standards, regulations and directives applicable in the EU and Germany, which may differ from those applicable outside the EU and in the case of regional residual standards, directives and regulations and which may have to be considered separately in each region.

The following standards and guidelines contain essential principles for designing, sizing, equipping and operating:

DIN EN 12828	Heating systems in buildings - design of water-based heating systems
DIN 4747 Part 1	Heating plants for district heating, safety equipment
DIN 4753 Part 1	Water heaters and water heating installations
DIN EN 12976/77	Thermal solar systems
VDI 6002 (draft)	Solar heating for potable water
VDI 2035 Sheet 1	Prevention of damage in water heating installations Limescale formation and corrosion on the heating water side
EN 13831	Expansion vessels with membrane for installation in water systems
VDI 4708 Sheet 1	Pressure maintenance
VDI 4708 Sheet 2	Degassing
DIN 4807 Part 5	Closed expansion vessels with membrane for potable water installations
DIN 1988-100	Codes of practice for potable water installations — Part 100: Protection of potable water, potable water quality control; DVGW code of practice
DIN 1988-200	Codes of practice for potable water installations — Part 200: Installation Type A (closed system) - design, components, apparatus, materials; DVGW code of practice
DIN EN 1717	Protection against pollution of potable water
Pressure Equipment Directive (PED)	Pressure Equipment Directive 2014/68/EU previously 97/23/EC
BetrSichV	Industrial Safety Directive
EnEV	Energy Saving Regulations
EN ISO 4126 Part 1	Safety devices for protection against excessive pressure (safety valves)

Design documents
The product-specific data required for calculations can be found in the respective product documentation of the Reflex price list and, of course, also under **www.reflex-winkelmann.com/en**.

System circuits
Not all system circuits are and can be covered by the standards. Taking into account new findings, we therefore also give you information for use in calculations for special systems, such as solar thermal systems, cooling circuits and district heating systems. Automation of system operation is becoming ever more important. For this reason, pressure monitoring and make-up systems are treated in just the same way as central ventilation and degassing systems.

Special systems
For special systems, e.g. pressure maintenance stations in district heating systems with more than 14 MW of heating power or flow temperatures greater than 105 °C, please contact our technical sales department directly.

Calculation program
For computer-aided calculation of pressurisation systems and heat exchangers, our calculation program is available online under **rsp.reflex.de/en**.

Terminology, code letters and symbols

Letter in formulae	Explanation	See pages (amongst others)
A_D	Pressure maintenance working range	18
A_{SV}	Closing differential pressure for safety valves	45
n	Expansion coefficient for water	12, 31
n*	Expansion coefficient for water mixtures	19
n_R	Expansion coefficient relative to return temperature	12
p_0	Minimum operating pressure	11, 16, 17, 20
p_{ini}	Initial pressure	6, 17, 22
p_{vap}	Evaporation pressure for water	12, 26, 31
p_{vap}^*	Evaporation pressure for water mixtures	16, 17, 35
p_{fin}	Final pressure	10, 24, 63
p_{fill}	Filling pressure	10
p_{st}	Static pressure	6, 18, 19, 23
p_{SV}	Safety valve actuating pressure	24, 74
$p_{in\ min}$	Minimum inlet pressure for pumps	8, 18, 19
p_N	Permissible operating overpressure	8, 43
V	Compensation volume flow	27, 28
V_{sys}	System volume	18, 19, 59
v_{sys}	Specific water content	7
V_e	Expansion volume	10, 16, 43
V_C	Collector content	16, 78
V_n	Nominal volume	12, 19, 23
V_{res}	Water reserve	10, 16
Δp_P	Pump differential pressure	17, 19, 24
ρ	Density	7, 70
x	Steam spread in the piping of solar thermal systems during the stagnation phase	18

Code letters*

T—Temperature

- **T** Temperature measurement connection
- **TI** Thermometer
- **TIC** Temperature controller with display
- **TAZ+** Temperature limiter, safety temperature limiter, safety temperature monitor

P—pressure

- **P** Pressure measurement connections
- **PI** Pressure gauge
- **PC** Pressure controller
- **PS** Pressure switch
- **PAZ–** Pressure limiter—min. safety pressure limiter_min
- **PAZ+** Pressure limiter—max. safety pressure limiter_max

L—Water level

- **LS** Water level switch
- **LS+** Water level switch—max.
- **LS–** Water level switch—min.
- **LAZ–** Water level limiter – min.

Symbols

- Shut-off valve
- Valve fitting with secured shut-off and draining
- Spring-loaded safety valve
- Backflow preventer
- Solenoid valve
- Motorised valve
- Overflow valve
- Pressure reducer
- Dirt trap
- Water meter
- System separator
- Pump
- Heat consumer
- Heat exchangers

* Code letters according to DIN 19227 Part 1, "Graphical symbols and identifying letters for process control engineering".

Pressure maintenance

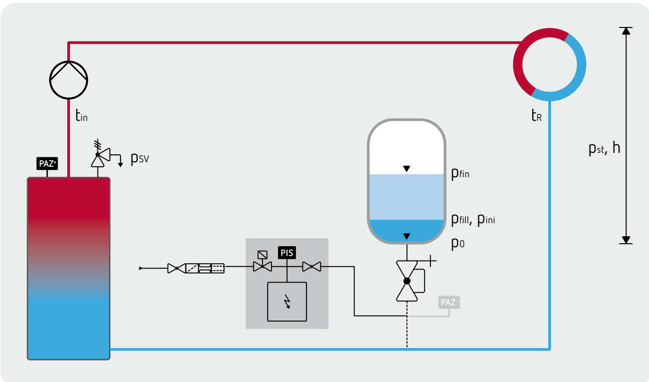
In heating or cold water systems

Tasks of pressurisation systems

Pressurisation systems are of central importance in heating and cooling circuits and must essentially fulfil three fundamental tasks:

1. Maintaining the pressure within permissible limits at every point of the system, that is, the permissible operating overpressure must not be exceeded as well as maintaining a minimum pressure to prevent vacuum, cavitation and evaporation.
2. Compensation of volume fluctuations of the heating or cooling water due to temperature fluctuations.
3. Providing a water reserve to prevent system-related water losses. Careful calculation, commissioning and maintenance are the prerequisite for the correct functioning of the overall system.

Calculation parameters



Most frequent circuit:

Circulating pump in the flow

Expansion vessel in the return = prepressure or suction pressure maintenance

Definitions according to DIN EN 12828 and VDI 4708 Sheet 1 based on the example of a heating system with an expansion vessel

Pressures are specified as gauge pressures and relate to the connector of the expansion vessel or the pressure sensor of pressure maintenance stations. Circuit according to the sketch on the left.

System pressures

p_{SV} Safety valve actuating pressure
The permissible operating overpressure must not be exceeded at any position in the system

PAZ+
= DBmax pressure limiter required according to DIN EN 12828, if the boiler individual capacity > 300 kW

p_{fin} Final pressure
System pressure at the maximum temperature

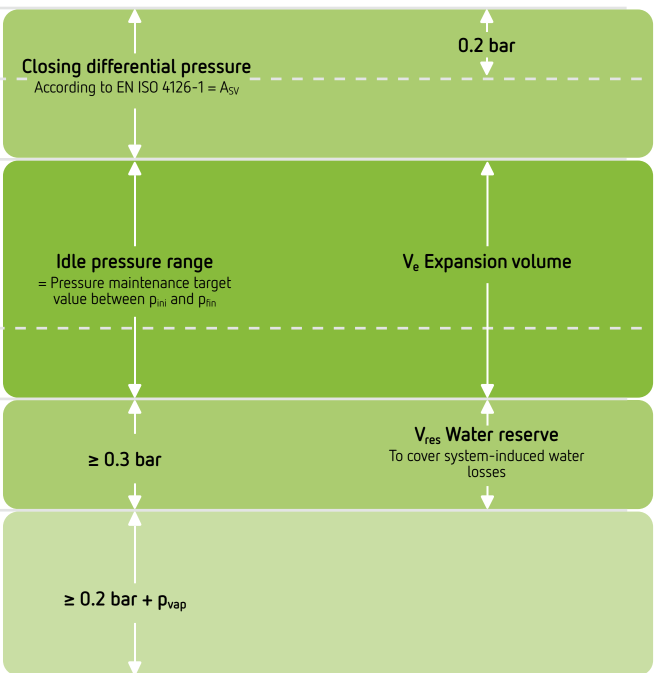
p_{fill} Filling pressure
System pressure at the filling temperature

p_{ini} Initial pressure
System pressure at the lowest temperature

p_0 Minimum operating pressure
Minimum pressure for preventing vacuum formation, cavitation and evaporation

PAZ-
= Prepressure for expansion vessel
= DBmin minimum pressure limiter according to DIN EN 12828; for ensuring p_0 in hot water systems, an automatic make-up system is recommended, use optional minimum pressure limiter

p_{st} Static pressure
Pressure of the water column corresponding to the static head (H)



Material values and auxiliary variables

Pure water without antifreeze

t [°C]	0	10	20	30	40	50	60	70	80	90	100	105	110	120	130	140	150	160
n [%] +10 °C relative to 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_{vap} [bar]	-	-0.99	-0.98	-0.96	-0.93	-0.88	-0.80	-0.69	-0.53	-0.30	0.01	0.20	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]	1,000	1,000	998	996	992	988	983	978	972	965	958	955	951	943	935	926	917	907

Water with 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 relative to 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_{vap} [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]	1,039	1,037	1,035	1,031	1,026	1,022	1,016	1,010	1,004	998	991	-	985	978	970	963	955	947

Water with 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 relative to 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_{vap} [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]	1,066	1,063	1,059	1,054	1,049	1,043	1,037	1,031	1,025	1,019	1,012	-	1,005	999	992	985	978	970

n = expansion factor of water relative to a minimum system temperature of +10 °C (in general filling water)
n* = expansion factor of water with antifreeze relative to a minimum system temperature of -10 °C or -20 °C
Δn = percentage expansion [%] of water for designing stratified temperature tanks between 70 °C and max. return temperature

p_{vap} = water evaporation pressure relative to atmospheric pressure
p_{vap}* = evaporation pressure for water with antifreeze
ρ = Density
* = Antifreeze Antifrogen N; if using another antifreeze, query the manufacturer for material values

Approximate determination of the water content V_{sys} of heating systems

Key data

Heat generator capacity $\dot{Q}$ = ... kW
Specific water content v_{sys} = ... l/kW
(Heat generator, manifold, heating surfaces)

Calculation

$V_{sys} = \dot{Q}_{tot} \times v_{sys}$ + Long pipelines + miscellaneous → for systems with natural circulation boilers
$V_{sys} = \dot{Q}_{tot}$ [v_{sys} − 1.4 l] + Long pipelines + miscellaneous → for systems with heat exchangers
$V_{sys} = \dot{Q}_{tot}$ [v_{sys} − 2.0 l] + Long pipelines + miscellaneous → for systems without heat generators

Installed heating capacity

V_{sys} = ... + ... + ... = ... litre

Calculation example

Capacity-specific water content in litre/kW on heating systems (heat generator, manifold, heating surfaces)

t_{in}/t_R [°C]	Radiators		Plates	Convectors	Ventilation	Underfloor heating
	Cast iron radiators	Pipes and steel radiators				
60 / 40	27.4	36.2	14.6	9.1	9.0	V_{sys} = 20 l/kW $V_{sys}^{**} = 20\,l/kW \cdot \frac{n_{fh}}{n}$
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	

** If the underfloor heating system is operated and secured as part of the overall system with a low flow temperature, then the total water volume v_{sys}** should be used for the calculation.

n_{fh} = percentage expansion relative to the maximum flow temperature of the underfloor heating

Attention!
Approximately, significant deviations are possible in individual cases.

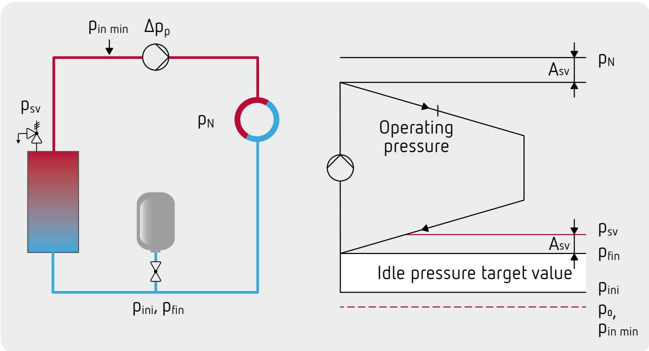
Approximate water content of heating pipes

DN	10	15	20	25	32	40	50	60	65	80	100	125	150	200	250	300
litre/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 connection

The hydraulic connection of the pressure maintenance unit into the system has a fundamental impact on the working pressure curve. This is comprised of the idle pressure level of the pressure maintenance and the differential pressure created while the circulating pump is running. Essentially, a differentiation is made between three types. In practice, there are other deviating versions.

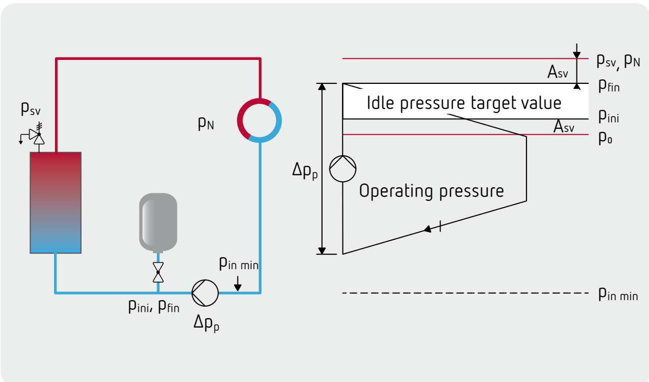
Prepressure maintenance (suction pressure maintenance)



The pressure maintenance is incorporated **upstream** of the circulating pump, that is at the suction side. This type is the most commonly used as it needs the least technical effort.

- Advantages:
  - + Low idle pressure level
  - + Operating pressure > Idle pressure, so there is no danger of vacuum formation
- Disadvantages:
  - – High working pressure at circulating pump pressure (in large systems), nominal network pressure p_N must be taken into consideration

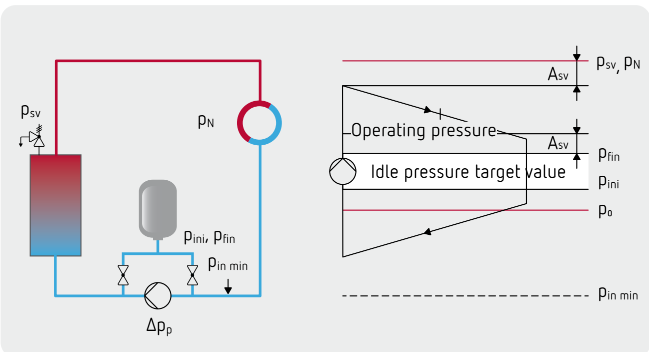
Follow-up pressure maintenance



The pressure maintenance system is implemented **downstream** of the circulating pump, that is at the pressure side. To determine the idle pressure, a system-specific differential pressure portion of the circulating pump (50 ... 100%) must be taken into account. Application is limited to a few individual situation e.g. solar thermal systems.

- Advantages:
  - + Low idle pressure level, if not the entire pump pressure must be loaded
- Disadvantages:
  - – High idle pressure level
  - – Increased need to maintain the required inlet pressure $p_{in\ min}$ according to manufacturer information for the circulating pump

Middle pressure maintenance



The measuring point for the idle pressure level is "moved" to the system through an analogue measurement section. Stagnation and working pressure levels can be perfectly coordinated and variably designed (symmetrical, asymmetrical average pressure maintenance). Due to the relatively high technical effort where the devices are concerned, use is limited to systems with complicated pressure conditions, usually in the district heating sector.

Advantages:
- + Optimum, variable harmonising of operating and idle pressure

- Disadvantages:
  - – Increased equipment complexity and expense

Reflex — recommendation
Apply suction pressure maintenance!
Only deviate in exceptional and duly justified cases. Contact us!

Pressurisation units from Reflex

Reflex manufactures two different types of pressurisation systems:

1. **Static pressure maintenance** function without auxiliary energy and, for this reason, are also classified as static pressurisation systems. Here, the pressure maintenance is implemented by a gas buffer in the vessel. To achieve automated operation combination with an automated make-up unit of the Fillcontrol series or a Servitec make-up and degassing system makes sense.
2. **Dynamic pressure maintenance** operate using auxiliary energy and therefore are assigned to the dynamic pressurisation systems. A differentiation is made between pump and compressor-controlled systems. While Variomat and Variomat Giga directly control the pressure in the facility system by means of pumps and pressure relief valves on the water side, with the Reflexomat Silent Compact or Reflexomat, the pressure is regulated on the air side using a compressor and a discharge valve.

Both systems have their merits. For instance, water-controlled systems work very quietly and can react very quickly to pressure changes. By storing the expansion water in an unpressurised manner, they can be used simultaneously as a central venting and degassing system (Variomat). Compressor-controlled systems (Reflexomat) allow very flexible operation within very tight pressure limits of approximately ± 0.1 bar about the target value (by comparison, the equivalent figure for Variomat systems is approximately ± 0.2 bar). Optionally, optimum degassing and automatic make-up are possible in combination with a Servitec.
Our configuration software helps you to choose the best solution.

Favoured applications are listed in the following table. Here, experience shows that it makes sense to automate the pressure maintenance, that is to monitor the pressure and replenish it promptly as well as performing automatic central venting of the system. There is no need to fit conventional air diverters or air and/or microbubble separators, while troublesome re-venting is eliminated, operation becomes more reliable and costs are reduced.

Reflex pressure maintenance solutions — overview

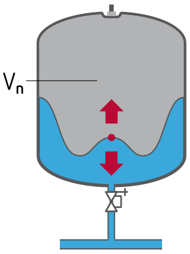
		Flow temperature ≤ 120 °C**	Pressurisation	Automatic operation with make-up	Central venting and degassing	Preferred capacity range
Reflex		▪ without additional equipment ▪ with Fillcontrol make-up ▪ with Servitec (magcontrol)	✓ ✓ ✓	- ✓ ✓	- - ✓	up to 1,000 kW
Variomat		▪ 1 single pump system ▪ 2-1 single pump system ▪ 2-2 twin pump system	✓ ✓ ✓	✓ ✓ ✓	✓ ✓ ✓	150 – 2,000 kW 150 – 4,000 kW 500 – 8,000 kW
Variomat Giga		▪ without additional equipment ▪ with Servitec (levelcontrol)	✓ ✓	✓ ✓	✓ * ✓	5,000 – 60,000 kW
		▪ Customised system solutions		Task-dependent		
Reflexomat Silent Compact		▪ without additional equipment ▪ with Fillcontrol / Fillvalve make-up ▪ with Servitec (levelcontrol)	✓ ✓ ✓	- ✓ ✓	- - ✓	100 – 2,000 kW
Reflexomat		▪ without additional equipment ▪ with Fillcontrol / Fillvalve make-up ▪ with Servitec (levelcontrol)	✓ ✓ ✓	- ✓ ✓	- - ✓	150 – 24,000 kW

* For return temperatures < 70 °C, the Variomat Giga can also be used without additional degassing equipment.
**Systems with higher operating temperatures are available dependent on the task.

Reflex expansion vessels

Series N, C, F, S, G and SL

Nominal volume V_n



The pressure in the expansion vessel is generated by a preset gas buffer. Water level and pressure in the gas chamber are interconnected (p× V = constant). For this reason, it is not possible to utilise the entire nominal volume for holding water. The nominal volume is larger than the required water holding volume $V_e + V_{res}$ by factor $\frac{p_{fin} + 1}{p_{fin} - p_0}$.
This is one reason why dynamic pressure maintenance stations in larger facility systems and systems with tight pressure ratios ($p_{fin} - p_0$) may represent the optimum solution. When Servitec degassing systems are used, the volume of the degassing pipe must be taken into account when determining the size.

Prepressure / minimum operating pressure p_0, pressure monitoring
The gas prepressure must be checked manually before commissioning and during annual maintenance work, and set to the minimum operating pressure of the facility system and entered on the type plate. It must be specified by the planner in the drawing documents. To avoid cavitation in the circulating pumps, we recommend that the minimum operating pressure should not be less than 1 bar, even with roof units and heating systems in low-rise buildings. Usually, the expansion vessel is integrated on the suction side of the circulating pump (prepressure maintenance). For pressure-side connection (follow-up pressure maintenance), the differential pressure of the circulating pumps Δp_P must be taken into account to prevent vacuum formation at the high points . When calculating p_0, a safety allowance of 0.2 bar is recommended. This allowance should only be foregone in the event of very tight pressure ratios.

Initial pressure p_{ini}, make-up
One of the most important pressures!
The initial pressure limits the lower target range of the pressure maintenance and at the same time safeguards the water reserve V_{res}, i.e. the minimum water volume in the expansion vessel. Reliable control and checking of the initial pressure is only ensured if the Reflex formula for the initial pressure is complied with. Our calculation program takes this into account. Stable operation is ensured by the higher initial pressures (larger water reserve) in comparison with conventional designs. In this way, the known malfunctions of expansion vessels due to insufficient or even a completely missing water reserve are prevented. Especially where there are small differences between final pressure and prepressure, the new calculation method can result in slightly larger vessels. However, this should not come into consideration when compared with the need to maximise operating safety. Reflex make-up stations automatically monitor and ensure the initial and filling pressure.

You can find more information in the brochure Make-up systems and water treatment technology

Filling pressure p_{fill}
The filling pressure p_{fill} is the pressure that must be applied when filling a system,related to the temperature of the filling water, so that the water reserve V_{res} is still guaranteed even at the lowest system temperature. For heating systems, generally filling pressure = initial pressure (lowest system temperature = filling temperature = 10°C). Example: For cooling circuits with system temperatures below 10°C, the filling pressure is above the initial pressure.

Final pressure p_{fin}
The final pressure limits the upper target range of the pressure maintenance. This must be defined so that the pressure at the system safety valve is lower by at least the closing differential pressure A_{SV} in accordance with TRD 721. The closing differential pressure depends on the type of the safety valve.

Degassing, venting
Sealed systems in particular must be specifically vented or degassed, otherwise accumulations of nitrogen will lead to annoying operating faults and customer dissatisfaction. Servitec automatically degasses and replenishes.

You can find more information in the brochure on P. 57

No degassing

$$V_n = (V_e + V_{res}) \times \frac{p_{fin} + 1}{p_{fin} - p_0}$$

With Servitec

$$V_n = (V_e + V_{res} + 5\,l) \times \frac{p_{fin} + 1}{p_{fin} - p_0}$$

Prepressure maintenance

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

$p_0 \geq 1$ bar → Reflex recommendation

Follow-up pressure maintenance

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

Reflex formula for initial pressure

$p_{ini} \geq p_0 + 0.3$ bar

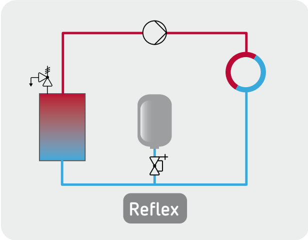
Reflex recommendation

p_{fin}	=	$p_{SV} - A_{SV}$
p_{SV}	≥	$p_0 + 1.5$ bar for $p_{SV} \leq 5$ bar
p_{SV}	≥	$p_0 + 2.0$ bar for $p_{SV} > 5$ bar

Closing differential pressure A_{SV} according to EN ISO 4126

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

Heating water systems



Calculation According to DIN EN 12828 and VDI 4708 sheet 1.

Circuit Mainly in prepressure maintenance (also referred to as suction pressure maintenance) according to the adjacent sketch with circulating pump in the flow and expansion vessel in the return, i.e. the suction side of the circulating pump.

Material values n, p_{vap} In general material values for pure water without antifreeze additives.
For more information, see P. 7

Expansion volume V_e, maximum temperature t_{TR} Determination of the percentage expansion, generally between the lowest temperature = filling temperature = 10 °C and the maximum target setting of the temperature controller t_{TR}.

Minimum operating pressure p_0 In particular for low rise buildings and roof units, because of the low static pressure p_{st} the minimum inlet pressure for the circulating pump should be considered in accordance with the manufacturer's specifications. For this reason, even with low static heads, we recommend that the minimum operating pressure p_0 is not selected to be less than 1 bar.

→ **Caution** with roof units and low-rise buildings

Filling pressure p_{fill}, Initial pressure p_{ini} As the filling temperature at 10 °C is usually equal to the lowest system temperature, for expansion vessels filling pressure = initial pressure. For compressor-controlled pressure maintenance stations, it must be ensured that filling and make-up facilities are able to run against the final pressure, e.g. as is the case for the Reflexomat.

$p_0 \geq 1$ bar → Reflex recommendation

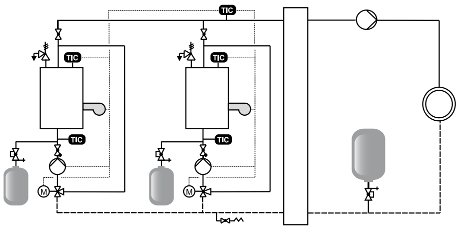
Pressure maintenance As static pressure maintenance with Reflex expansion vessel also in combination with make-up and degassing systems. From about 150 kW as a dynamic pressure maintenance station for pressure maintenance, degassing and make-up with Variomat or as a compressor-controlled pressure maintenance station with Reflexomat.
For more information, see P. 15
For systems with oxygen-rich water (e.g. underfloor heating systems with non-diffusion-tight plastic pipes) Refix DE, DC or C-DE is used up to 70 °C (all water-carrying parts are corrosion-resistant).

→ If there is a risk of corrosion, use a Refix

Degassing, venting, make-up To achieve continuously safe, automatic operation of the heating system, it makes sense to supplement the pressurisation facilities with Fillcontrol automatic make-up systems or with Servitec degassing systems and / or Exvoid microbubble separators.
For more information, see P. 26

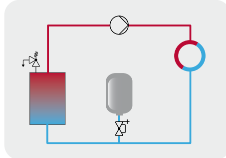
Intermediate vessels If the max. operating temperature is permanently exceeded in the pressure maintenance system, a Reflex V intermediate vessel must be installed upstream of the expansion vessel to protect the membrane. For more information, see P. 43

Individual protection Each heat generator must always be connected to a pressurisation system in accordance with DIN EN 12828. Only secured shut-offs are permitted. If a heat generator is hydraulically shut off (e.g. boiler sequential circuit), then, nevertheless, the connection to the pressure maintenance unit must always remain ensured. Therefore, according to the state of the art, each heat generator in a multi-boiler system must always be protected by its own expansion vessel. This is only designed for the relevant water content of the heat generator.



Attention! Due to the good degassing performance of Variomat, an expansion vessel (e.g. Reflex N) should always be installed to minimise the switching frequency, even with single boiler or heat exchanger systems, as a control vessel at the heat generator. Their total nominal volume can then be considered as the required control vessel volume according to the diagram P. 31.

Dimensioning Reflex N, C, F, S, G, SL in heating water systems



Circuit: Prepressure maintenance, expansion vessel in return, circulating pump in the flow, with follow-up pressure maintenance. Observe information on P. 10.

Object:

Start data

Heat generator		1	2	3	4		
Heating capacity	$\dot{Q}_W$	= .... kW	.... kW	.... kW	.... kW	$\dot{Q}_{Wtot}$	= .... kW
Water content	V_W	= .... litre	.... litre	.... litre	.... litre	V_{Wtot}	= .... litre
Design flow temperature	t_{in}	= .... °C	P. 7 Approximate water content $V_{sys} = f(t_{in}, t_R, Q)$			V_{sys}	= .... litre
Design return temperature	t_R	= .... °C					
Known water content	V_{sys}	= .... litre					
Highest target value setting Temperature controller	t_{TR}	= .... °C	P. 7 expansion factor n (with antifreeze additive n*)			n	= .... %
Antifreeze additive		= .... %					
Safety temperature limiter	$t_{safety\ temperature\ limiter}$	= .... °C	P. 7 Evaporation pressure p_{vap} at >100 °C (with antifreeze p_{vap}*)			p_{vap}	= .... bar
Static pressure	p_{st}	= .... bar				p_{st}	= .... bar

→ for t_R > 70 °C V provide intermediate vessel

Pressure calculation

Prepressure	p_0 = [static pressure] p_{st} + [evaporation pressure] p_{vap} + 0.2 bar[1] p_0 = ... + ... + 0.2 bar[1] = ... bar p_0 ≥ 1.0 bar[1]	p_0	= .... bar
Safety valve actuating pressure	p_{SV} → Reflex recommendation p_{SV} ≥ [prepressure] p_0 + 1.5 bar (for p_{SV} ≤ 5 bar) p_{SV} ≥ [prepressure] p_0 + 2.0 bar (for p_{SV} > 5 bar) p_{SV} ≥ .... + ... = ... bar	p_{SV}	= .... bar
Final pressure	p_{fin} ≤ [safety valve] p_{SV} – [closing differential pressure according to ISO 4126-1] p_{fin} ≤ p_{SV} – 0.5 bar (for p_{SV} ≤ 5 bar) p_{fin} ≤ p_{SV} – 0.1 × p_{SV} (for p_{SV} > 5 bar) p_{fin} ≤ .... – .... = ... bar	p_{fin}	= .... bar

[1] → Reflex recommendation

→ Check minimum inlet pressure of the circulating pump(s) according to manufacturer specifications

→ Check compliance with max. operating pressure

Vessel

Expansion Volume	$V_e = \frac{n}{100} \times V_{sys}$ = ... × .... = ... litre	V_e	= .... litre
Water reserve	V_{res} = 0.005 × V_{sys} (for V_n > 15 litre with V_{res} ≥ 3 litre) V_{res} ≥ 0.2× $_n$ (for V_n ≤ 15 litre) V_{res} ≥ .... × .... = ... × .... = ... litre	V_{res}	= .... litre
Nominal volume **without** Servitec	$V_n = (V_e + V_{res}) \times \frac{p_{fin} + 1}{p_{fin} - p_0}$		
with Servitec	$V_n = (V_e + V_{res} + 5\ \text{litre}) \times \frac{p_{fin} + 1}{p_{fin} - p_0}$ V_n ≥ .... × .... = ... litre Selected V_n Reflex = ... litre	V_n	= .... litre
Initial pressure check **without** Servitec	$p_{ini} = \frac{p_{fin} + 1}{1 + \frac{V_e (p_{fin} + 1)(n + n_R)}{V_n (p_0 + 1)\, 2n}} - 1\ \text{bar}$		
with Servitec	$p_{ini} = \frac{p_{fin} + 1}{1 + \frac{(V_e + 5\ \text{litre})(p_{fin} + 1)(n + n_R)}{V_n (p_0 + 1)\, 2n}} - 1\ \text{bar}$ $p_{ini} = \frac{......................}{1 + \frac{......................}{......................}}$ - 1 bar = ... bar	p_{ini}	= .... bar
Condition:	p_{ini} ≥ p_0 + 0.25...0.3 bar, otherwise calculation for large nominal volume		

→ Filling pressure = Initial pressure with 10 °C filling temperature

Results

Reflex .... / .... bar .... litre	Prepressure	p_0	= .... bar
Refix* .... / .... bar .... litre	Initial pressure	p_{ini}	= .... bar
	Final pressure	p_{fin}	= .... bar

*Refix only with oxygen-rich water (e.g. underfloor heating systems).

→ Check before commissioning

→ Check make-up setting

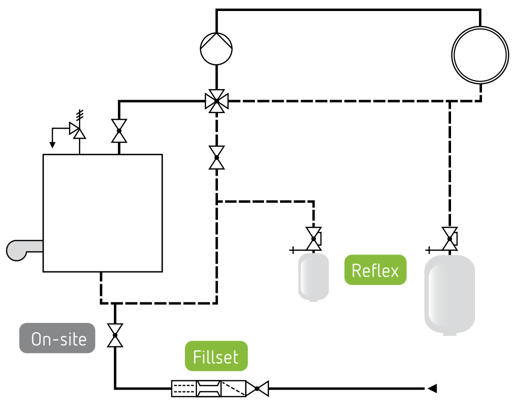
Installation examples Reflex N, C, F, S, G and SL in heating water systems

You should select this circuit:
Expansion vessel in the heat generator return — circulating pump in the heat generator flow.

- Direct connection expansion vessel – heat generator
- Low temperature loading of the membrane
- Expansion vessel on the suction side of the circulating pump, consequently reduction in the risk of vacuum formation

If your system differs, please ask your sales engineer!

Reflex
In a boiler system with 4-way mixer

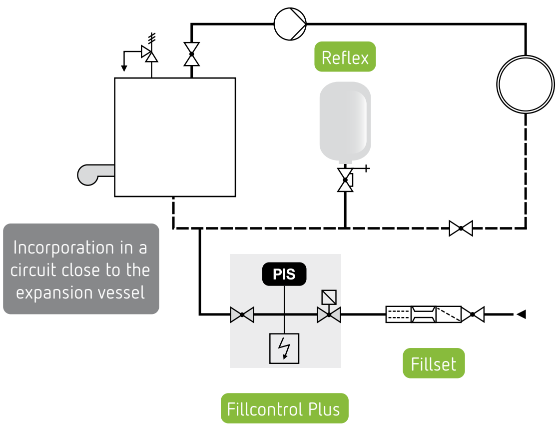


Model example:
Fillset

Note for the installer

- Both boiler and system each contain an expansion vessel. Even with mixers that are tightly sealed, a vacuum in the system circuit is reliably avoided.
- Fillset is a prefabricated valve assembly with a system separator of type BA, which allows direct connection to a potable water system for make-up and system filling.

Reflex
With automatic filling pressure monitoring



Model example:
Fillcontrol Plus

Note for the installer

- This function is optimally supported with a Fillcontrol Plus make-up system in "Magcontrol" (expansion vessel control) operating mode! The heating system always has enough system pressure. In this way, vacuum formation and the associated air problems an high points are minimised.
- Fillset with system separator and water meter are simply connected upstream, to enable direct connection to the (mains) potable water system.

Note P. 9
→ Reflex brochure Water make-up systems

According to **DIN EN 12828**, each heat generator must be connected by at least one expansion line to one or more expansion vessels.

The diagrams are solely to illustrate the connections. They must be matched to the local conditions and substantiated.

Installation examples Reflex N, C, F, S, G and SL in heating water systems

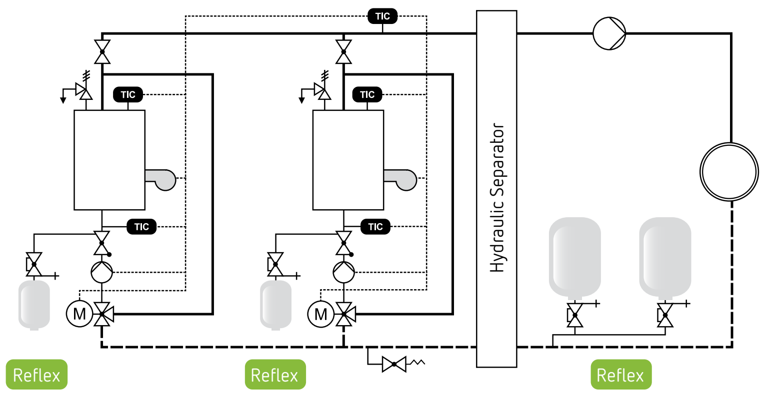
Which circuit should you select?

Both the individual protection of each heat generator with an expansion vessel as well as joint boiler and system protection are possible. It must be ensured that with shut-offs provided by boiler downstream circuits, the boiler concerned must remain connected with at least one expansion vessel. The most favourable circuit must always be determined in cooperation with the boiler manufacturer.

Note for the installer

- Through battery-type connection of several Reflex N vessels, it is generally possible to obtain economic alternatives to Reflex G large vessels, provided the operating conditions, such as maximum required operating pressure and dimensions permit this.
- The temperature control of the burner is used to switch off the corresponding circulating pump and close the motorised valve M. Here, the boiler remains connected to its Reflex. Most frequent circuit for boilers with a minimum return temperature. With the burner off, circulation across the boiler is reliably prevented.

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

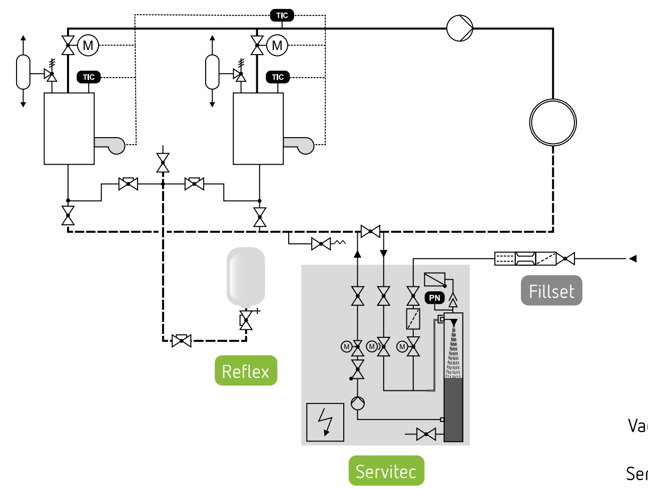


Note for the installer

- Upon switch off of the burner, the corresponding actuator M is closed by the temperature control, without incorrect circulation via the isolated boiler being possible. The junction of the boiler expansion line above the boiler middle prevents gravity circulation. Favoured for use in systems without a minimum boiler return temperature (e.g. condensing boiler systems).
- Our Servitec vacuum spray pipe degassing system provides you with effective system service:
  - Pressure display and monitoring
  - Automatic make-up
  - Central system and make-up water venting and degassing

→ Brochures
Vacuum spray-tube degassing and Separation technology

Reflex
In a multi boiler system with joint boiler and system protection



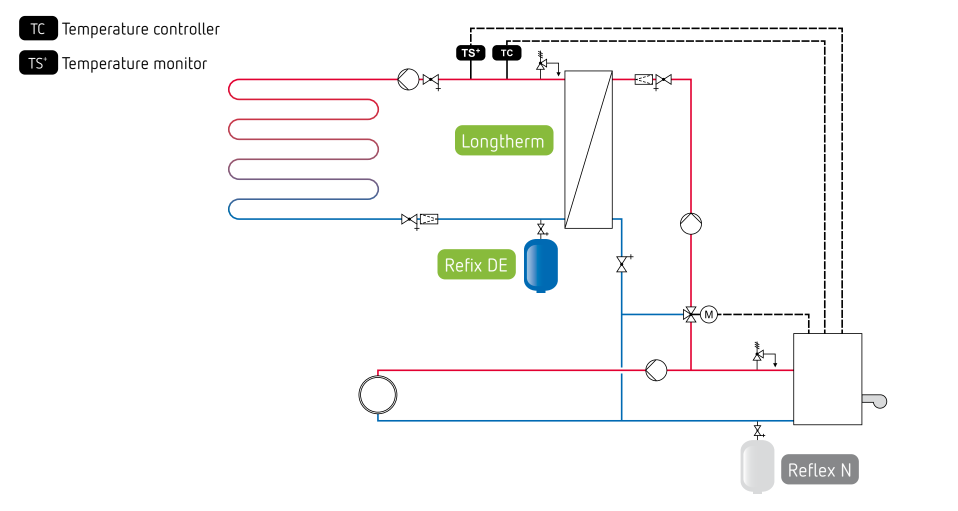
Servitec
Vacuum spray tube degassing system, model example: Servitec 60 with Control Touch

The diagrams are solely to illustrate the connections. They must be matched to the local conditions and substantiated.

According to **DIN EN 12828**, each heat generator must be connected by at least one expansion line to one or more expansion vessels.

Installation examples Reflex N, C, F, S, G and SL in heating water systems

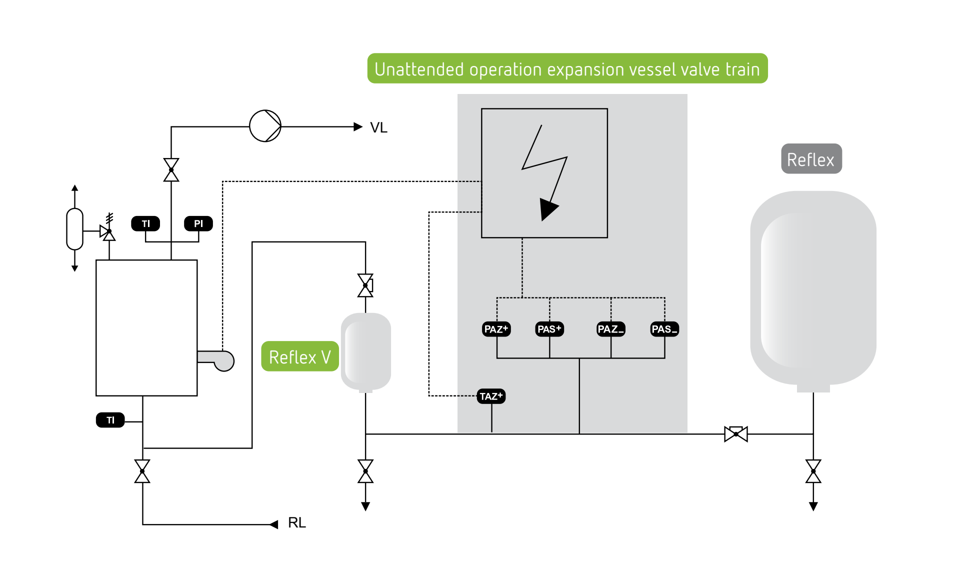
Refix DE
In a system with underfloor heating



Note for the installer

- If the underfloor heating system is not laid using **oxygen-impermeable** plastic pipes, there is a risk of corrosion.
- As previously, the safest solution is then the system separation of the boiler and underfloor circuits, e.g. using a Longtherm plate heat exchanger.
- To also exclude corrosion at the expansion vessel, here we recommend use of the Refix DE with special corrosion protection of all water-contacting parts.

Reflex
In a heating water system with $t_{TAZ+} > 110\,°C$



Note for the installer

- According to DIN EN 12953 or based on TRD 402, 18.6: "With pressure expansion vessel and collecting vessels, the actually occurring operating temperature can be used as the calculation temperature."
- TRD 604 Sheet 2, 1.3.: "With an expansion vessel, it is not necessary to fit a water level limiter, if a minimum pressure limiter fitted to the expansion vessel triggers when the level falls below the lowest permissible water level."
- **We recommend:** Reflex V Intermediate vessel >120 °C with Unattended operation expansion vessel valve train with each having a maximum/minimum pressure limiter PAZ+/PAZ- and monitor PAS+/PAS- as well as a safety temperature limiter TAZ+ for on-site installation.

The diagrams are solely to illustrate the connections. They must be matched to the local conditions and substantiated.

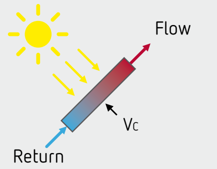
Solar thermal systems

Calculation

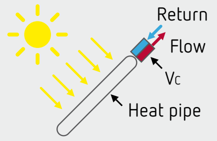
Based on VDI 6002 and VDI 4708 Sheet 1.

A special characteristic of solar thermal systems is that the highest temperature cannot be defined by the heat generator's controller, rather is determined by the stagnation temperature of the collector. As a result there are two possible calculation methods.

Direct heating in a flat-plate collector or evacuated tube collector with direct flow-through



Indirect heating in an evacuated tube collector operating using heat pipes



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

Percentage expansion n* and evaporation pressure p_{vap}* are related to the stagnation temperature. As temperatures in certain collectors can exceed 200 °C, this calculation method is excluded here. Indirectly heated evacuated tube collectors (system heat pipe and collectors with other switch-off methods , such e.g. automatic darkening) and systems with limiting of the stagnation temperature. If a minimum operating pressure of $p_0 \leq 4$ bar is sufficient to prevent evaporation, calculations can usually exclude evaporation.

The fact that under certain circumstances, an increased temperature load will reduce the antifreeze effect of the heat transfer medium must be taken into consideration.

→ Observe manufacturer specifications concerning stagnation temperatures!

Nominal volume without evaporation

$$V_n = (V_e + V_{res}) \times \frac{p_{fin} + 1}{p_{fin} - p_0}$$

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

Evaporation in the collector cannot be excluded in collectors with stagnation temperatures exceeding 200 °C. Then the evaporation pressure is only considered up to the desired boiling point (110 – 120 °C). Here in determining the nominal volume of the expansion vessel, the entire collector volume V_C and a pipe volume fraction x are considered as the “steam spread”[1)] in addition to the expansion volume V_e and the water reserve V_{res}.

This variant is to be favoured because the loaded is reduced by the lower temperature of the heat transfer medium and the frost protection effect of the antifreeze is maintained for longer.

Nominal volume **with** evaporation

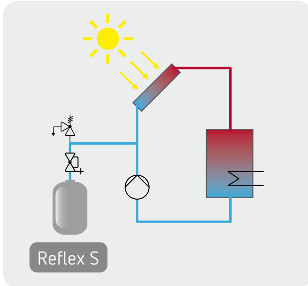
$$V_n = (V_e + V_{res} + V_C + (x \times V_R)) \frac{p_{fin} + 1}{p_{fin} - p_0}$$

[1)] If the hot water storage tanks of a solar system are charged, the solar circuit pump is switched off and the collector can no longer deliver any useful heat. This state is referred to as stagnation. The temperature of an absorber increases until its heat loss is equation to the absorbed solar radiation power. Flat-plate collector with a simple cover achieve a stagnation temperature of about 200 °C, while, dependent on type, vacuum tube collectors achieve a temperature significantly greater than 300 °C. However, the water-glycol mixture starts to boil at temperatures as low as 120 – 140 °C. The resulting steam, largely empties the collectors, in that it displaces the liquid into the pipes of the solar circuit. At the same time, a corresponding volume of liquid is pushed from the pipes into the expansion vessel. A certain residual quantity of liquid always remains in the absorbers. The residual quantity evaporates during stagnation. In a collector array, this condition is referred to as empty boiling. The steam expands into the pipes. Here the steam condenses, heating the pipe wall. The length of the steam-filled pipes is referred to as the steam spread. The maximum steam spread is reached when the volume of liquid evaporated in the collectors equals the volume condensing in the pipes. At this point in time, the volume of steam is also at its greatest.

Reflex S in solar thermal systems

Circuit

As the expansion vessel with safety valve must be installed in the return so that it cannot be isolated from the collector, this means that there is inevitably a pressure maintenance, i.e. the connection of the expansion vessel is made on the discharge side of the circulating pump.



Material values n*, p_{vap}*

Antifreeze additives of up to 40% must be considered when determining percentage expansion n* and evaporation pressure p_{vap}* in accordance with manufacturer specifications.

For more information about material values for water mixtures with Antifogen N see P. 7

If evaporation in the collector is anticipated, the evaporation pressure p_{vap}* is optionally allowed for up to a boiling temperature or pump cut-off temperature of e.g. 110 °C or 120 °C. The percentage expansion n* is then determined between the lowest outside temperature (e.g. -20 °C) and the boiling temperature.

If evaporation is not anticipated in the collector, evaporation pressure p_{vap}* and percentage expansion n* must be related to the stagnation temperature of the collector.

With evaporation

p_{vap}^* = f (boiling/pump switch-off temperature)

n^* = f (boiling/pump switch-off temperature)

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

Without evaporation

p_{vap}^* = f (stagnation temperature)

n^* = f (stagnation temperature)

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

Prepressure p_0, Minimum operating pressure

Depending on the method of calculation, the minimum operating pressure (= prepressure) is matched to the stagnation temperature in the collector (= without evaporation) or the boiling temperature (= with evaporation). In both cases, circulating pump pressure ΔpP must be considered for the usual, above-mentioned circuit, as the expansion vessel is integrated on the pressure side of the circulating pump (pressure maintenance).

→ **Attention!**
Enter the set prepressure on the type plate

Filling pressure p_{fill}, initial pressure p_{ini}

The filling temperature (10°C) is usually much higher than the lowest system temperature, so that the filling pressure is greater than the initial pressure.

Pressure maintenance

Usually as static pressure maintenance with Reflex S, also in combination with make-up systems which are supplied from water reserve or pre-mixing vessels.

Intermediate vessels

If a stable return temperature ≤ the max. operating temperature of the Reflex or the pressure maintenance station cannot be guaranteed, an intermediate vessel (Reflex V) must be installed at the expansion vessel.

For more information, see P. 73

Reflex V intermediate vessel

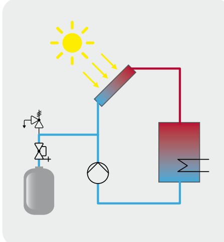
Reflex S expansion vessels for solar systems

Dimensioning Reflex S in solar thermal systems with evaporation

Calculation method: The minimum operating pressure p_0 is calculated so that up to flow temperatures of 110 °C or 120 °C or until switching off of the solar circuit pump no evaporation occurs, i.e., at stagnation temperatures **evaporation is allowed in the collector**.

Circuit: Pressure maintenance, expansion vessel in return flow to the collector.

Object:



Start data

Number of collectors	z	.... Pcs.		
Collector area	A_C	.... m²	$A_{Ctot} = z \times A_C$ A_{Ctot} = ... ×	A_{Ctot} = ... m²
Water content per collector	V_C	.... litre	$V_{Ctot} = z \times V_C$ V_{Ctot} = ... ×	V_{Ctot} = ... litre
Maximum flow temperature	t_{in}	110 °C or 120 °C	P. 7 percentage expansion n* and expansion pressure p_{vap}*	n* = ... %
Lowest outside temperature	t_a	– 20 °C		p_{vap}* = ... bar
Antifreeze additive		.... %		
Static pressure	p_{st}	.... bar		p_{st} = ... bar
Circulating pump differential pressure	Δp_P	.... bar		Δp_P = ... bar
Steam spread	x	.... %		x = ... %

→ Maintaining of the minimum inlet pressure $p_{in\,min}$ for the circulating pumps, check manufacturer's specifications!
$p_{in\,min} = p_0 - \Delta p_P$

Pressure calculation

Prepressure	p_0 = [static pressure] p_{st} + [pump pressure] Δp_{vap} + [evaporation pressure] p_{vap}* p_0 = ... + ... + ... = ... bar	p_0 = ... bar
Safety valve actuating pressure	p_{SV} → Reflex recommendation p_{SV} ≥ [prepressure] p_0 + 1.5 bar (for $p_{SV} \le 5$ bar) p_{SV} ≥ [prepressure] p_0 + 2.0 bar (for $p_{SV} > 5$ bar) p_{SV} ≥ .... + ... = ... bar	p_{SV} = ... bar
Final pressure	p_{fin} ≤ [safety valve] p_{SV} – [closing differential pressure according to ISO 4126-1] p_{fin} ≤ p_{SV} – 0.5 bar (for $p_{SV} \le 5$ bar) p_{fin} ≤ p_{SV} – 0.1 bar × p_{SV} (for $p_{SV} > 5$ bar) p_{fin} ≤ .... – .... = ... bar	p_{fin} = ... bar

→ **Attention!** Check compliance with permissible operating pressure

Vessel

System volume	V_{sys} = [collector] V_{Ctot} + [pipes] V_R + [buffer tank] V_{bt} + [miscellaneous] V_{sys} = ... + ... + ... + ... = ... litre	V_{sys} = ... litre
Expansion Volume	$V_e = \frac{n^*}{100} \times V_{sys}$ = ... × .... = ... litre	V_e = ... litre
Water reserve	$V_{res} = 0.005 \times V_{sys}$ (for $V_n > 15$ litre with $V_{res} \ge 3$ litre) $V_{res} \ge 0.2 \times V_n$ (for $V_n \le 15$ litre) V_{res} ≥ .... × .... = ... × .... = ... litre	V_{res} = ... litre
Nominal volume x = Steam fraction in piping system (steam spread)	$V_n \ge (V_e + V_{res} + V_{Ctot} + x \times V_R) \times \frac{p_{fin} + 1}{p_{fin} - p_0}$ V_n ≥ .... × .... = ... litre Selected V_n Reflex S = ... litre	V_n = ... litre
Check Initial pressure	$p_{ini} = \frac{p_{fin} + 1}{1 + \frac{(V_e + V_{Ctot} + x \times V_R) \times (p_{fin} + 1)}{V_n \times (p_0 + 1)}} - 1$ bar p_{ini} = ... / (1 + ... / ....) – 1 bar = ... bar	p_{ini} = ... bar
Condition	$p_{ini} \ge p_0$ + 0.25...0.3 bar, otherwise calculation for larger nominal volume	
Percentage expansion	Between lowest temperature (-20 °C) and filling temperature (usually 10 °C) P. 7 n^*_{fill} = ... %	n^*_{fill} = ... %
Filling pressure	$p_{fill} = V_n \times \frac{p_0 + 1}{V_n - V_{sys} \times n_{fill}^* - V_{res}} - 1$ bar p_{fill} = ... × .... – 1 bar = ... litre	p_{fill} = ... bar

Results

Reflex S/10 bar .... litre

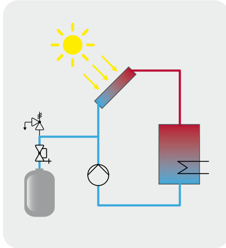
Prepressure	p_0 = ... bar
Initial pressure	p_{ini} = ... bar
Filling pressure	p_{fill} = ... bar
Final pressure	p_{fin} = ... bar

→ Check before commissioning
→ Check make-up setting
→ System refilling

Dimensioning Reflex S in solar thermal systems <u>without</u> evaporation

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

Circuit: Pressure maintenance, expansion vessel in return flow to the collector.



Object:

Start data

Number of collectors	z .... Pcs.		
Collector area	A_C .... m²	$A_{Ctot} = z \times A_C$ A_{Ctot} = ... ×	A_{Ctot} = ... m²
Water content per collector	V_C .... litre	$V_{Ctot} = z \times V_C$ V_{Ctot} = ... ×	V_{Ctot} = ... litre
Maximum flow temperature	t_{in}	P. 7 percentage expansion n* and expansion pressure p_{vap}*	n* = ... %
Lowest outside temperature	t_a – 20 °C		p_{vap}* = ... bar
Antifreeze additive	.... %		
Static pressure	p_{st} .... bar		p_{st} = ... bar
Circulating pump differential pressure	Δp_P .... bar		Δp_P = ... bar

→ Maintaining of the minimum inlet pressure $_{in\ min}$ for the circulating pumps, check manufacturer's specifications!
$p_{in\ min} = p_0 - \Delta p_P$

Pressure calculation

Prepressure	p_0 = [static pressure] p_{st} + [pump pressure] Δp_{vap} + [vapour pressure] p_{vap}* p_0 = ... + ... + ... = ... bar	p_0 = ... bar
Safety valve actuating pressure	p_{SV} → Reflex recommendation p_{SV} ≥ [prepressure] p_0 + 1.5 bar (for $p_{SV} \le 5$ bar) p_{SV} ≥ [prepressure] p_0 + 2.0 bar (for $p_{SV} > 5$ bar) p_{SV} ≥ .... + ... = ... bar	p_{SV} = ... bar
Final pressure	p_{fin} ≤ [safety valve] p_{SV} – [closing differential pressure according to ISO 4126-1] p_{fin} ≤ p_{SV} – 0.5 bar (for $p_{SV} \le 5$ bar) p_{fin} ≤ p_{SV} – 0.1 bar × p_{SV} (for $p_{SV} > 5$ bar) p_{fin} ≤ .... – .... = ... bar	p_{fin} = ... bar

→ Attention!
Check compliance with permissible operating pressure

Vessel

System volume	V_{sys} = [collector] V_{Ctot} + [pipes] V_R + [buffer tank] V_{SP} + [miscellaneous] V_{sys} = ... + ... + ... + ... = ... litre	V_{sys} = ... litre
Expansion Volume	$V_e = \frac{n^*}{100} \times V_{sys}$ = ... × .... = ... litre	V_e = ... litre
Water reserve	$V_{res} = 0.005 \times V_{sys}$ (for $V_n > 15$ litre with $V_{res} \ge 3$ litre) $V_{res} \ge 0.2 \times V_n$ (for $V_n \le 15$ litre) V_{res} ≥ .... × .... = ... × .... = ... litre	V_{res} = ... litre
Nominal volume	$V_n \ge (V_e + V_{res} + V_{Ctot}) \times \frac{p_{fin} + 1}{p_{fin} - p_0}$ V_n ≥ .... × .... = ... litre Selected V_n Reflex S = ... litre	V_n = ... litre
Check Initial pressure	$p_{ini} = \frac{p_{fin} + 1}{1 + \frac{V_e + (p_{fin} + 1)}{V_n (p_0 + 1)}} - 1$ bar $p_{ini} = \frac{.....................}{1 + \frac{.....................}{.....................}} - 1$ bar = ... bar	p_{ini} = ... bar
Condition	$p_{ini} \ge p_0$ + 0.25...0.3 bar, otherwise calculation for larger nominal volume	
Percentage expansion	Between lowest temperature (-20 °C) and filling temperature (usually 10 °C) P. 7 n^*_{fill} = ... %	n^*_{fill} = ... %
Filling pressure	$p_{fill} = V_n \times \frac{p_0 + 1}{V_n - V_{sys} \times n_{fill}^* - V_{res}} - 1$ bar p_{fill} = ... × .... – 1 bar = ... litre	p_{fill} = ... bar

Results

Reflex S/10 bar .... litre	Prepressure	p_0 = ... bar
	Initial pressure	p_{ini} = ... bar
	Filling pressure	p_{fill} = ... bar
	Final pressure	p_{fin} = ... bar

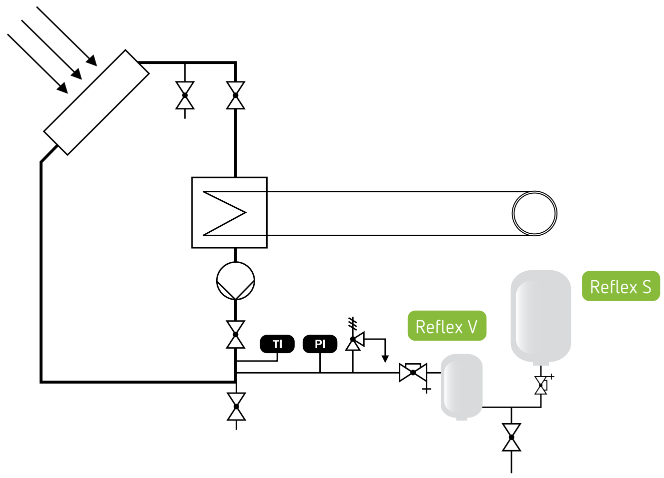
→ Check before commissioning
→ Check make-up setting
→ System refilling

Reflex S installation examples in solar thermal systems

Note for the installer

- Due to the low temperature load, the circulating pump and Reflex S are installed in the collector return line. Based on reasons for the direct protection of the collector, this necessitates the installation of the expansion vessel at the discharge side of the circulating pump.
- The pressure of this circulating pump must be taken into account when the supply pressure p_0 is calculated.
- Installation of the Reflex V intermediate vessel is not required if the temperature load at the expansion vessel or the pressure maintenance station cannot exceed the maximum operating temperature.

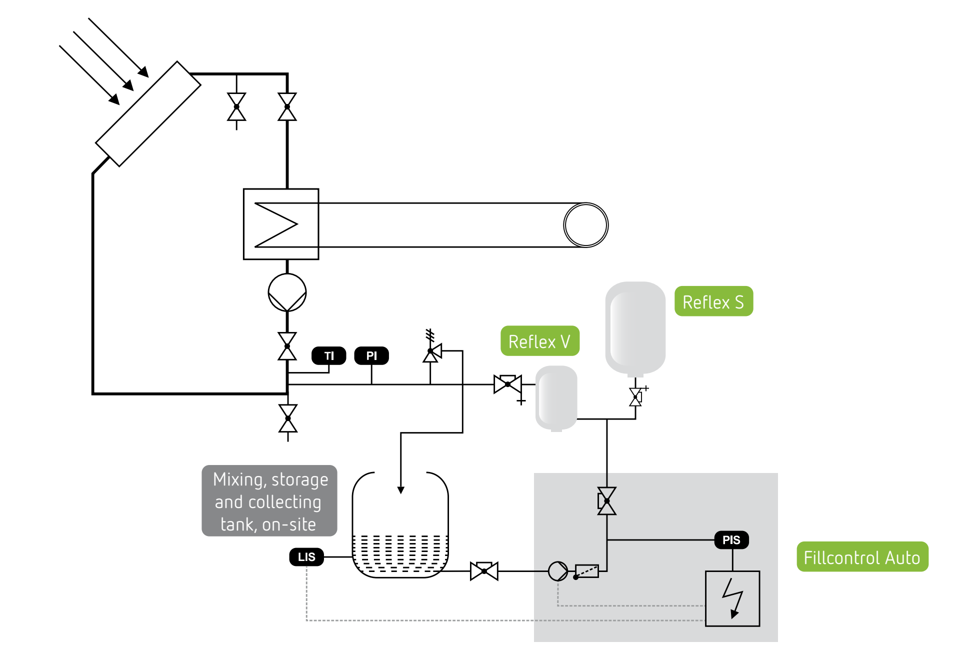
Reflex S
In a solar heating system



The diagrams are solely to illustrate the connections. They must be matched to the local conditions and substantiated.

Reflex S installation examples in solar systems

Reflex and Fillcontrol Auto
in a solar system

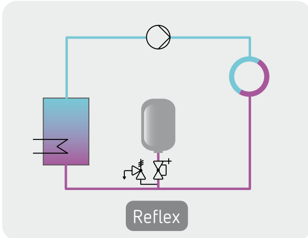


Note for the installer

- The Fillcontrol Auto can be used as a make-up option and the solar thermal fluid (glycol-water mixture) taken from a site-provided storage vessel into which the safety valve opens out.
- This vessel has three functions: it acts as storage, mixing and collecting tank simultaneously. Moreover, it must be installed on-site and unlike the Fillcontrol Auto is not supplied by Reflex.

The diagrams are solely to illustrate the connections. They must be matched to the local conditions and substantiated.

Cold water systems



Calculation Based on DIN EN 12828 and VDI 4708 Part 1.

Circuit As prepressure maintenance according to adjoining sketch with expansion vessel on the intake side of the circulating pump or also as follow-up pressure maintenance.

Material values n* Antifreeze additives, in accordance with the lowest system temperature, must be considered during the specification of percentage expansion n* in accordance with manufacturer specifications.

For more information about material values for water mixtures with Antifogen N see P. 7

Expansion volume V_e Percentage expansion n* is usually determined between the lowest system temperature (e.g. stagnation during winter -20 °C) and the highest system temperature (e.g. stagnation during summer +40 °C).

Min. operating pressure p_0 As temperatures > 100°C are not tolerated, special additions are not necessary.

→ Attention!
Enter the set prepressure on the type plate

Filling pressure p_{fill}, Initial pressure p_{ini} The lowest system temperature is frequently lower than the filling temperature, so that the filling pressure is above the initial pressure.

Pressure maintenance Generally as static pressure maintenance with Reflex expansion vessels also in combination with make-up and degassing systems. As a dynamic pressure maintenance station for pressure maintenance, degassing and make-up with Variomat or as a compressor-controlled pressure maintenance station with Reflexomat.

Degassing, venting, make-up To achieve continuously safe, automatic operation of the cold water systems, it makes sense to supplement the pressurisation facilities with Fillcontrol automatic make-up systems or with Servitec degassing and make-up systems. This is particularly important for cold water systems, as thermal degassing effects must be completely foregone.

For more information, see P. 57

Intermediate vessels Although Reflex membranes are indeed suitable for temperatures down to approximately -20 °C, and the vessels suitable for temperatures down to -10 °C, there is a possibility of the membrane "freezing" against the vessel. We therefore recommend installing a Reflex V intermediate vessel in the return flow to the chiller at temperatures ≤ 0 °C.

For more information, see P. 73

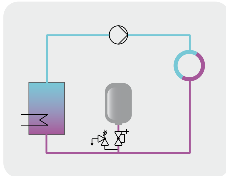
Reflex V intermediate vessel

Individual protection Analogue to heating systems, we recommend individual protection if several cooling machines apply.

For more information, see P. 11

Dimensioning Reflex N, C, F, S, G, SL in cold water systems

Circuit: Prepressure maintenance, expansion vessel on the suction side, circulating pump, with follow-up pressure maintenance Observe notes on P. 8.



Object:

Start data

Return temperature to the chiller	t_R = ... °C	
Flow temperature from the chiller	t_{in} = ... °C	
Lowest system temperature	t_{Smin} = ... °C (e.g. stagnation in winter)	
Highest system temperature	t_{Smax} = ... °C (e.g. stagnation in summer)	
Antifreeze additive	= .... %	
Percentage expansion n* P. 7	= n* ((f)t_{Smax} o. (f)t_R at highest temp.) – n* ((f)t_{Smin} o. f(t_{in}) at lowest temp.) = ... – .... = ... °C	n* = ... %
Percentage expansion between lowest temperature and filling temperature = ...°C		n_{fill}* = ... %
Static pressure	p_{st} = ... bar	p_{st} = ... bar

Pressure calculation

Prepressure	p_0 = [static pressure] p_{st} + 0.2 bar[1)] p_0 = ... + 0.2 bar[1)] = ... bar	p_0 = ... bar
Safety valve actuating pressure	p_{SV} → Reflex recommendation p_{SV} ≥ [prepressure] p_0 + 1.5 bar (for p_{SV} ≤ 5 bar) p_{SV} ≥ [prepressure] p_0 + 2.0 bar (for p_{SV} > 5 bar) p_{SV} ≥ .... + ... = ... bar	p_{SV} = ... bar
Final pressure	p_e ≤ [Safety valve] p_{SV} – [Closing differential pressure according to ISO 4126-1] p_{fin} ≤ p_{SV} – 0.5 bar (for p_{SV} ≤ 5 bar) p_{fin} ≤ p_{SV} – 0.1 bar × p_{SV} (for p_{SV} > 5 bar) p_{fin} ≤ .... – .... = ... bar	p_{fin} = ... bar

1) → Reflex recommendation

→ Check minimum inlet pressure of the circulating pump according to manufacturer specifications

→ Attention! Check compliance with permissible operating pressure

Vessel

System volume	V_{sys} Chillers : .... litre Cooling registers : .... litre Pipes : .... litre Other : .... litre = System volume V_{sysTot} : .... litre	V_{systot} = ... litre
Expansion Volume	$V_e = \frac{n^*}{100} \times V_{sys}$ = ... × .... = ... litre	V_e = ... litre
Water reserve	V_{res} = 0.005 × V_{sys} (for V_n > 15 litre with V_{res} ≥ 3 litre) V_{res} ≥ 0.2 × V_n (for V_n ≤ 15 litre) V_{res} ≥ .... × .... = ... × .... = ... litre	V_{res} = ... litre
Nominal volume **without** Servitec **with** Servitec	$V_n = (V_e + V_{res}) \times \frac{p_{fin} + 1}{p_{fin} - p_0}$ $V_n = (V_e + V_{res} + 5\ \text{litre}) \times \frac{p_{fin} + 1}{p_{fin} - p_0}$ V_n ≥ .... × .... = ... litre Selected V_n Reflex = ... litre	V_n = ... litre
Initial pressure check **without** Servitec **with** Servitec	$p_{ini} = \frac{p_{fin} + 1}{1 + \frac{V_e + (p_{fin} + 1)}{V_n (p_0 + 1)}} - 1\ \text{bar}$ $p_{ini} = \frac{p_{fin} + 1}{1 + \frac{(V_e + 5\ \text{litre})(p_{fin} + 1)}{V_n (p_0 + 1)}} - 1\ \text{bar}$ p_{ini} = ... / (1 + ... / ....) – 1 bar	p_{ini} = ... bar
Condition	p_{ini} ≥ p_0 + 0.25...0.3 bar, otherwise calculation for larger nominal volume	
Filling pressure	$p_{fill} = V_n \times \frac{p_0 + 1}{V_n - V_{sys} \times n_{fill}^* - V_{res}} - 1\ \text{bar}$ p_{fill} = ... × .... – 1 bar = ... litre	p_{fill} = ... bar

→ n_f = (f)t_F (filling temperature)

Results

Reflex ....../...... bar .... litre

Min. operating pressure	p_0 = ... bar
Initial pressure	p_{ini} = ... bar
Filling pressure	p_{fill} = ... bar
Final pressure	p_{fin} = ... bar

→ Check before commissioning
→ Check make-up setting
→ System refilling

Reflex pressure maintenance stations with external pressure generation

Reflexomat and Variomat

Circuit
In principle, the same conditions apply in respect of connection, selection and calculation as for the expansion vessels.

Heating water systems P. 11
Solar Thermal Systems P. 16
Cold water systems P. 22

Moreover, in general, use is only in the wider capacity range.
For more information, see P. 9

Nominal volume V_n
Pressurisation systems with external pressure generation are notable in that the pressure is controlled by a control unit independently of the level of filling in the expansion vessel. In this way it is possible to use nearly the entire nominal volume V_n to hold water ($V_e + V_{res}$). This is a key advantage in comparison with static pressure maintenance using expansion vessels because the nominal volume of the vessels can be designed to be significantly smaller.

Minimum operating pressure p_0, pressure monitoring
A safety allowance of 0.2 bar is recommended when calculating the minimum operating pressure in order to ensure sufficient pressure at the high points. This should only be omitted in exceptional cases because otherwise there is a risk of outgassing at the high points.

Initial pressure p_{ini}
This limits the lower target range of the pressure maintenance. If the initial pressure is undershot, the pressurisation pump or the compressor is switched on and switched off with a hysteresis of 0.2 ... 0.1 bar. The Reflex formula for initial pressure provides the necessary safety of at least 0.5 bar above the saturation pressure at the high point of a system.

Final pressure p_{fin}
It limits the upper target range of the pressure maintenance. This must be defined so that the pressure at the system safety valve is lower by at least the closing differential pressure A_{SV} in accordance with ISO 4126 Part 1. The overflow device must open by the time the final pressure is exceeded.

Working range A_D of the pressure maintenance
This is dependent on the type and is limited by the supply pressure and final pressure of the pressure maintenance unit. As a minimum, the adjacent values should be complied with.

Degassing, venting, make-up
Sealed systems in particular must be specifically vented, otherwise accumulations of nitrogen will lead to annoying operating faults and customer dissatisfaction. Variomat units are supplied as standard with make-up and degassing. It makes sense to supplement Variomat Giga and Reflexomat pressurisation units with Servitec make-up and degassing systems.
Partial-flow degassing systems are function correctly if they are incorporated in the representative main flow of the facility system.
For more information, see P. 57

Nominal volume expansion vessel

$$V_n \geq 1.1 \times (V_e + V_{res})$$

Prepressure maintenance

$$p_0 \geq p_{st} + p_{vap} + 0.2\ \text{bar}$$

Follow-up pressure maintenance

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

Initial pressure

$$p_{ini} \geq p_0 + 0.3\ \text{bar}$$

Final pressure

$$p_{fin} \geq p_{ini} + A_D$$

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

Closing differential pressure

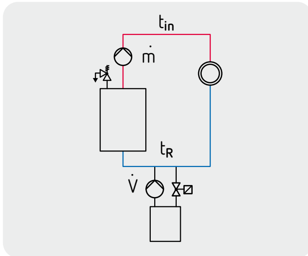
According to ISO 4126	A_{SV}
SV-H	0.5 bar
SV-D/G/H	0.1 p_{SV} 0.3 bar for p_{SV} < 3 bar

Pressure maintenance working range

	$A_D = p_{ini} - p_{fin}$
Variomat	≥ 0.4 bar
Variomat Giga	≥ 0.4 bar
Reflexomat	≥ 0.2 bar

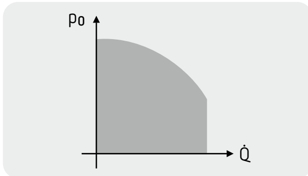
Compensation volume flow V

For heating systems that are equipped with pressurisation systems that have an external energy supply control, the compensation volume flow to be provided is dependent on the installed rated heating capacity of the heat generator.



With a homogeneous heat generator temperature of 140 °C, the specific volume flow to be provided is typically 0.85 l/kW. With evidence, e.g. based on VDI 4708 Part 1 (figure H1) the value may deviate from this.

Cooling circuits are generally operated in the temperature range < 30 °C. The compensating volume flow is approximately half as large as that in heating systems. Therefore when selecting using the diagram for heating systems, only half of the rated heating capacity $\dot{Q}$ need be considered.



To make the selection easier for you, we have prepared diagrams, from which you can determine the achievable minimum operating pressure p_0 directly dependent on the rated capacity $\dot{Q}$.

Redundancy by permanent partial load operation

To improve the partial load behaviour especially with pump-controlled systems, it makes sense, at least from 2 MW heating capacity, to use two pumps. In sectors with particularly high requirements for operating safety, the operator frequently requires a redundancy element. It makes sense to half the power per pump unit. Generally, full redundancy is not necessary if one considers that in normal operation less than 10 % of the pump and overflow capacity is required.

→ **Reflex recommendation**
from 2 MW two pump systems with dimensioning 50 % + 50 % = 100 %
→ Variomat 2-2

Variomat 2-2 and Variomat Giga systems are notable in that they are equipped not only with two pumps, but also with two overflow valves or motorized ball valves. Changeover occurs in a load and time-dependent manner as well as in the event of a fault.

Minimum pressure protection with Variomat Giga

Reflexomat Silent Compact
≤ 2 MW
compressor-controlled

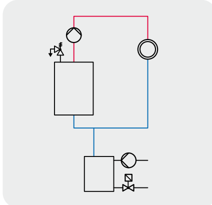
Reflexomat
≤ 24 MW
compressor-controlled

Variomat
≤ 8 MW
pump-controlled

Variomat Giga
≤ 60 MW
pump-controlled

Dimensioning, Reflexomat and Reflexomat Silent Compact in heating or cold water systems

Circuit: Prepressure maintenance, Reflexomat, Reflexomat Silent Compact in the return, circulating pump in the flow, in the event of follow-up pressure maintenance observe the information on P. 8.



Object:

Start data

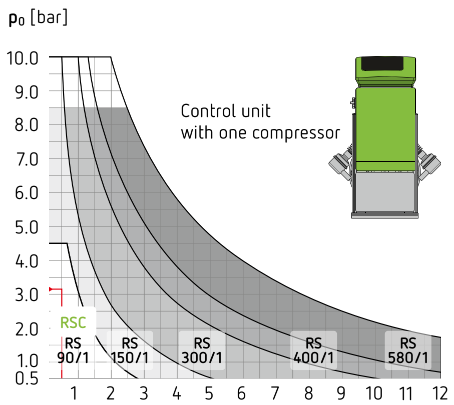
			1	2	3	4		
Heat generator								
Heating capacity	$\dot{Q}_W$		= ....kW	..........kW	..........kW	..........kW	$\dot{Q}_{Wtot}$ = ...kW	
Water content	V_W		= .... litre	.... litre	.... litre	.... litre	V_{Wtot} = ...litre	
Design flow temperature	t_{in}		= ....°C	P. 7 Approximate water content $V_{sys} = f(t_{in}, t_R, \dot{Q})$			V_{sys} = ... litre	→ at t_R > 70 °C Intermediate vessel Reflex V provided
Design return temperature	t_R		= ....°C					
Known water content	V_{sys}		= .... litre					
Highest target value setting Temperature controller	t_{TR}		= ....°C	P. 7 Percentage expansion n (with antifreeze n*)			n = ... %	→ t_{TR} max. 105 °C
Antifreeze additive			= .... %					
Safety temperature limiter	t_{safety} temperature limiter		= ....°C	P. 7 Evaporation pressure p_{vap} at temperature > 100 °C (with antifreeze p_{vap}*)			p_{vap} = ... bar	→ if 110 < $t_{safety\ temperature\ limiter}$ ≤ 120 °C Consultation with our specialist department
Static pressure	p_{st}		= .... bar				p_{st} = ... bar	

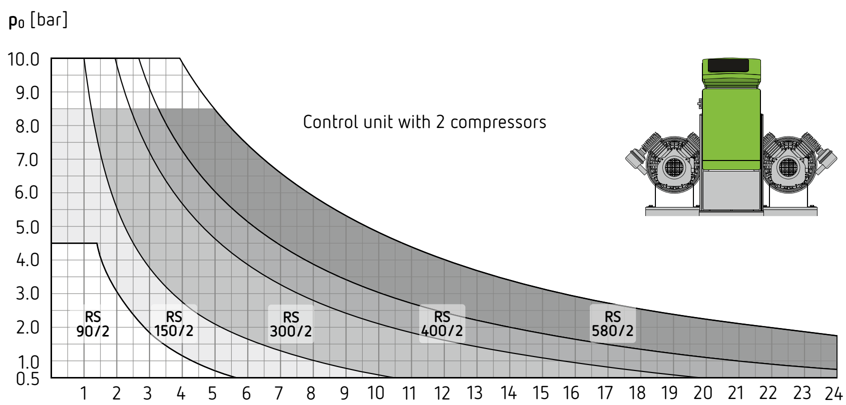
Pressure calculation

Minimum operating pressure	p_0 = [Static pressure] p_{st} + [Evaporation pressure] p_{vap} + 0.2 bar[1]	p_0 = ... bar	[1] → Reflex recommendation
	p_0 = ... + ... + 0.2 bar[1] = ... bar		
Recommendation	p_0 ≥ 1.0 bar		
Final pressure	p_{fin} ≥ [Minimum operating pressure] p_0 + 0.3 bar + [Reflexomat working range] A_D	p_{fin} = ... bar	→ Note! Working range A_D of Reflexomat preset in factory to 0.2 bar. Changeable in the Control Menu if necessary.
	p_{fin} ≥ .... + 0.3 bar + 0.2 bar = ... bar		
Safety valve actuating pressure	p_{SV} ≥ [Final pressure] p_{fin} + [Closing differential pressure] A_{SV}	p_{SV} = ... bar	→ Attention! Check compliance with permissible operating pressure
	p_{SV} ≥ p_{fin} + 0.5 bar (for p_{SV} ≤ 5 bar)		
	p_{SV} ≥ p_{fin} + 0.1 × 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 required





Total heating capacity of the heat generating system $\dot{Q}_{tot}$ [MW]

Vessel

Nominal volume	V_n taking into consideration the minimum water reserve $V_n = 1.1 \times V_{sys} \frac{n + 0.5}{100}$ = 1.1 × .... × ....= .... litre	V_n = ... litre	→ The nominal volume can be distributed across multiple vessels.

Results

Reflexomat with control unit RS	........./......	Minimum operating pressure	p_0 = ... bar
RG primary vessel	.... litre		
or Reflexomat Silent Compact RSC	.... litre	Final pressure	p_{fin} = ... bar

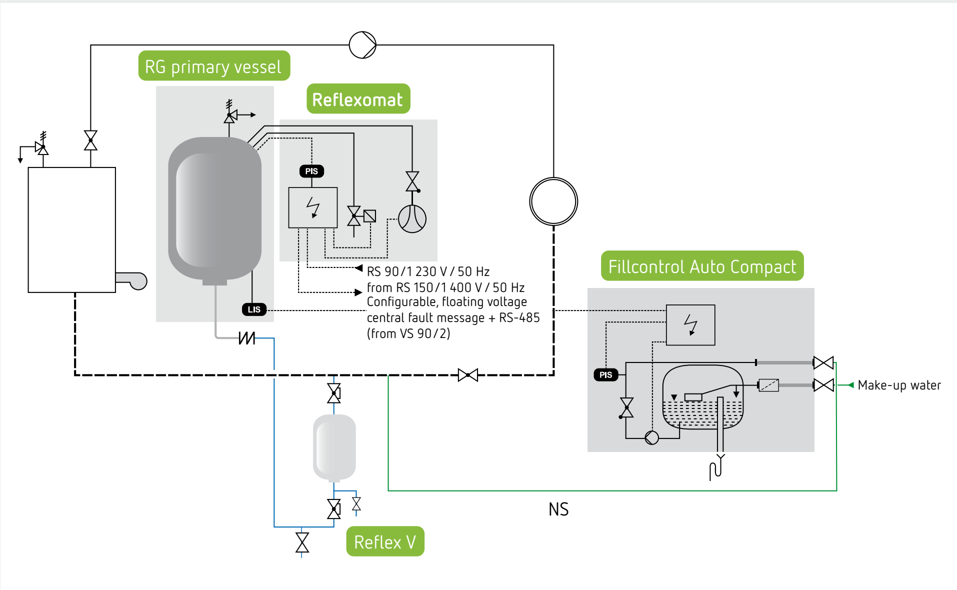
Installation examples Reflexomat in heating or cold water systems

You should select this circuit:
Reflexomat in the boiler flow — Circulating pump in the boiler return

- Direct connection of the Reflexomat with the heat generator. Low temperature loading of the membrane.
- If there is a risk of permanent loading of the membrane > 70 °C a Reflex V intermediate vessel must be installed in the expansion line.
- Install the Reflexomat on the suction side of the circulating pump, consequently reduction in the risk of vacuum formation.
- In multi-boiler systems (P. 17) both the individual protection of each heat generator with an additional expansion vessel and a common heat generator and system protection are normal.
- It must be ensured that with shut-offs provided by downstream circuits, the heat generator concerned must remain connected with at least one expansion vessel. The most favourable circuit must always be determined in cooperation with the heat generator manufacturer.

If your system differs, ask your sales engineer!

Reflexomat with RS…/1
In a single boiler system, make-up with Fillcontrol Auto Compact



Note for the installer

- The Reflexomat is integrated in the return line between the boiler shut-off and the boiler, at return temperatures > 70 °C, with a Reflex V intermediate vessel.
- Fillcontrol Auto Compact Pump make-up is set to "level control" when used in Reflexomat systems. Make-up is then carried out depending on the filling level in the RG primary vessel.
- Fillcontrol Auto Compact has an open system separator vessel and can be connected directly to the potable water system. The pump rate is 120 – 180 l/h at a delivery pressure up to 8.5 bar.

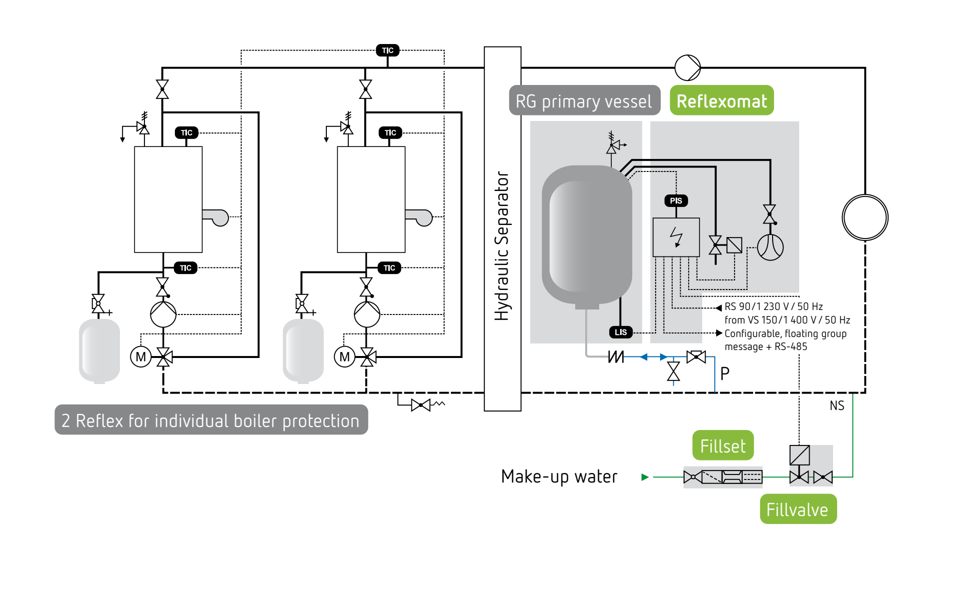
The diagrams are solely to illustrate the connections. They must be matched to the local conditions and substantiated.

Installation examples Reflexomat in heating or cold water systems

Note for the installer

- **Individual boiler protection**
  The temperature control of the burner is used to switch off the corresponding circulating pump and close the motorised valve M. Here, the boiler remains connected with the Reflex expansion vessel for boiler individual protection. This is the most common circuit with heat generators with a minimum return temperature. With the burner off, circulation across the heat generator is reliably prevented.
- **Made up without pump**
  If the make-up pressure is at least 1.3 bar higher than the final pressure of the Reflexomat, make-up can be performed directly with the Fillvalve without an additional pump. With make-up from the potable water system, the Fillset must be connected upstream as a system separation.

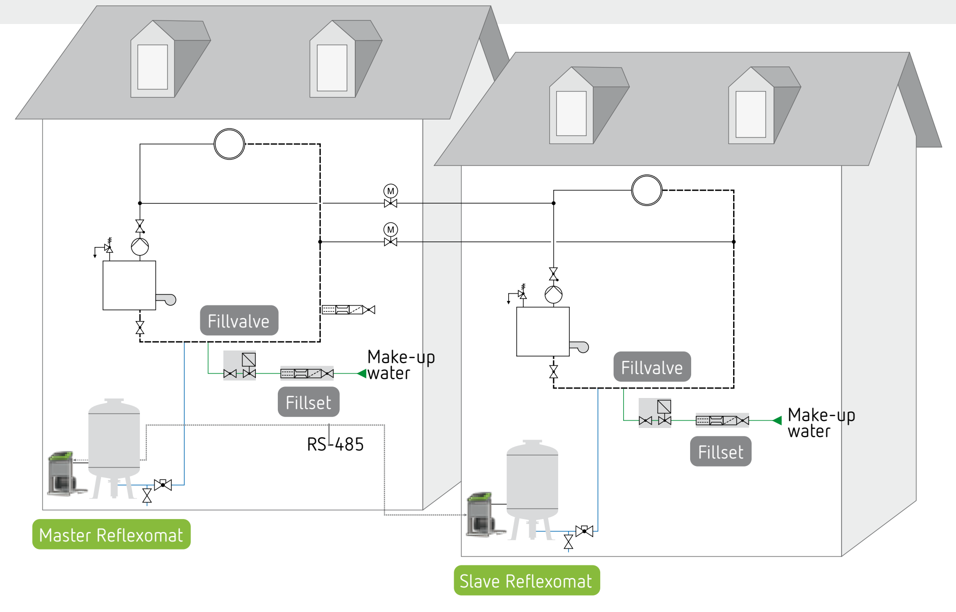
Reflexomat with RS.../1
In a multi-boiler system, make-up with Fillvalve



Note for the installer

- Are hydraulic systems to be optionally separated or driven together, then "master/slave operation" is required. Examples include the summer and winter operation of cooling and heating systems or the combination of several heat generator systems.
- So the two Reflexomats in the example can communicate with each other in composite mode (motorised valves open) in master-slave mode via the RS-485 interface, whereby the "Master Reflexomat" takes over pressure maintenance and the "Slave Reflexomat" serves only for volume compensation. In island operation (motorised valve M closed) both Reflexomats are operated independently of each other as a "master" with a pressurisation function.

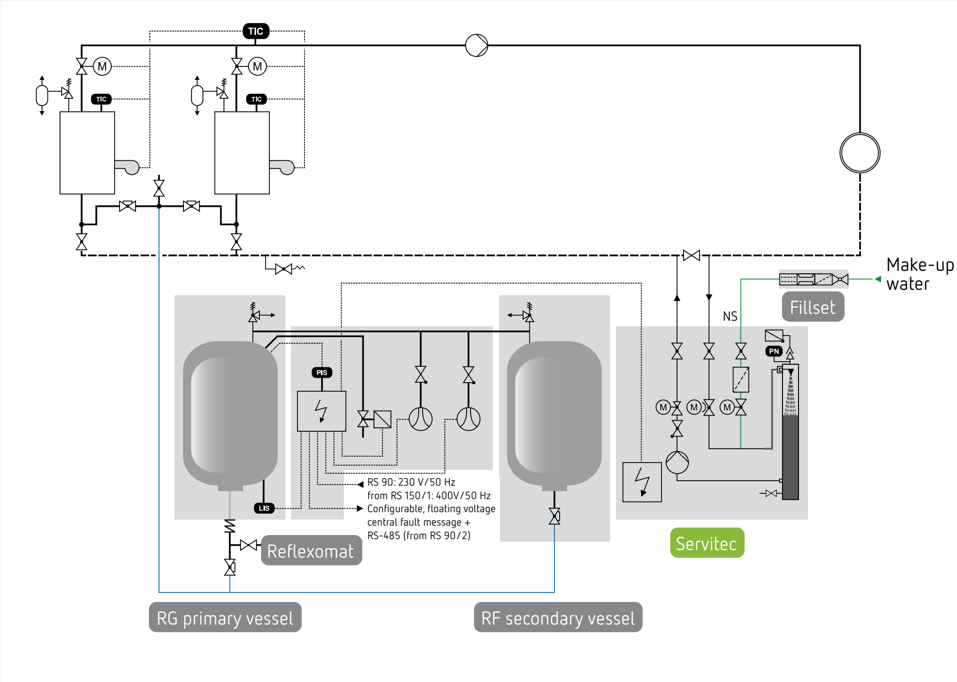
Reflexomat
in Master/Slave Operation



The diagrams are solely to illustrate the connections. They must be matched to the local conditions and substantiated.

Installation examples Reflexomat in heating or cold water systems

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



Note for the installer

- **Total boiler and system protection**
  Upon switch off of the burner, the corresponding actuator M is closed by the temperature control, without incorrect circulation via the isolated boiler being possible.

  The junction of the boiler expansion line above the boiler middle prevents gravity circulation.

  Favoured for use in systems without a minimum boiler return temperature (e.g. condensing boiler systems).

Servitec
Vacuum spray tube degassing system, model example: Servitec 60 with Control Touch

Reflexomat and Servitec — the ideal combination

Combine the Reflexomat with Servitec spray tube degassing. The combination not only removes dissolved gases from the make-up water but also ensures that the whole plant and any system water is nearly entirely gas-free. In this way circulation and noise problems resulting from free gas bubbles at system high points, circulating pumps or control valves are reliably avoided and corrosion problems effectively prevented.

This too is an argument for the combination of Reflexomat and Servitec: The pressure in the extremely degassed, bubble-free content water is "gently cushioned" by the Reflexomat.

Variomat installation notes

Extracts from using the installation, operation and maintenance manual

- Upright installation of VG and VF vessels in a frost-free, ventilated room with drainage capability.
- Positioning of the control unit VS and the vessels VG and possibly VF at the same level. Under no circumstances must the control unit be installed higher than the vessel(s).
- The weight measuring device for determining the filling level must be installed on the base of the VG primary vessel provided for this purpose.
- To ensure that the weight measuring device can function properly, VG primary vessel and the first secondary vessel VF installed must always be connected with the supplied flexible connection set.
- Do not fix the VG primary vessel to the ground, e.g. with screws.
- To optimise the energy efficiency in heating systems, VW thermal insulation is recommended for the VG primary vessel.
- Flush connection lines before commissioning!
- **Detail: Variomat connection**
  Correct degassing is only guaranteed if the Variomat is connected in a representative main volume flow of the facility system.

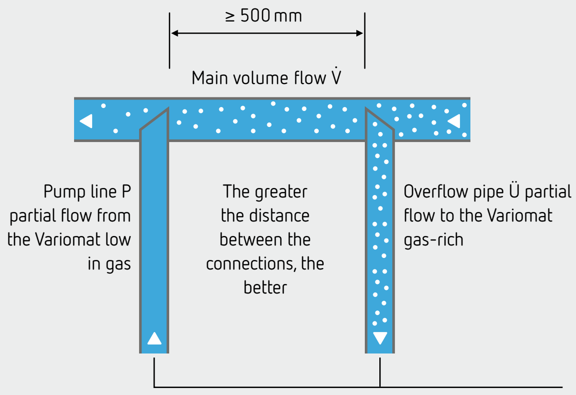
  The following minimum volume flow rates $\dot{V}_{min}$ must be adhered to for the Variomat versions during operation. (see table right)

  With a temperature difference of Δt = 20 K, this corresponds to a minimum design capacity of the consumer system of $\dot{Q}_{min}$.

Variomat type	$\dot{V}_{min}$	$\dot{Q}_{min}$
1	2 m³/h	47 kW
2-1	4 m³/h	94 kW
2-2/35	2 m³/h	47 kW
2-2/60-95	4 m³/h	94 kW

More information on the Variomat is available online under **www.reflex-winkelmann.com/en** and as well as in the Reflex Pressurisation Systems brochure.

Correct connection of a Variomat in the system



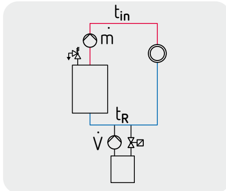
To prevent the direct penetration of coarse dirt into the Variomat, the connection pipes must be connected into the main pipe from above or, as shown, as an immersion pipe.

The dimension of the expansion lines must be selected according to P. 31.

Variomat dimensioning in heating or cold water systems

Circuit: Prepressure maintenance, Variomat in return, circulating pump in the flow, with follow-up pressure maintenance Observe information on P. 8.

Object:



Start data

		1	2	3	4	
Heat generator						
Heating capacity	$\dot{Q}_W$	= .... kW	.... kW	.... kW	.... kW	$\dot{Q}_{tot}$ = ... kW
Water content	V_W	= .... litre	.... litre	.... litre	.... litre	V_{Wtot} = ... litre
Design flow temperature	t_{in}	= .... °C	P. 7 Approximate water content $V_{sys} = f(t_{in}, t_R, \dot{Q})$			
Design return temperature	t_R	= .... °C				
Known water content	V_{sys}	= .... litre				V_{sys} = ... litre
Highest temperature controller target value setting	t_{TR}	= .... °C	P. 7 Percentage expansion n (with antifreeze additive n*)			n = ... %
Antifreeze additive		= .... %				
Safety temperature limiter	$t_{safety\ temperature\ limiter}$	= .... °C	P. 7 Evaporation pressure p_{vap} at temperature > 100 °C (with antifreeze p_{vap}*)			p_{vap} = ... bar
Static pressure	p_{st}	= .... bar				p_{st} = ... bar

→ at t_R > 70 °C Intermediate vessel Reflex V provided

→ t_{TR} max. 105 °C

→ if 110 < $t_{safety\ temperature\ limiter}$ ≤ 120 °C Consultation with our specialist department

Pressure calculation

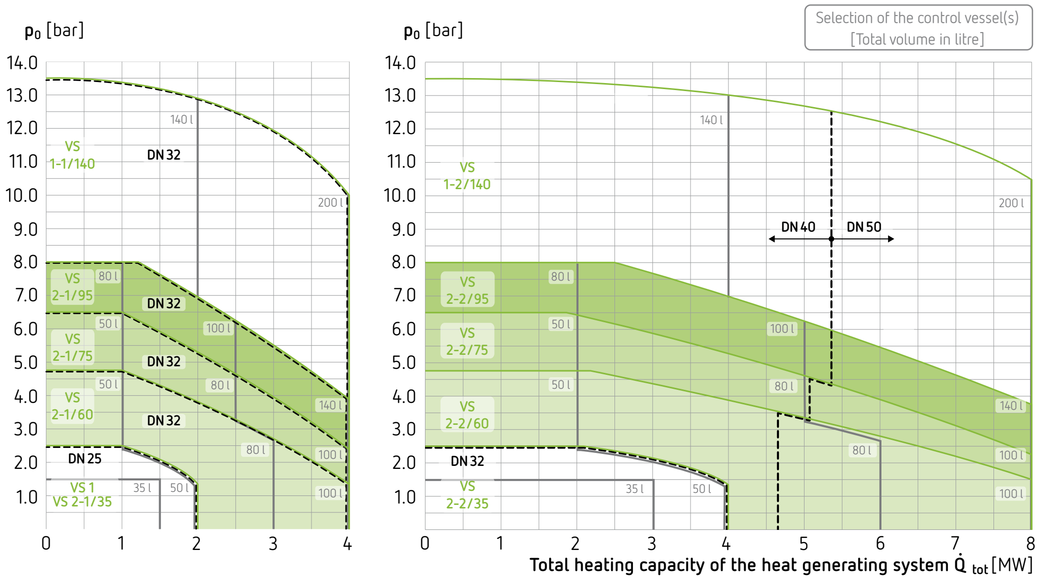
Minimum operating pressure	p_0 = [static pressure] p_{st} + [evaporation pressure] p_{vap} + 0.2 bar[1)] p_0 = ... + ... + 0.2 bar[1)] = ... bar	p_0 = ... bar
Final pressure	p_{fin} ≥ [Minimum operating pressure] p_0 + 0.3 bar + [Variomat working range] A_D p_{fin} ≥ .... + 0.3 bar + 0.4 bar = ... bar	p_{fin} = ... bar
Safety valve actuating pressure	p_{SV} ≥ [Final pressure] p_{fin} + [Closing differential pressure] A_{SV} p_{SV} ≥ p_{fin} + 0.5 bar (for p_{SV} ≤ 5 bar) p_{SV} ≥ p_{fin} + 0.1 × p_{SV} (for p_{SV} > 5 bar) p_{SV} ≥ .... + ... = ... bar	p_{SV} = ... bar

1) The greater p_0 is than p_{st}, the better the degassing function; at least 0,2 bar is required.

→ Attention! Check compliance with permissible operating pressure

Variomat VS control unit selection

Diagram valid for **heating systems**
For **cooling systems** t_{max} ≤ 30 °C only 50 % of $\dot{Q}_{tot}$ is required



	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

Expansion lines (ADL)

- See the entries in the adjacent characteristic curves
- Please observe the pressure-dependent dimensioning for two-pump systems.
- If the expansion line is > 10 long, we recommend selecting the next size up for the nominal diameter.

Variomat 2-2

- Recommended for special security of supply requirements for capacities ≥ 2 MW
- Per pump and overflow valve 50% of the total capacity
- Automatic, load-dependent connection and fault switching of pumps and overflow valves with Variomat 2-2

→ Minimum volume flow $\dot{V}$ In the system circuit at the Variomat connection point

VG

Nominal volume	V_n taking into consideration the minimum water reserve $V_n = 1.1 \times V_{sys} \times \frac{n + 0.5}{100}$ = 1.1 × .... × .... = ... litre	V_n = ... litre

→ The nominal volume can be divided across multiple vessels.

Results

Variomat	.... litre	
VG primary vessel	.... litre	
VF secondary vessel	.... litre	
VW thermal insulation (for heating systems only)	.... litre	
Minimum operating pressure	p_0	= .... bar
Final pressure	p_{fin}	= .... bar

Note:
Due to the good degassing performance of the Variomat use of a Reflex expansion vessel for individual protection of the heat generator is generally recommended. With appropriate dimensioning, the latter also takes over the absolutely necessary control vessel volume, provided that the total of the expansion vessel individual protection rated volumes ≥ the necessary control vessel volume.

Variomat installation examples in heating or cold water systems

Individual protection: Due to the high degassing capacity of the Variomat, the installation of an expansion vessel (e.g. Reflex N) at the heat generator is recommended in order to minimise switching frequency, even with single boiler systems.

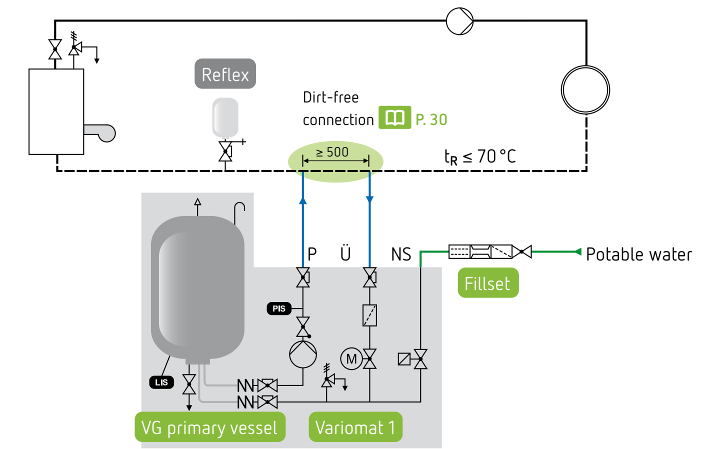
Connection in the system: To avoid the ingress of coarse dirt and the overloading of the Variomat dirt trap, the connection must be made according to the above diagram of P. 30. The heating system pipelines and the potable water make-up must be flushed prior to commissioning.

Make-up connection pipe: With direct connection of the make-up line to a potable water system, a Fillset (shut-off valves, system separator, water meter, dirt trap) must be connected upstream of the connection to provide system separation according to standards. If a Fillset is not installed as a minimum a dirt trap with a ≤ 0.25 mm mesh must be fitted to protect the make-up solenoid valve. The pipe between the dirt trap and solenoid valve must be kept as short as possible and must be flushed prior to commissioning.

Note for the installer

- You do not need to fit any additional cap valves in the expansion line.
- Fillset with integral system separator must be connected upstream when connecting to the potable water system.
- For expansion lines longer than 10 m, we recommend that the nominal diameter be increased by one size, e.g. DN 32 instead of DN 20. P. 31

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



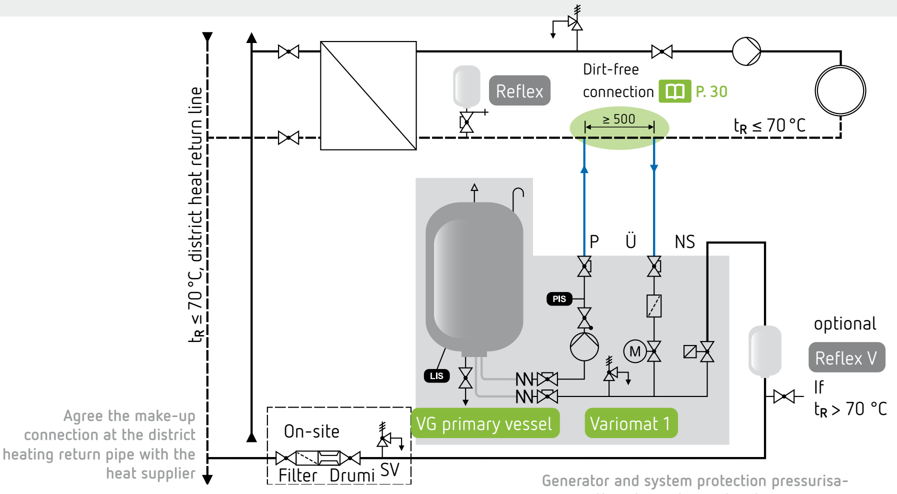
Boiler and system protection;pressurisation, degassing and make-up

Connection of the make-up feed directly to the potable water system

Note for the installer

- In general district heat water is ideally suited as make-up water. Water treatment is not necessary.
- Agreement with the heat supplier is necessary! Observe the connection requirements!
- For expansion lines longer than 10 m, we recommend that the nominal diameter be increased by one size, e.g. DN 32 instead of DN 20. P. 31
- **Building automation:** For special requirements, e.g. in respect of district heat, an optional extension module (I/O module) with 6 digital inputs and 6 floating output contacts plus analogue pressure and level outputs are available. **Please contact us.**

Variomat 1
In a district heating house substation, make-up via district heating return



Generator and system protection pressurisation, degassing and make-up

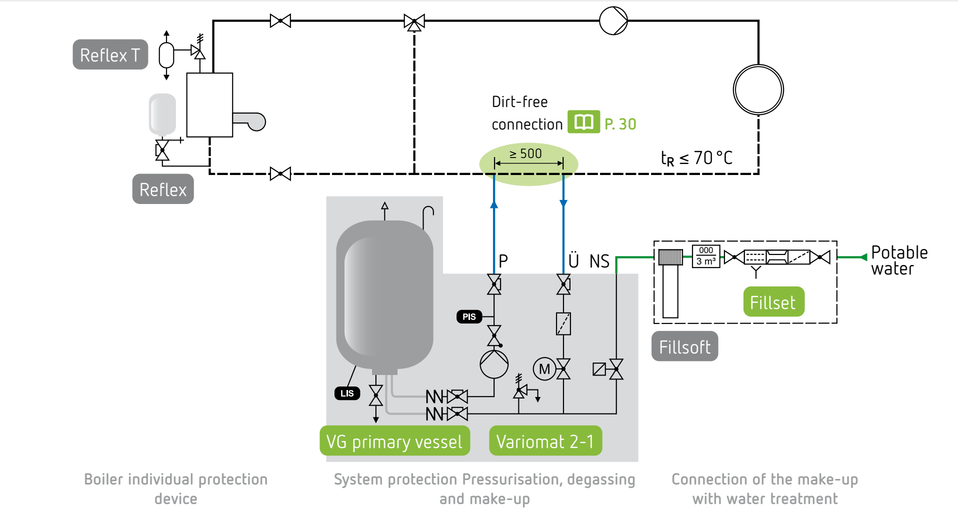
The diagrams are solely to illustrate the connections. They must be matched to the local conditions and substantiated.

Variomat installation examples in heating or cold water systems

Special features of Variomats Type 2 and 2-2

	Softstart	Electrical main switch	Load-dependent switching on	Fault switching
Variomat type 1	-	-	-	-
Variomat type 2	✓	✓	-	-
Variomat type 2-2	✓	✓	✓	✓

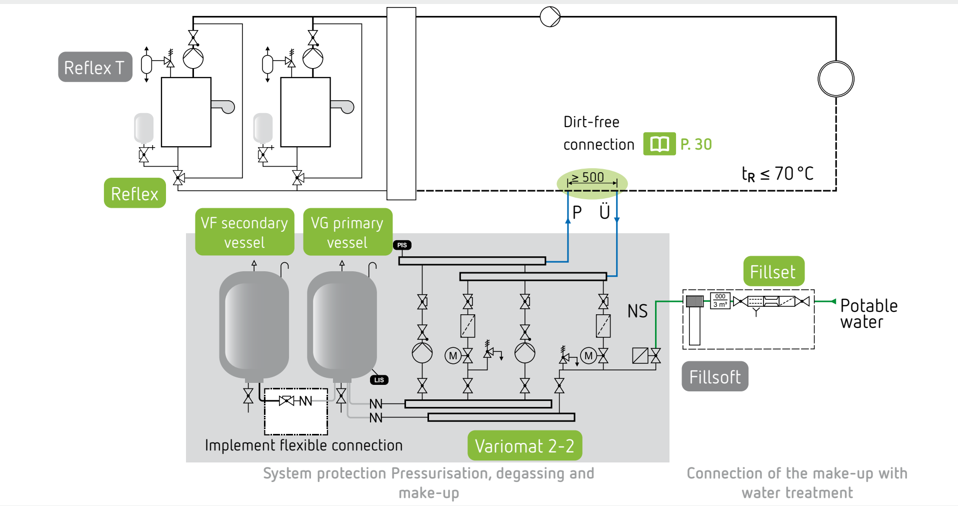
Variomat 2-1 in a system with central return addition, Fillset make-up with Fillsoft water treatment



Note for the installer

- The Variomat must always be connected in the main volume flow, so that a representative partial flow can be degassed. With central return addition this is the system side. In this case the boiler is then fitted with an individual protection.
- If the capacity of the Fillset is exceeded (k_{VS} = 1 m³/h), then the user must provide an alternative equivalent connection set for the make-up line on-site. The mesh size of the filter must not exceed 0.25 mm. P. 31

Variomat 2-2 In a multi boiler system, return > 100 °C, make-up via a water softening system



Note for the installer

- For water treatment systems the Fillset is installed with a system separator and water meter upstream of the corresponding facility.
- For multi boiler systems, provide individual protection with Reflex.
- Multiple VF secondary vessels can be connected.
- Make a flexible connection between the VG primary vessel and the first VF secondary vessel so that weight measurement at the VG is not influenced.

The diagrams are solely to illustrate the connections. They must be matched to the local conditions and substantiated.

District heating, large-scale and special plants

Calculation The usual approach for heating systems, such as specified in DIN EN 12828, is frequently not applicable for district heating systems. For plants subject to mandatory inspection, we therefore recommend consulting the network operator and official expert. Contact our technical sales department for special systems!

Circuit Circuit deviating from standard heating engineering is frequently preferred for district heating plants. Apart from traditional prepressure maintenance, systems with holding and average pressure maintenance are also applied. This, in turn has an impact on the calculation process.

Material values n, p_{vap} In this case, material values are usually used for pure water without antifreeze additives.

Expansion volume V_e Due to the frequently very large system volumes and the fewer day and weekend temperature fluctuations in comparison to heating systems, calculation approaches are used which deviate from DIN EN 12828 and frequently result in smaller expansion volumes. When specifying the expansion coefficient, both the temperatures in the network supply and the network return are therefore taken into consideration. In extreme cases, the calculation is only based on the temperature fluctuations between supply and return flow.

Minimum operating pressure p_0 This must be adjusted to the safety temperature of the heat generator and determined in such a way, that the permissible quiescent and working pressure is not exceeded or undershot at any point in the network and no cavitation occurs at the pumps and regulating valves.

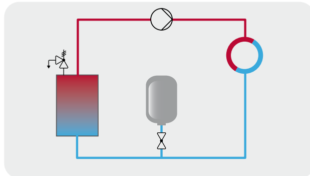
Initial pressure p_{ini} In pressure maintenance stations, the pressurisation pump is actuated when the pressure drops below the initial pressure. Dynamic run-up and run-down actions must be observed, especially in networks with large circulating pumps. The difference between p_{ini} and p_0 (= DB_{min}) should then be at least 0.5 to 1 bar.

Pressure maintenance In larger networks, almost exclusively as pressure maintenance with external pressure generation, such as Variomat, Variomat Giga, Reflexomat Silent Compact or Reflexomat. The special requirements of DIN EN 12952, DIN EN 12953 or taken from TRD 604 sheet 2 can be applied for operating temperatures above 105 °C or safety temperature limiter safety temperatures > 110 °C.

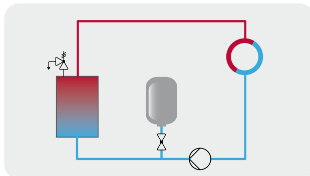
Degassing Heat generation systems without a thermal degassing system should be equipped with a Servitec vacuum spray-tube degassing system.

→ Special pressure maintenance
Please contact technical sales.

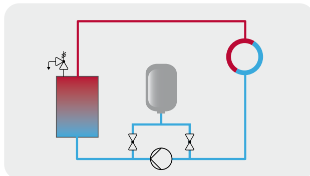
Prepressure maintenance



Follow-up pressure maintenance

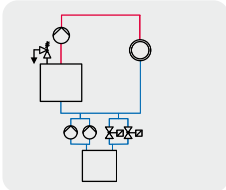


Medium pressure maintenance



Dimensioning Variomat Giga in district heating, large-scale and special plants

Circuit: Prepressure maintenance, Variomat Giga in return, circulating pump in the flow, with follow-up pressure maintenance Observe information on P. 8.



Object:

Start data

Heat generator		1	2	3	4		
Heating capacity	$\dot{Q}_W$	= .... kW	.... kW	.... kW	.... kW	$\dot{Q}_{tot}$	= .... kW
Water content	V_W	= .... litre	.... litre	.... litre	.... litre	V_{Wtot}	= .... litre
System water content	V_{sys}	= .... litre	P. 7 approximate water content $V_{sys} = f(t_{in}, t_R, \dot{Q})$			V_{sys}	= .... litre
Highest target value setting Temperature controller	t_{TR}	= .... °C	P. 7 Percentage expansion n (with antifreeze additive n*)			n	= .... %
Antifreeze additive		= .... %					
Safety temperature limiter	$t_{safety\ temperature\ limiter}$	= .... °C	P. 7 Evaporation pressure p_{vap} at temperatures > 100 °C (with antifreeze p_{vap}*)			p_{vap}	= .... bar
Static pressure	p_{st}	= .... bar				p_{st}	= .... bar

→ at t_R > 70 °C Intermediate vessel Reflex V provided

→ t_{TR} max. 105 °C

→ if 110 < $t_{safety\ temperature\ limiter}$ ≤ 120 °C Consultation with our specialist department

Pressure calculation

Minimum operating pressure

p_0 = [static pressure] p_{st} + [evaporation pressure] p_{vap} + 0.2 bar[1)]

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

Condition p_0 ≥ 1.3 bar

[1)] → Reflex recommendation

Final pressure

p_{fin} ≥ [Minimum operating pressure] p_0 + 0.3 bar + [Variomat Giga working range] A_D

p_{fin} ≥ .... + 0.3 bar + 0.4 bar = ... bar p_{fin} = ... bar

Safety valve actuating pressure

p_{SV} ≥ [Final pressure] p_{fin} + [Closing differential pressure] A_{SV}

p_{SV} ≥ p_{fin} + 0.5 bar (for p_{SV} ≤ 5 bar)

p_{SV} ≥ p_{fin} + 0.1 × p_{SV} (for p_{SV} > 5 bar)

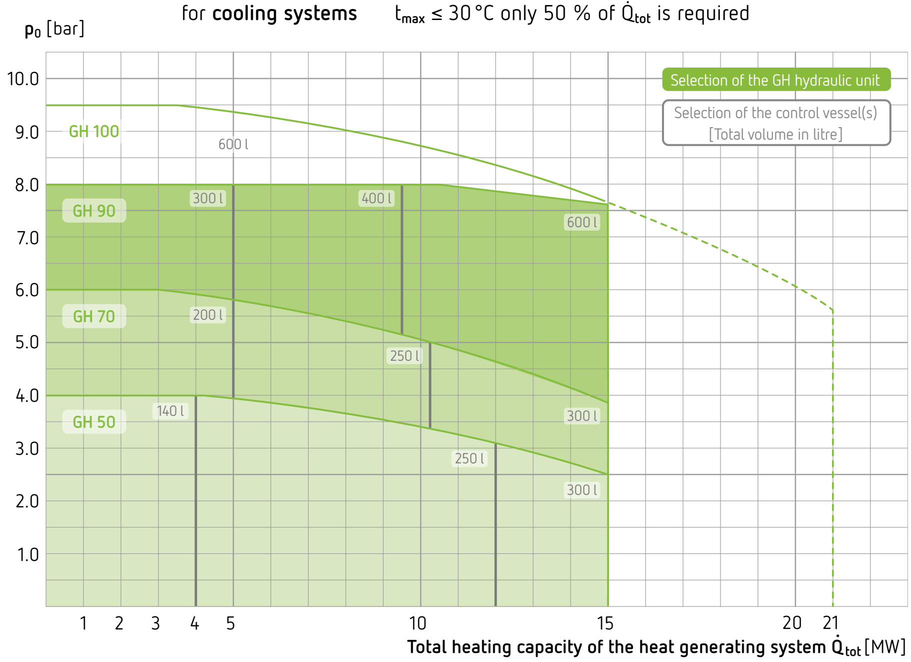
p_{SV} ≥ .... + ... = ... bar p_{SV} = ... bar

→ Attention! Check compliance with permissible operating pressure

Control unit selection

Diagram valid for **heating systems safety temperature limiter ≤ 120 °C**

for **cooling systems** t_{max} ≤ 30 °C only 50 % of $\dot{Q}_{tot}$ is required



→ Systems outside the presented capacity ranges – on request, please contact our technical sales department.

Vessel

Nominal volume V_n taking into consideration the minimum water reserve

$V_n = 1.1 \times V_{sys} \frac{n + 0.5}{100} = 1.1 \times$ .... × .... = ... litre V_n = ... litre

→ The nominal volume can be divided across multiple vessels.

Results

GH hydraulic unit ....

GG primary vessel .... litre

GF secondary vessel.................. litre

Minimum operating pressure p_0 = ... bar

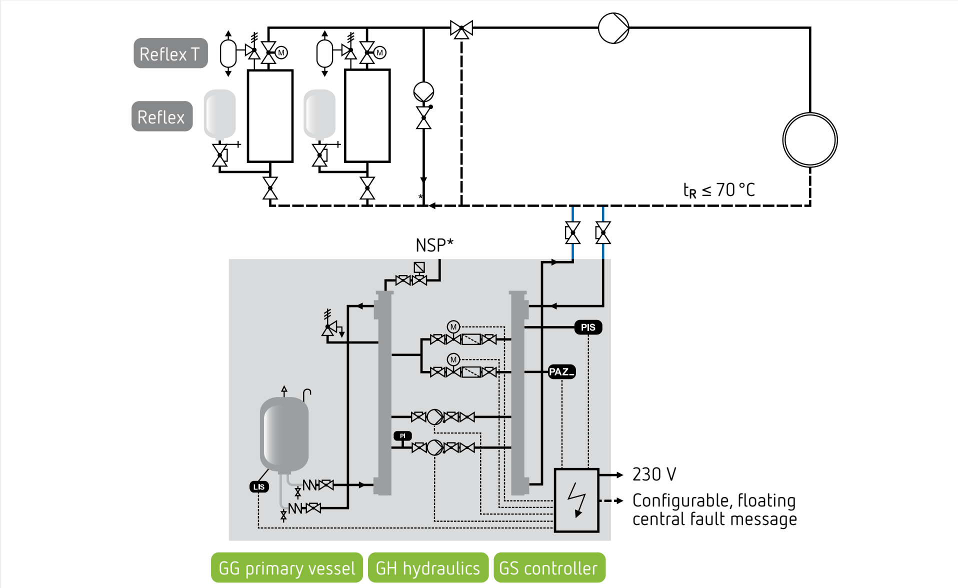
Final pressure p_{fin} = ... bar

Installation examples Variomat Giga in district heating, large-scale and special plants

Note for the installer

- Installation of the Variomat Giga upstream of the connection point of the return temperature raising facility (seen in the direction of flow) is recommended in order to minimise the temperature load on the vessel membrane.

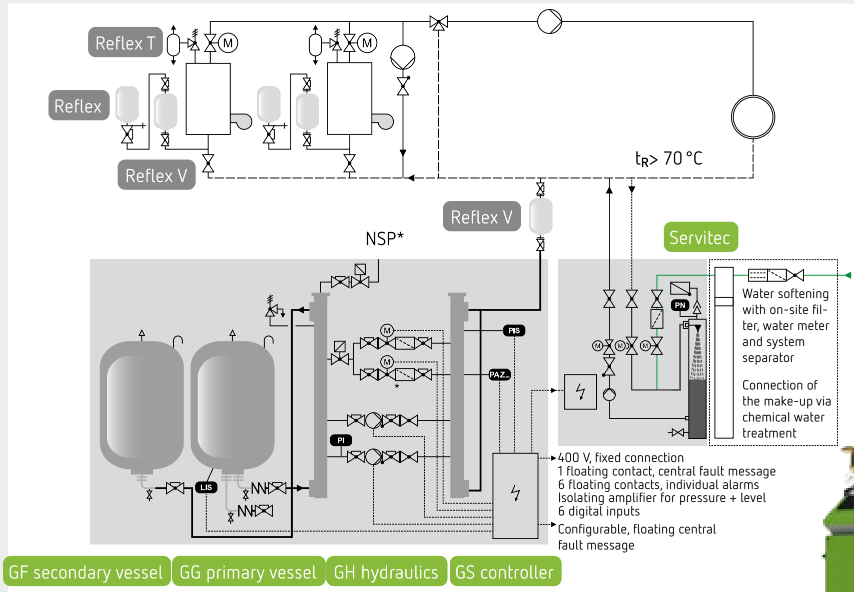
Variomat Giga up to $T_R \leq 105\,°C$ with GH hydraulics and controller GS 1,1 in a multi-boiler system, return temperature ≤ 70 °C



Note for the installer

- Due to the low temperature load of the Variomat Giga in multi-boiler systems with a Hydraulic Separator, it is recommended that the expansion line be connected on the consumer side and that a boiler individual protection device be provided.
- With Variomat Giga, the minimum pressure protection PAZ is provided by an additional solenoid valve, which is switched by the station's own minimum pressure limiter.
- Variomat Giga systems are primarily used in larger capacity ranges. Here (Return > 70 °C), we recommend the use of Servitec spray pipe degassing for active corrosion protection, as a central "network venting point" and for central make-up.

Variomat Giga up to $T_R \leq 105\,°C$ with GH hydraulics and controller GS 3 in a multi-boiler system, return temperature > 70 °C (with Servitec degassing unit)



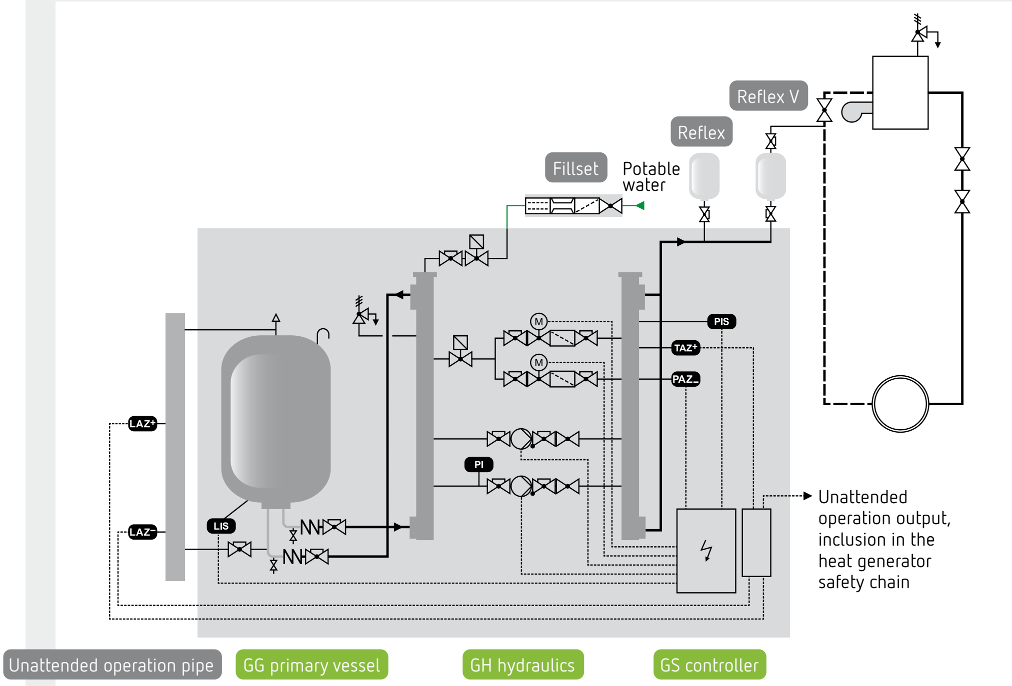
Servitec
Vacuum spray tube degassing

* When using Servitec systems, the NSP make-up connection on the Variomat Giga must be closed, as replenishment takes place directly via the Servitec into the network.

The diagrams are solely to illustrate the connections. They must be matched to the local conditions and substantiated.

Installation examples Variomat Giga in district heating, large-scale and special plants

Variomat Giga greater than T_R > 105 °C with unattended operation 72 h based on TRD 604 Sheet 2 (without degassing function Return > 70 °C)



Note for the installer

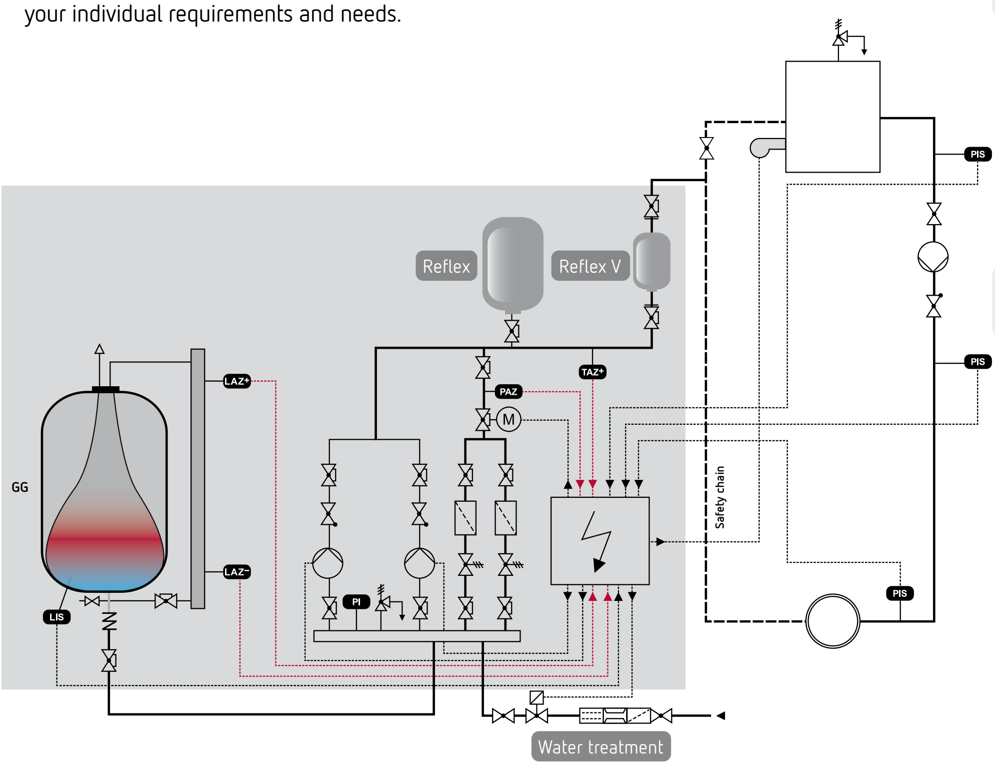
- Up to capacities of 30 MW, a standardised range is available, also for use in systems above 105 °C with unattended operation in accordance with TRD 604 Sheet 2, DIN EN 12952 and 12953. The selection of the Variomat Giga and the corresponding accessory technology is carried out on a project-by-project basis in agreement with Reflex.
- A temperature protection device **TAZ**, which triggers the safety circuit if a set temperature is exceeded (usually > 70 °C), is integrated alongside the pressure measurement **PIS** and pressure relief device **PAZ**.

The diagrams are solely to illustrate the connections. They must be matched to the local conditions and substantiated.

Customized solutions of Variomat Giga (with TÜV accreditation)

Customized solutions of Variomat Giga
explained using an example of average pressure maintenance

Customized solutions of Variomat Giga are tailored to your individual requirements and needs.



---- Red signal lines
= Safety circuit with shut-down of heat generation

Variomat Giga special control unit with electric overflow valves, electric actuator and PLC

PIS Average, intake, follow-up pressure maintenance

Especially in the case of complicated network pressure ratios, it may be necessary to use average pressure maintenance instead of conventional intake or follow-up pressure maintenance.

P. 34

PAZ – Minimum pressure monitoring

If the minimum operating pressure on the type-tested minimum pressure limiter is undershot PAZ–, the electrical actuator in the overflow pipe is closed and heat generation is switched off. The minimum pressure limiter must be installed in the expansion line, in an average pressure maintenance regime.

LAZ ± Operation based on TRD 604 Sheet 2

For systems with TAZ+ >110 °C and unattended operation, the water level in the expansion vessels is monitored with additional type-tested water level probes.

TAZ+ Temperature monitoring

In TAZ+ systems, a safety temperature limiter is installed downstream of the intermediate vessel, which is integrated into the safety chain.

Pressure maintenance

in potable water systems

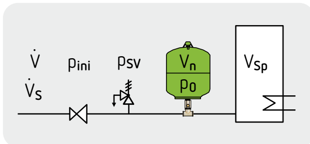
Refix expansion vessels in water heating systems

Potable water is a food! Expansion vessels in potable water installations must therefore comply with the special requirements of DIN 4807 Part 5. Only "flow-through" vessels are permitted.

Calculation According to DIN 4807 Part 5. See form P. 40

Circuit According to the adjoining sketch.
The safety valve is usually installed immediately at the cold-water inlet of the water heater. With Refix DD and DT, the safety valve may also be installed in the direction of flow directly upstream of the flow through valve provided the following conditions are met:

Refix DD with T-piece:	Rp ¾	max. 200 l water heater
	Rp 1	max. 1.000 l water heater
	Rp 1¼	max. 5.000 l water heater
Refix DT flow through valve:	Rp 1¼	max. 5,000 l storage water heater



Material values n, p_{vap} Generally, determination between the cold water temperature 10 °C and the maximum hot water temperature 60 °C. Optionally consider phases with higher temperatures, e.g. during thermal disinfection.

Prepressure p_0, Minimum operating pressure The minimum operating pressure or prepressure p_0 in the expansion vessel must be at least 0.2 bar below the minimum flow pressure. Supply pressure settings from 0.2 to 1.0 bar below the setting pressure of the pressure reducer may be required, depending on the distance between the pressure reducer and the Refix.

→ Attention!
Enter the set prepressure on the type plate

Initial pressure p_{ini} This is identical to the setting pressure of the pressure reducer. Pressure reducers are specified according to DIN 4807 Part 5 to attain a stable initial pressure and therefore full Refix capacity.

Refix vessels

Expansion vessel In systems with potable water utilisation according to DIN 1988, only Refix flow-through vessels according to DIN 4807 T5 may be used. Refix with one connection are sufficient for non-potable water.

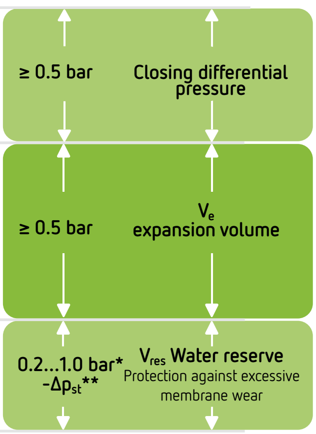
System pressures

p_{SV} Safety valve actuating pressure
The maximum permissible operating overpressure of all components in the system must not be exceeded.

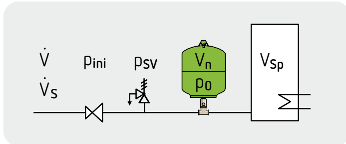
p_{fin} Final pressure
Pressure in the hot water storage tank after full heating

p_{ini} Initial pressure
Set value at pressure reducer, minimum flow pressure

p_0 Minimum operating pressure
= p_{ini} – 0.2 bar* – Δp_{st}**
* at long distances (pressure drop) from the pressure reducer, increase the difference to 1 bar
** -Δpst = static pressure drop with a vessel located higher than the pressure reducer
+Δpst = static pressure increase with vessel located lower than the pressure reducer



Dimensioning Refix in water heating systems



Object:

Start data

Tank volume	V_{Sp}	= .... litre		
Heating capacity	$\dot{Q}$	= ....kW		
In the hot water storage tank	t_{HW}	= ....°C	As per controller setting 50...60 °C	
			P. 7 Percentage expansion n	n = ... %
Pressure reducer setting pressure	p_{ini}	= .... bar		
Safety valve actuating pressure	p_{SV}	= .... bar	Reflex recommendation: p_{SV} = 10 bar	
Peak flow	$\dot{V}_S$	= .... m³/h		

Selection of tank volumes V_n

Prepressure p_0 = [Pressure reducer setting pressure] p_{ini} – (0.2...1.0 bar)

p_0 = ... – .... = ... bar

p_0 = ... bar

→ Set prepressure 0.2 - 1.0 bar below pressure reducing value (depending on distance between pressure reducer and Refix)

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

V_n = ... = ... litre

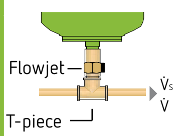
Selected = ... litre

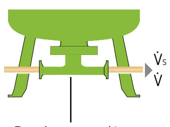
V_n = ... litre

Checking of the selection after the peak volume flow

When the nominal volume of the Refix has been selected, you must check as to whether the peak volume flow $\dot{V}_s$, resulting from the pipe system calculation to DIN 1988 can be realised at the Refix for flow-through vessels.

If this is note the case, a Refix DT 60 litre must be used instead of a 8-33 litre vessel for Refix DD to ensure a larger flow. Alternatively, you may use a Refix DD with a correspondingly larger T-piece.





	Recommended max. peak volume flow $\dot{V}_S$*	Actual Pressure loss at volume flow $\dot{V}$
Refix DD 8 – 33 litre With or without Flowjet Passing T-piece Rp ¾ = standard T-piece Rp 1 (on-site)	≤ 2.5 m³/h ≤ 4.2 m³/h	$\Delta p = 0.03\ bar \left(\frac{\dot{V}\ [m^3/h]}{2.5\ m^3/h}\right)^2$ Negligible
Refix DT 60 – 500 litre With Flowjet Rp 1¼	≤ 7.2 m³/h	$\Delta p = 0.04\ bar \left(\frac{\dot{V}\ [m^3/h]}{7.2\ m^3/h}\right)^2$
Refix DT 80 – 3,000 litre Dual connection DN 50	≤ 15 m³/h	$\Delta p = 0.14\ bar \left(\frac{\dot{V}\ [m^3/h]}{15\ m^3/h}\right)^2$
Dual connection DN 65	≤ 27 m³/h	$\Delta p = 0.11\ bar \left(\frac{\dot{V}\ [m^3/h]}{27\ m^3/h}\right)^2$
Dual connection DN 80 Dual connection DN 100	≤ 36 m³/h ≤ 56 m³/h	Negligible
Refix DE, DC (non water-carrying)	Unlimited	Δp = 0

*calculated for a speed of 2 m/s

Δp = ...bar

G = ...

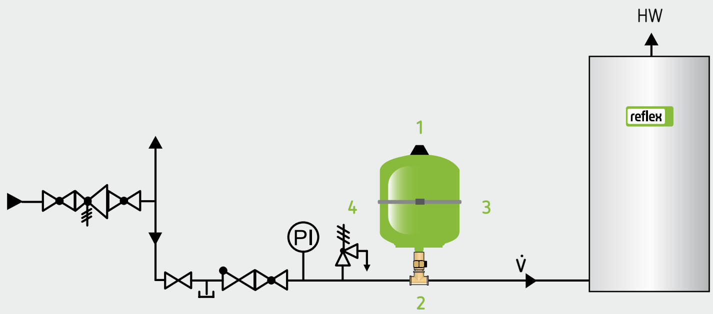
Results

Refix DT .... litre			
Refix DD .... litre, G = ... (Standard Rp ¾ supplied)	Nominal volume	V_n = ... litre
	Prepressure	p_0 = ... bar
Refix DT .... litre		

Installation examples Refix in water heating systems

Citation from DIN 4807 Part 5:
"To carry out maintenance and checking of the gas prepressure... a ... secured shut-off valve with a draining capability must be installed."
"For safe continuous operation ... maintenance must be carried out at least annually with checking of the set prepressure."
Prepressure p_0 of the Refix 0.2 ... Set 1 bar below the pressure reducer set value.

Refix DD, DT 60 – 500 with Flowjet flow through valve

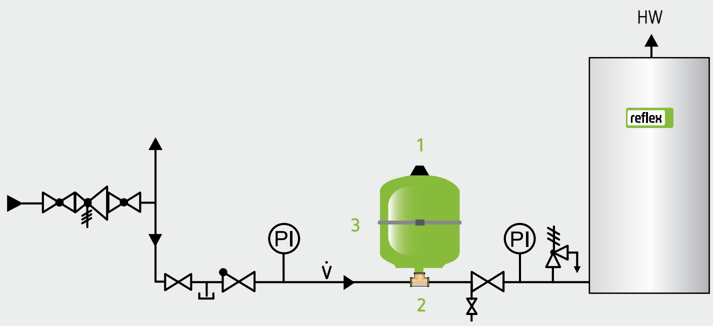


Complete solution with Flowjet flow through valve

Advantage: With Flowjet, your installation will be easy and DIN-compliant. Shut-off, draining and flow through the Refix are ensured.

1 Refix DD or Refix DT 60 – 500
2 Flowjet flow through valve with Refix DD optional as an accessory: Standard with T-piece Rp ¾, V̇ ≤ 2.5 m³/h with T-piece Rp 1, V̇ ≤ 4.2 m³/h with Refix DT 60 – 500 with Flowjet: Standard with Rp 1¼, V̇ ≤ 7.2 m³/h
3 Reflex wall mount for 8 – 25 litre (33 l with butt straps, DT with feet)
4 A safety valve may also be used in the direction of flow upstream of the Refix DD or DT with Flowjet, provided that the nominal diameter of the required SV is ≤ that of the downstream tank supply line.

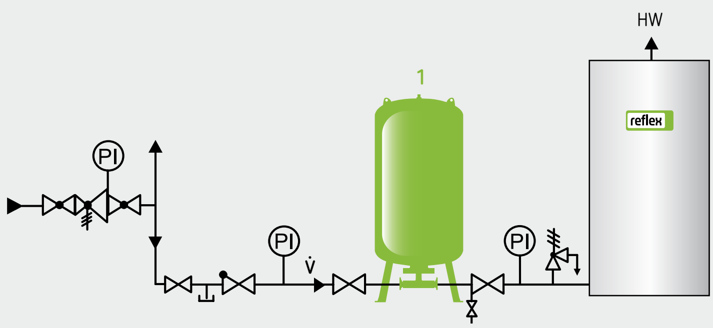
Refix DD without Flowjet flow through valve



Without a Flowjet flow through valve, the supply line to the storage water heater must be shut-off during maintenance work and the Refix DD must be emptied via a site-provided valve.

1 Refix DD
2 T-piece Rp ¾, V̇ ≤ 2.5 m³/h with T-piece Rp 1, V̇ ≤ 4.2 m³/h
3 Reflex wall mount for 8 – 25 litre (33 l with butt straps)

Refix DT with Duo connection



Additional valves are required to shut-off and drain the Refix DT with Duo-connection.
The safety valve at the cold-water inlet of the water heater in such a way that it cannot be shut-off.

1 Refix DT with Duo connection

Refix expansion vessels in pressure booster systems

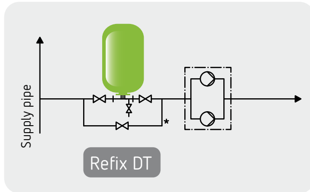
Calculation

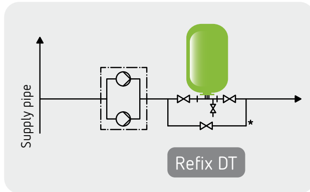
According to DIN 1988-500, Codes of practice for potable water installations, a pressure or suction-side expansion vessel is not required for booster systems with speed-controlled pumps. Nevertheless, their use is recommended for stable operation, especially in the lower partial load range. Calculation is based on the storage volume specification.

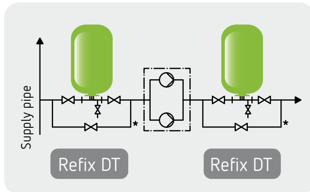
See form P. 43 or based on the defined storage volume specification.

Optionally, for PBSs, which do not work with speed-controlled pumps, a calculation can be performed according to the no longer valid DIN 1988 Part 5.

See form P. 43







Circuit

Refix expansion vessels relieve the connection pipe and the supply mains on the **PBS inlet side**. Utilisation must be coordinated with the water supply company.

Refix installation on the **downstream side of a PBS**, will reduce the switching frequency, especially in cascade-controlled systems.

Bilateral PBS installation may also be necessary.

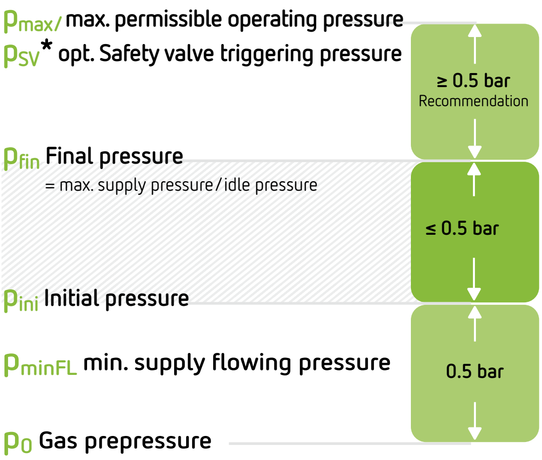
* For reasons of operating safety, especially in the case of maintenance, a bypass on the vessel may be useful. The same applies to volume flows that cannot be handled by the vessel connection alone. In potable water systems, this must be hydraulically adjusted with the main connection to avoid stagnation and must always be open during operation.

→ Attention!
Enter the set prepressure on the type plate

Prepressure p_0, initial pressure p_{ini}

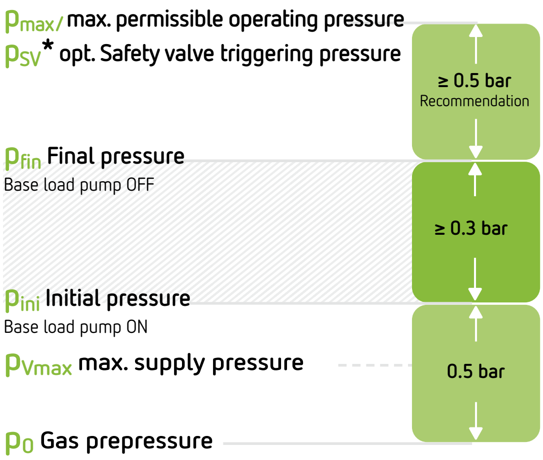
The minimum operating pressure or prepressure p_0 in the Refix must be set to approximately 0.5 ... 1 bar below the minimum supply pressure when installing on the inlet side. When installed on the discharge side of the PBS, the prepressure must be 0.5 ... 1 bar below the cut-in pressure of the base load pump. As the initial pressure p_a is at least 0.5 bar higher than the prepressure, there is always a sufficient water reserve, an important prerequisite for low-wear operation. In systems with potable water utilisation according to DIN 1988, only Refix flow-through vessels according to DIN 4807 T5 may be used. Refix with one connection are sufficient for non-potable water.

Refix in booster systems
Suction side



* Safety valve only required if temporarily $p_{fin} > p_{max}$

Refix in booster systems
pressure side



* Safety valve only required if $p_{Vmax} + \Delta p_{pump} > p_{max}$

Dimensioning Refix expansion vessels in pressure booster systems

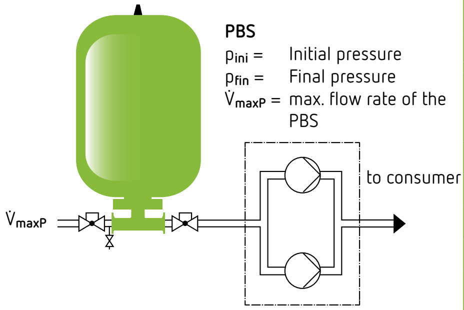
Object:

Circuit: Refix on the PBS prepressure side in accordance with DIN 1988-Part 5

Installation: In coordination with the responsible water supply company (WSC)

Necessity: When the following criteria are not met:

- in the event of a PBS pump failure, the flow velocity in the connection pipe of the PBS must not change by more than 0.15 m/s
- in the event of all pumps failing, by not more than 0.5 m/s
- during the pump runtime, the minimum supply pressure p_{minV} must not be undershot by more than 50 % and must always be at least 1 bar



Start data:

Min. supply pressure p_{minV} = ... bar

Max. flow rate $\dot{V}_{maxP}$ = ... m³/h

Selection acc. to DIN 1988 Part 5

Max. flow rate $\dot{V}_{maxP}$/m³/h	Refix DT with Duo connection V_n/litre	Refix DT V_n/litre
≤ 7	300	300
> 7 ≤ 15	500	600
> 15	---	800

V_n = ... litre

Prepressure p_0 = [min. supply pressure] p_{minV} – 0.5 bar

p_0 = ... – 0.5 bar = ... bar

p_0 = ... bar

Circuit: Refix on the holding pressure side of the PBS

To limit the switching frequency for pressure-controlled systems without speed control, based on DIN 1988 Part 5

Maximum delivery head of the PBS H_{max} = ... mWs

Max. supply pressure p_{maxV} = ... bar

Initial pressure (pump ON) p_{ini} = ... bar

Final pressure (pump OFF) p_{fin} = ... bar

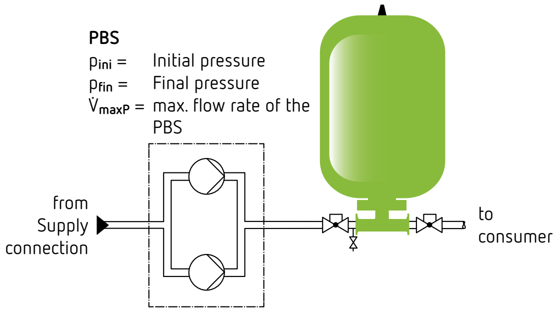
Max. flow rate V_{maxP} = ...l/h

Switching frequency s = ... 1/h

Number of pumps n = ...

Electrical power of the most powerful pump P_{el} = ...kW

s - switching frequency	1/h	20	15	10
Pump capacity	kW	≤ 4.0	≤ 7.5	> 7.5



Nominal volume $V_n = 0.33 \times V_{maxP} \times \frac{p_{fin} + 1}{(p_{fin} - p_{ini}) \times s \times n}$

V_n = 0.33 × .... × .... = ... litre

Selected = ... litre

V_n = ... litre

Circuit: Refix on the holding pressure side of the PBS

For storing the minimum storage volume V_e between on and off of the PBS for all control variants

Cut-in pressure p_{ini} = ... bar

Cut-out pressure p_{fin} = ... bar

Refix prepressure p_0 = ... bar → Reflex recommendation: $p_0 = p_{ini} - 0.5$ bar

Storage quantity V_e = ... litre

p_0 = ... bar

Nominal volume $V_n = V_e \frac{(p_{ini} + 1)\,(p_{fin} + 1)}{(p_0 + 1)\,(p_{fin} - p_{ini})}$

V_n = ... × .... = ... litre

Selected = ... litre

V_n = ... litre

Check perm. operating overpressure

$p_{max} \leq 1.1 \times p_N \times \frac{H_{max}\,[mWs]}{10}$

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

p_{max} = ... bar

Results

Refix DT	.... litre	10 bar ☐	Nominal volume	V_n	= .... litre
with Duo connection DN 50	.... litre	10 bar ☐	Useful volume	V_0	= .... litre
Refix DT	.... litre	16 bar ☐	Prepressure	p_0	= .... bar

Make-up & degassing

In heating or cold water systems

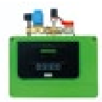
Make-up and degassing systems can automate system operation and contribute significantly to operating safety. While the make-up and degassing are already integrated in Variomat pressure maintenance stations, they are provided by Reflex expansion vessels as well as by Reflexomat and Variomat Giga pressure maintenance stations.

Fillcontrol make-up units always ensure there is sufficient water in the expansion vessel, an elementary prerequisite for the function — also in pressure maintenance stations. At the same time, they meet the requirements of DIN EN 1717 and DIN 1988-100 for safe make-up from potable water systems.

Fillsoft water treatment supports the make-up systems in fulfilling the requirement for the system technology to provide the required water properties of the filling and make-up water in respect of calcium content (hardness) and conductivity.

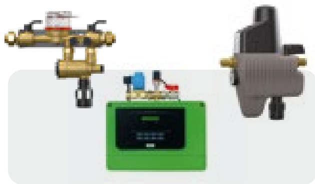
Servitec degassing stations can not only make-up, but also centrally vent and degas systems. Our joint research projects with the Technical University of Dresden have confirmed that this is particularly necessary for sealed systems. For example, measurements indicated nitrogen concentrations between 25 and 45 mg / litre in the system water. This is up to 2.5 times higher than the natural level in potable water. P. 58

Overview of Reflex make-up valves and systems

	Make-up valves			Automatic make-up systems		Automatic make-up systems with pump	
	Fillset Compact	Fillset	Fillset Impuls	Fillcontrol Plus	Fillcontrol Plus Compact	Fillcontrol Auto Compact	Fillcontrol Auto
							
DVGW-tested system separation	✓	✓	✓		✓	System separator vessel with free outlet	
KVS	0.86 m³/h	0.8 m³/h	0.8 m³/h	1.4 m³/h	0.4 m³/h	0.18 m³/h	0.18 m³/h
Pump discharge pressure	-	-	-	-	-	8.5 bar	5.5 bar
Integrated shut-off	✓	✓	✓	✓	✓	✓	✓
Wall mount		✓	✓	✓		✓	
Checking of the automatic make-up				Operating time Number of cycles Total quantity		Operating time Number of cycles Total quantity	Operating time Number of cycles Total quantity
Function reference (operating mode)				Levelcontrol fill-level dependent Magcontrol pressure dependent	Magcontrol pressure dependent	Levelcontrol fill-level dependent Magcontrol pressure dependent	Levelcontrol fill-level dependent Magcontrol pressure dependent
Fault message				✓	✓	✓	✓
Water meter		✓	Contact water meter				
Analysis Water treatment				In conjunction with contact water meter or Fillguard		In conjunction with contact water meter or Fillguard	In conjunction with contact water meter or Fillguard

Make-up systems in Magcontrol mode

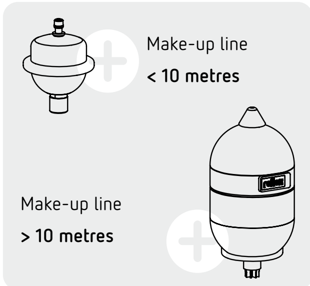
The system pressure is shown on the display and monitored in the controller. Make-up water is added in a controlled manner if the initial pressure $p < p_0 + 0.3$ bar is not reached. Faults are displayed and can be forwarded via a signal contact. With make-up from the potable water system, the Fillset must be connected upstream. The compact combination of both provides the Fillcontrol Plus Compact for lower make-up quantities, together with an integrated pressure reducer. The pressure directly upstream of the make-up must be at least 1.3 bar above the prepressure of the expansion vessel. The make-up quantity $\dot{V}$ can be determined from the k_{vs} value (flow factor).



Fillset | Fillcontrol Plus | Fillcontrol Plus Compact

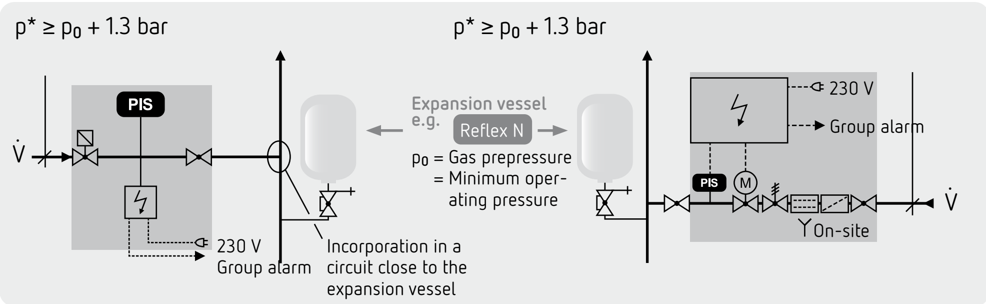
Make-up line information

Valid for systems with longer piping between the system separator and the make-up valve (Fillcontrol Plus, Variomat) resulting from on-site conditions. Depending on the length of the make-up line (depending on the system separator, system side), pressure fluctuations can occur due to thermal expansion of the cold make-up water.



- If the length is less than 10 m, a Reflex water shock absorber must be used.
- Above a length of 10 m or more, we recommend the use of a small Refix (e.g. 2 l) expansion vessel to ensure reliable operation of the system separator.

installation example Fillcontrol Plus | Installation example Fillcontrol Plus Compact



Make-up quantity

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

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

Set values

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

Minimum flow pressure formula

$$p^* \geq p_0 + 1.5 \text{ bar}$$

*p = gauge pressure directly upstream of the make-up station in bar

Fillcontrol Auto Compact

Fillcontrol Auto Compact is a make-up system with a pump and an open collection container (system separator vessel) as a system separation from the potable water system in accordance with DIN 1988 or DIN EN 1717.

Fillcontrol Auto is usually used when the fresh water inlet pressure p is too low for direct make-up without a pump or an intermediate tank is required to separate the system from the potable water system.

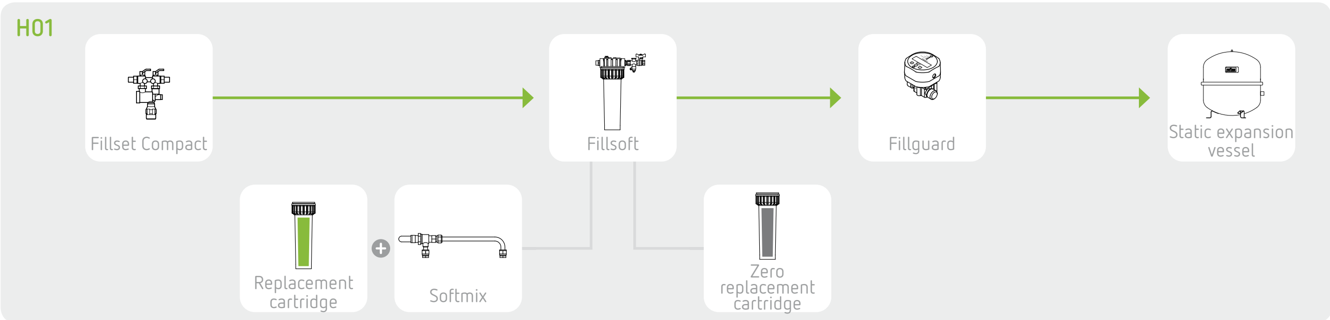
The pump capacity is between 120 and 180 l/h at a delivery head up to 8.5 bar.

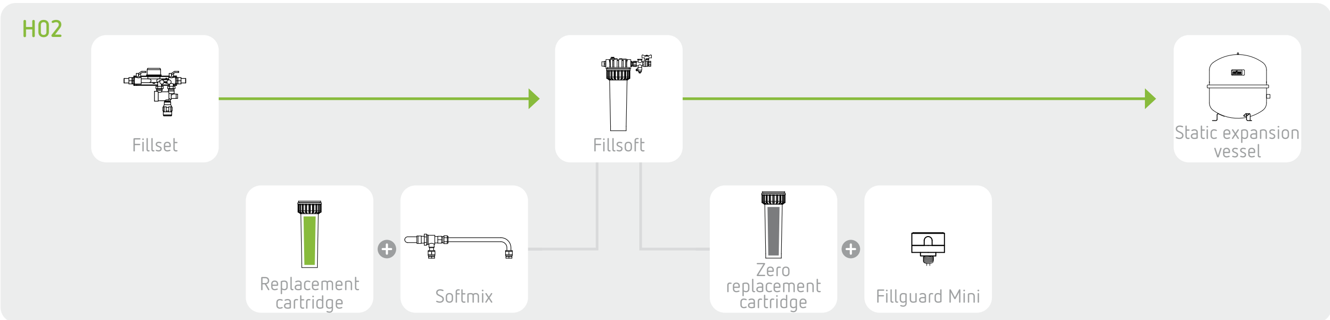
Fillcontrol Auto Compact

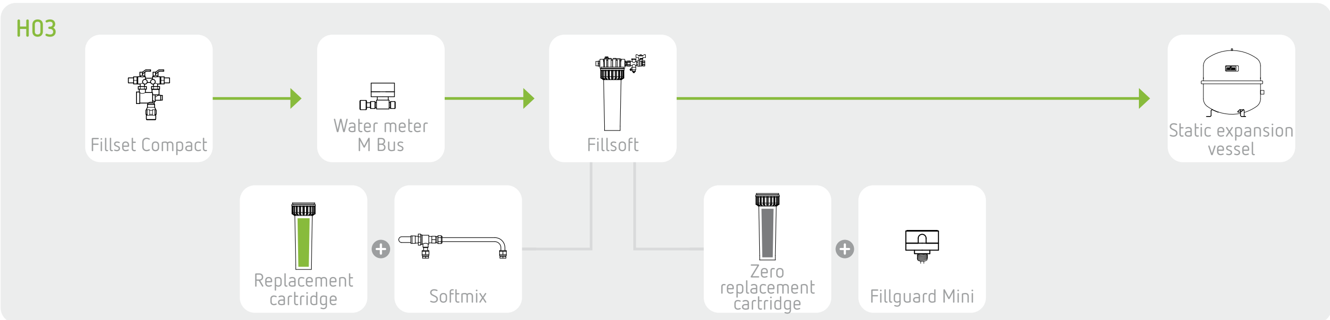
Use and combination options

The combination of Fillcontrol make-up systems and Fillsoft water treatment technology is both obvious and useful. The question as to which combinations are recommended in detail always arises against the background of specific system design. In the following, typical configurations are presented to demonstrate the interaction and the possible functionality.

Manual make-up

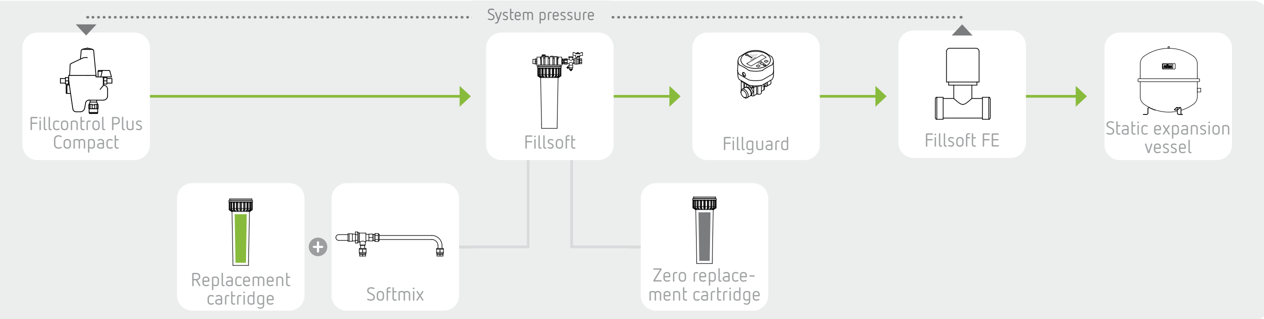




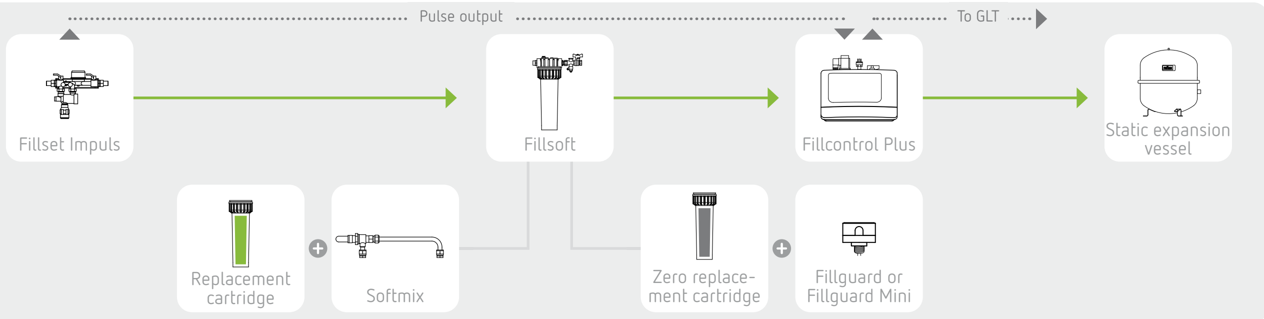


Automatic make-up

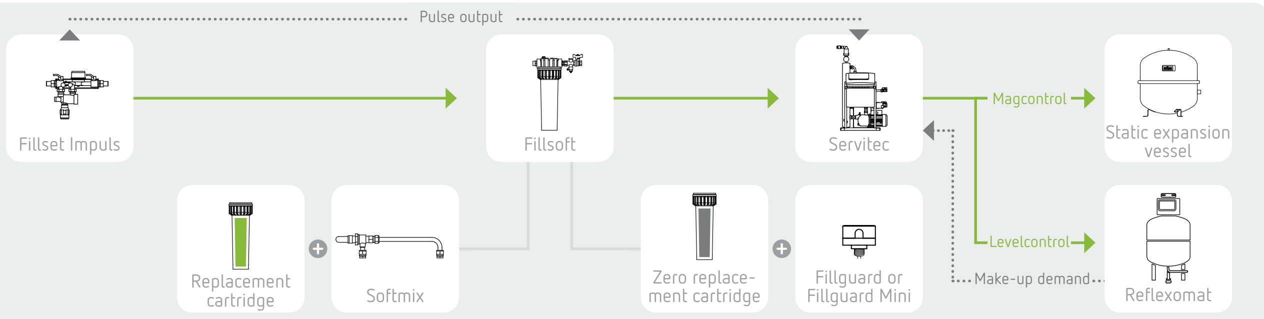
A01



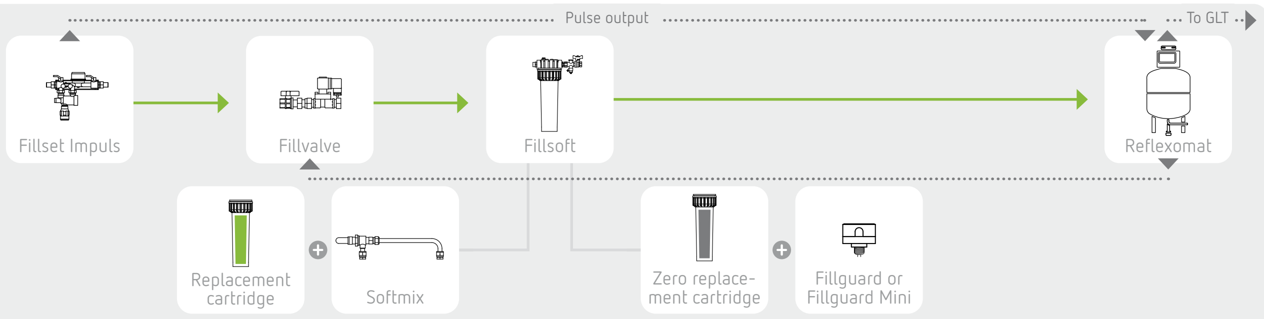
A02



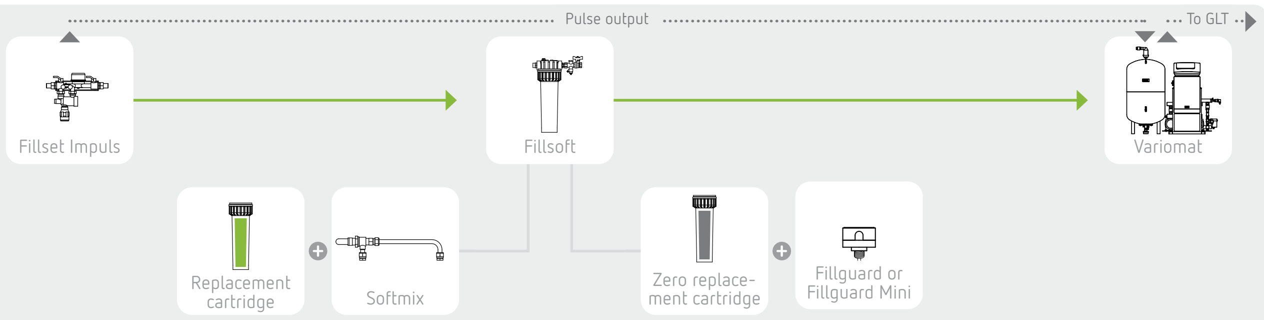
A03



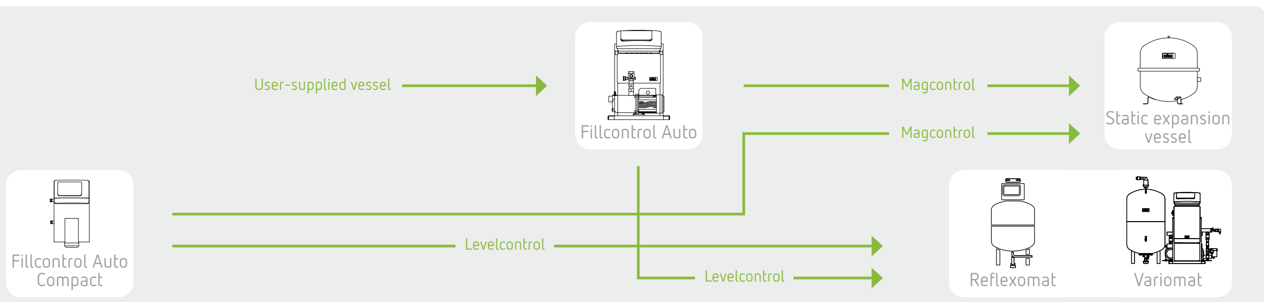
A04



A05



A06

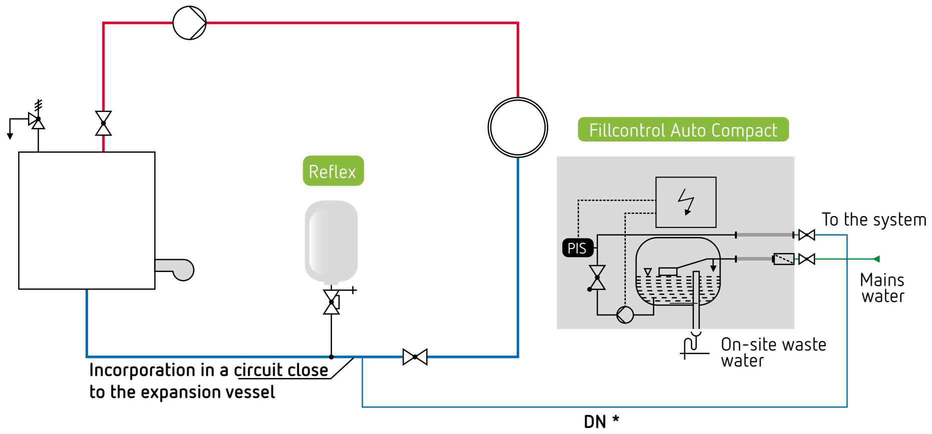


Installation examples Fillcontrol

Note for the installer

- Fillcontrol Auto Compact is used in systems with expansion vessels (MAG) such as Reflex set to “pressure-dependent control = Magcontrol”. The make-up is then carried out when the filling pressure or initial pressure is undershot in the expansion vessel. The make-up line must be connected close to the expansion vessel.
- DN 15 up to 10 m connection pipe
- DN 20 for greater than 10 m connection pipe

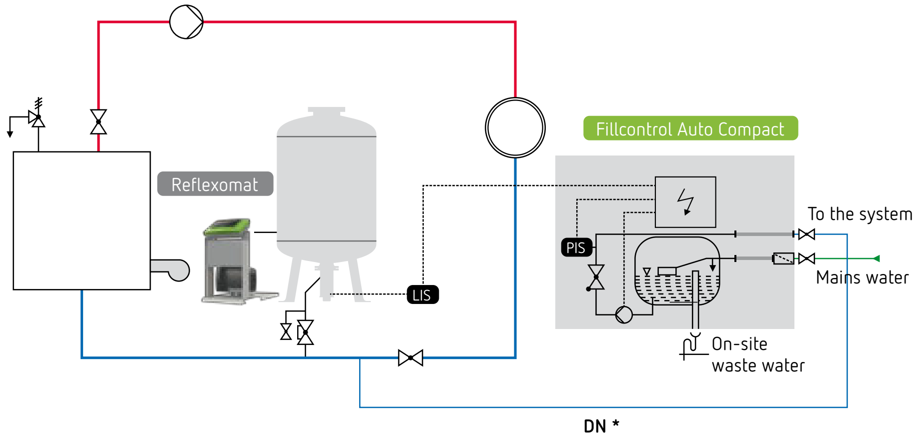
Fillcontrol Auto Compact with pressure-dependent control in an expansion vessel system (Magcontrol)



Note for the installer

- Fillcontrol Auto Compact is set to “level-dependent control = Levelcontrol” for systems with pump or compressor-controlled pressure maintenance stations Reflexomat. The make-up is then carried out depending on the filling level LIS in the expansion vessel of the pressure maintenance station. A 230 V input is available on the Fillcontrol Auto for this purpose.
- DN 15 up to 10 m connection pipe
- DN 20 for greater than 10 m connection pipe

Fillcontrol Auto Compact with level-dependent control in a system with compressor pressure maintenance (Levelcontrol)



The diagrams are solely to illustrate the connections. They must be matched to the local conditions and substantiated.

Water hardness

The need to protect heat generation systems (boilers and heat exchangers) from limescale deposits is dependent on the regional overall water hardness of the filling and make-up water amongst other things. The assessment basis is primarily VDI 2035 Sheet 1 and the data of the heat generator manufacturers.

Necessity: VDI 2035 Sheet 1; Requirements for filling and make-up water
The need to avoid limescale deposits is constantly increasing due to the compact design of modern heat generators. Here the current trend is high heating capacity with low water content. VDI 2035 Sheet 1 specifically considers this topic and its recommendations are aimed at preventing possible damage.

Limescale formation: $Ca^{2+} + 2HCO_3^- \rightarrow CaCO_3 + CO_2 + H_2O$
The location to usefully introduce required measures is the filling and make-up line of the heating system. Corresponding systems for automatic make-up should be simply expanded according to the necessary requirements.

Standard values for the total hardness of the filling and make-up water according to VDI 2035 Sheet 1 - 2021

Group	Total heat capacity	Total hardness [°dH] Depending on the specific system volume v_{sys} (system volume / smallest individual heat capacity)		
		≤ 20 l/kW	> 20 l/kW and ≤ 40 l/kW	> 40 l/kW
1	≤ 50 kW	None	≤ 16.8 °dH	< 0.3 °dH
1a*	≤ 50 kW	≤ 16.8 °dH	≤ 8.4 °dH	< 0.3 °dH
2	> 50 – ≤ 200 kW	≤ 11.2 °dH	≤ 5.6 °dH	< 0.3 °dH
3	> 200 – ≤ 600 kW	≤ 8.4 °dH	< 0.3 °dH	< 0.3 °dH
4	> 600kW	< 0.3 °dH	< 0.3 °dH	< 0.3 °dH

Start data
Heating capacity
Capacity-specific system volume
Capacity-specific heat generator content

* Circulatory type water heaters and devices with electric heating elements

Definition of circulatory type water heater

$V_C = 0.3$ l/kW

Total heat capacity
The total of all heat generator individual capacities.

Smallest individual heating capacity
This is the lowest heating capacity of a single heat generator in a group of multiple heat generators.

Capacity-specific system volume
The total water content of the system including the heat generators related to the smallest individual heating capacity.

Capacity-specific heat generator volume
The characteristic value determined from the heat generator content related to its heating capacity. The smaller the value, the thicker the limescale layers to be expected in the heat generator.

Regional overall water hardness
It is often practical to use water, which is available from the public water supply, as filling or make-up water for systems. However the local lime content or the regional water hardness can be very different and also sometimes fluctuate within a region. The regional water hardness must therefore be requested from the water supplier or can be determined on site by means of a test (Reflex overall water hardness measuring instrument). The required measures are derived from this. The water hardness is usually specified in °dH. 1 °dH corresponds to 0.176 mol alkaline earth / m³ or, inversely, 1 mol alkaline earth / m³ corresponds to 5.6 °dH.

Reflex overall water hardness measuring set
for independent determination of the local total or residual water hardness

Conductivity

In addition to water hardness, electrical conductivity is another important water parameter in sealed heat supply systems. It is primarily an indicator of a possible rate of corrosion, e.g. in the case of oxygen corrosion. Usually, however, from the viewpoint of sustainability and permanent function, the supply networks should normally be designed as sealed systems for corrosion purposes (citation VDI 2035). In rare cases, however, due to their high salt content (conductivity), some waters are not completely suitable as a heat transfer medium, even if the water hardness is adjusted accordingly.

To achieve a low salt operating mode with ≤ 100 µS/cm, the filling and make-up water should **have a conductivity of ≤ 10 µS/cm.**

Necessity: VDI 2035 Sheet 1; Requirements for heating water
Here too, VDI 2035 provides important information for a practical classification and approach. However, manufacturers whose heat generators are equipped with aluminium alloys also issue specifications dealing with how filling and make-up water should be treated. The latter are based not so much on the need to slow down oxygen corrosion, but rather on the impact of full softening in respect of the change in pH in a heat distribution system. Experience shows that low-salt operation offers a wider range for all materials in relation to the pH value of the facility water.

Heating water standard values according to VDI 2035 Sheet 1 - 2021

Operating mode	Conductivity in µS/cm
Low salt	> 10 µS/cm up to ≤ 100 µS/cm
Saline	> 100 µS/cm up to ≤ 1,500 µS/cm
Appearance	
Clear, free of sedimenting substances	
Materials in the system	**pH value**
Without aluminium alloys	8.2 – 10.0
With aluminium alloys	8.2 – 9.0

Salty operation
Potable water or water from the local water supply or in-house wells necessarily contains salt-forming ions, which result in conductivity > 100 µ/cm. A reduction of the hardness components Ca^{2+} and Mg^{2+} by softening or full softening will not significantly change this. Therefore, if water is used that has been treated accordance with the requirements of VDI 2035, a conductivity of > 100 µS/cm will result for the system water, so-called salty operation.
For many sealed heat supply systems with water as a heat transfer fluid, the use of a softened or low-hardness water represents standard practice and is completely adequate. In addition, this method is coupled with relatively low production costs. Water with a conductivity of more than 1,500 µS/cm is unsuitable as filling and make-up water and must undergo demineralisation.

Low-salt operation
If the conductivity of the heating water is reduced to ≤ 100 µS/cm, this is referred to as low-salt operation. Experience shows that this requires demineralisation of the filling and make-up water of ≤ 10 µS/cm. Otherwise, an unavoidable salinity in the network would lead to overshooting of the target conductivity of this operating mode. Low-salt operation requires, in contrast to softening, a more costly ion-exchange approach or salt removal.

Citation VDI 2035 Sheet 1-2021:

In systems with aluminium materials, a complete softening of the filling and make-up water must be avoided. Low-salt operation based on demineralisation is to be favoured.

Water treatment processes — softening / demineralisation

There are various methods to remove or render the hardness components ineffective:

Softening via cation exchanger
By means of cation exchange, the calcium and magnesium ions in the filling water are exchanged for sodium ions with the calcium and magnesium remaining in the cation exchanger. In this way the hardness ions are removed from the heating system. This procedure has no impact on the pH of the filling water and the conductivity does not change either.

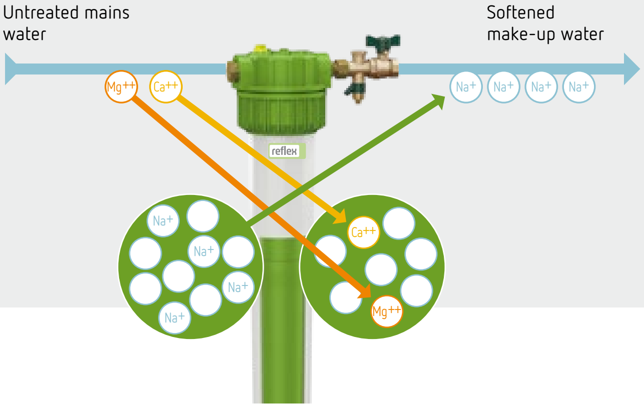
Based on design of the cation exchanger, the filling and make-up water is simply routed over a plastic medium enriched with sodium ions, and the chemical ion exchange process then runs autonomously.

Demineralisation
As the name suggests, demineralisation removes some of the salt-forming anions and cations. In principle, in complete demineralisation all ions are removed (deionized water). In the application case of sealed heating and cooling water circuits, operation with low salt content in the circuit water is realized for various technical reasons with a conductivity of ≤ 100 mS / cm and is then referred to as low-salt operation. For this purpose, filling and make-up water with a conductivity of ≤ 10 mS / cm is used for the systems. There are two methods that are preferred for the corresponding water supply. Firstly, the ion exchange process is again used in a mixed-gas exchanger. Secondly, reverse osmosis is used, in which the salts are removed from the water through a membrane. This process is more complex technically and also requires more energy. Furthermore, it is more suitable for large quantities of water.

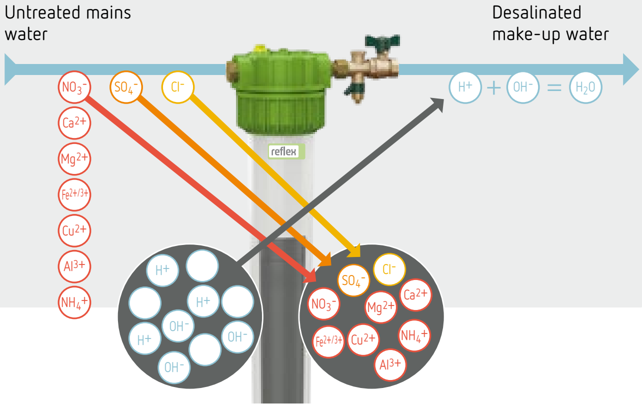
Hardness stabilisation
Hardness stabilisation is water treatment process that influences the separating out of the calcium in such a way that limescale formation does not occur. Two processes are worthy of mention here. In the first, polyphosphates are added thus suppressing limescale formation, however, it is not completely prevented. Sludge can form (lime precipitation in water) because the carbonate fraction is not reduced. This process requires chemical expertise, monitoring and a consistent orderly approach. In the second process, under the general concept of physical water treatment, the approach uses the formation of stabilising seed crystals, e.g. using magnetic fields, and dispenses with the need for any chemicals. There is some dispute about the effectiveness of the last process.

Functionality

Water softening with Fillsoft
The softening process (reduction of water hardness, °dH) is based on the cation replacement principle. Hard mains water is transported through the exchanger pillar. The magnesium and calcium ion hardening constituents are exchanged with the sodium ions of the resin beads, which softens the water. The cartridge must be replaced when the sodium ion capacity is exhausted. The pH value and the conductivity are not affected by this process.



Demineralisation by Fillsoft Zero
Demineralisation works based on the principle of the exchange of cations and anions. Fillsoft Zero makes it possible to demineralise filling and make-up water. All minerals are absorbed by the cartridge. The cartridge capacity decreases and it must be replaced when conductivity and the ion number increases. Here, the desired conductivity is to be read off on the Fillguard Mini.



Make-up water softening in practice

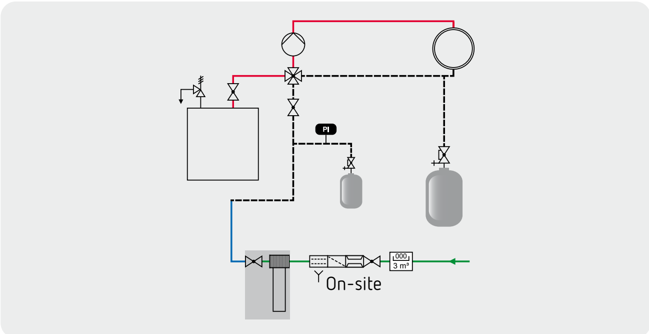
For heating systems in the small to medium capacity range, the softening procedure using cation exchangers is the optimum approach for protection against limescale deposits in the heat generator. The equipment required is inexpensive, while application is simple and the most suitable for the requirements.

Softening with cation exchanger in the filling and make-up line
Depending on the requirements, fully or partially softened water must be produced with the appropriately selected Fillsoft cation exchanger.

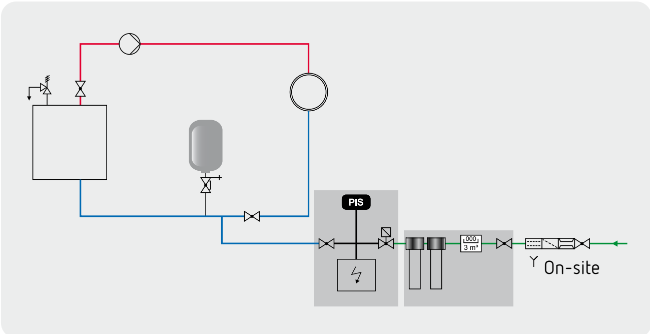
Filling and make-up water
The term from VDI 2035 Sheet 1 refers to the water and the quantity that must be added for the complete refilling of a system or during operation.

Soft water
This is water that has had the hardness ions calcium and magnesium removed so that limescale formation no longer occurs.
A specific characteristic value for the amount of soft water that a softening system can produce is the soft water capacity Kw [l × °dh].
The filling and make-up water does not always have to be or need to be completely softened. Water that does not have the hardeners fully removed is also called partially softened.

Installation example:
Fillsoft I + Fillset Compact
as a manual filling and make-up facility in a system with an expansion vessel



Installation example:
Fillcontrol Plus + Fillsoft II + Fillset with contact water meter
as an automatic filling and make-up facility with pressure monitoring in a system with an expansion vessel



Fillsoft I

Softening with the Fillsoft cation exchanger

Fillsoft II

FS Softmix

Softmix produces partially softened water

Fillguard

Fillguard monitors the capacity of Fillsoft or the conductivity of the filling and make-up water with Fillsoft Zero

Fillsoft dimensioning for water softening

Object:

Start data

Heat generator		1	2	3	4	
Heating capacity	$\dot{Q}_K$	= .... kW	.... kW	.... kW	.... kW	$\dot{Q}_{tot}$ = ... kW
Water content	V_W	= .... litre	.... litre	.... litre	.... litre	$\dot{Q}_{min}$ = ... kW
Known water content	V_{sys}	= .... litre	P. 7 Approximate water content $V_{sys} = f(t_{in}, t_R, \dot{Q}_{tot})$			V_{sys} = ... litre

Specific characteristic values

Capacity-specific Boiler water content	v_K	$= \frac{V_C}{\dot{Q}_C}$ = ____________ = ... l/kW	v_K = ... l/kW
Capacity-specific System content	v_{sys}	$= \frac{V_{sys}}{\dot{Q}_{min}}$ = ____________ = ... l/kW	v_{sys} = ... l/kW

→ $\dot{Q}_{Min}$ = **lowest value of $\dot{Q}_C$**

Water hardness

Regional overall water hardness	TH_{Actual} = ... °dH	P. 29 Information via water supply company or own measurement	TH_{Actual} = ... °dH
Target total water hardness	TH_{Target} = ... °dH	Table P. 49 or specifications of water softener manufacturer	TH_{Target} = ... °dH
Soft water capacity of: Fillsoft I Fillsoft II Fillsoft FP	K_W = 6,000 l × °dH K_W = 12,000 l × °dH K_W = 6,000 l × °dH / unit		K_W = ... l × °dH

→ Checks whether it is a circulatory type water heater (< 0.3 l/kW)

→ Softening is required if **TH > TH_{Target}**

Possible quantities of filling and make-up water

Possible filling water quantity (mixed)	V_F	$= \frac{K_W}{(TH_{Actual} - TH_{Target})}$ = = ____________ = ...	For $TH_{Actual} > TH_{Target}$	V_F = ... litre
Possible make-up water quantity	V_n	$= \frac{K_W}{(TH_{Actual} - 0.11\ °dH)}$ = ____________ = ...	For TH_{Actual} > 0.11 °dH	V_n = ... litre
Number of cartridges required for system filling	n	$= \frac{V_{sys}\ (TH_{Actual} - TH_{Target})}{K_W}$ = = ____________ = ...		n[1] = ... litre
Possible residual make-up quantity after filling process	V_n	$= \frac{\times\ 6{,}000\ l\ °dH - (V_{sys} * (TH_{Actual} - TH_{Target}))}{(TH_{Actual} - 0.11\ °dH)}$ = ____________ = ...	For TH_{Actual} > 0.11 °dH	V_n = ... litre

[1] Cartridge number n rounded up to an integer

Results

Fillsoft housing	Type	System content V_{sys}	.... litre
Fillsoft cartridge	Number	Possible filling water quantity (partially/fully softened)	.... litre
Softmix	☐ yes ☐ no	Possible residual make-up quantity (fully softened)	.... litre
Fillguard	☐ yes ☐ no	Possible residual make-up quantity (partially softened)	.... litre
Hardness measuring	Number		

Calculation for demineralisation

Note: A precise capacity calculation for the material requirements of Fillsoft Zero is not possible. Depending on the ion distribution of the local water, the capacity of the mixed bed resin cartridge varies. The following gives an indication, which must be checked by a conductivity measurement in-situ.
Circuit: Pressure maintenance, expansion vessel in return flow to the collector.
Object:

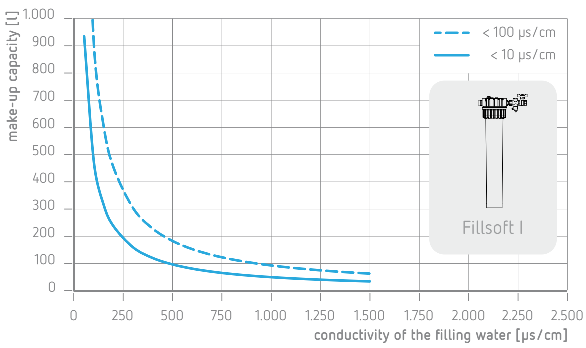
Info		
Specific characteristic values	Ability to achieve the targeted filling and make-up water under low-salt operation according to VDI 2035 s ≤ 10µS/cm	

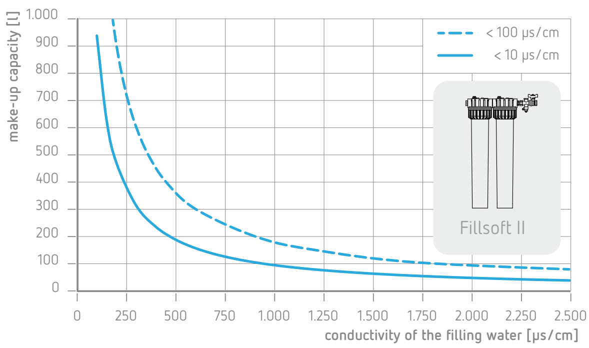
Variant 1

Water hardness (as indicative equivalence) Regional overall water hardness	TH_{Actual} = ...°dH	TH_{Actual} = ...°dH
Equivalence capacity of: Fillsoft I Fillsoft II	K_W = 3,000 l × °dH K_W = 6,000 l × °dH	
Possible filling and make-up water quantities as equivalent to water hardness (indication only) Possible quantities of filling and make-up water	$V_F = \frac{K_W}{TH_{actual}}$ = ... litre V_F = ――― = ... litre	V_F = ... litre
Number of cartridges required for system filling	$n = \frac{V_{sys} \times TH_{actual}}{K_W}$ = ... n = ――― = ...	n = ... Number
Possible residual make-up quantity after filling process	$V_n = \frac{n \times 3{,}000\,l \times °dH - V_{sys} \times TH_{actual}}{TH_{actual}}$ = ... = ――― = ...	V_n = ... litre

Variant 2

Conductivity of the make-up water as indicative equivalent





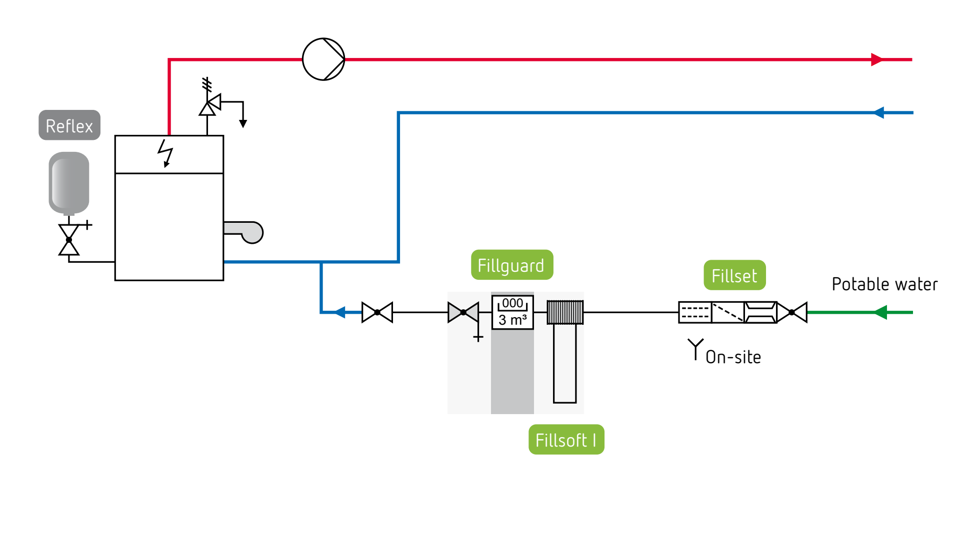
Attention! The actual yield of the cartridge in the case of demineralisation is strongly dependent on the local water properties and can only be reliably checked by measuring the conductivity during the filling or make-up process.

Results

Fillsoft housing	.... Type	System content V_{sys}	.... litre
Fillsoft Zero cartridge	.... Number	Possible filling water quantity (low-salt)	.... litre
Fillguard	yes ☐ no ☐	Possible residual make-up quantity (low-salt)	.... litre

Installation examples Fillsoft

Fillsoft
With Fillguard in a system with a pressure expansion vessel



Note for the installer

- Fillguard with runtime and monitoring of capacity.
- Softmix to achieve the desired water hardness.
- Overall water hardness measuring set for determination of the regional water hardness.
- For small boiler systems, which may be equipped with a wall unit, softening may be necessary at < 50 kW.
- The easiest way of integrating Fillsoft is to use manual make-up with the Fillguard as a capacity control. For make-up from the potable water system, do not forget Fillset.

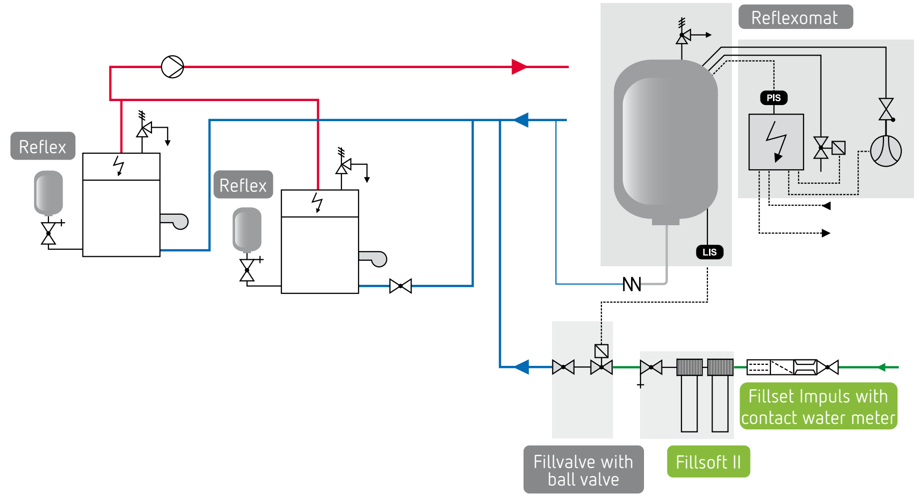
The diagrams are solely to illustrate the connections. They must be matched to the local conditions and substantiated.

Installation examples Fillsoft

Note for the installer

- For multi-boiler systems, at least the performance-specific water content doubles and is expected to increase the requirements according to VDI 2035 Sheet 1.
- Important prerequisites for the make-up function are already available using Reflex system technology. For make-up from the potable water system, also combine Fillsoft with Fillset with contact water meter.

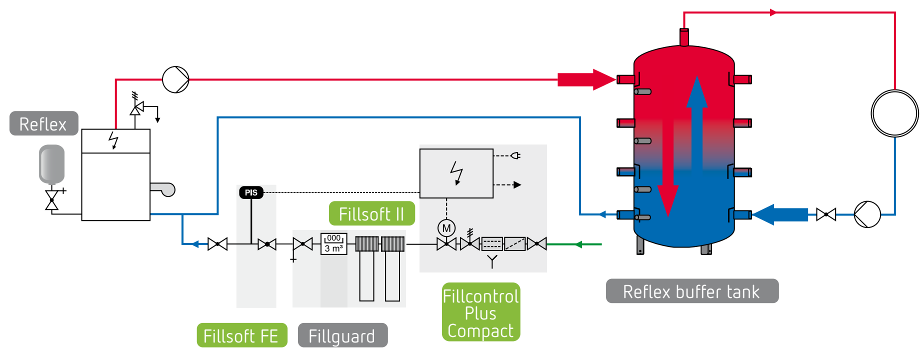
Fillsoft
With Fillset in a system with a pressure maintenance station



Note for the installer

- Installations with buffer tanks in smaller networks usually result in a requirement for full softening according to VDI 2035 Part 1. The Fillsoft is already set up for this.
- In conjunction with a Fillcontrol make-up unit, do not forget the Fillsoft FE external pressure sensor.

Fillsoft
With Fillset in a system with a buffer tank



The diagrams are solely to illustrate the connections. They must be matched to the local conditions and substantiated.

Degassing systems

In most cases, easy sampling in a glass container is sufficient to identify excess gas accumulations in sealed systems. The sample will exhibit a milky colour during expansion due to micro-bubble formation.

→ gas-rich, milky sampling

Servitec in the operating modus Magcontrol for Reflex and other expansion vessels

The pressure is shown on the display and monitored from the controller. In case of the pressure dropping below the initial pressure ($p < p_0$ +0.3 bar), degassed water is made up under controlled conditions and with leakage volume monitoring. Oxygen ingress into the system can be minimised in this way. The additional cyclic degassing of the circulation water evacuates the accumulation of excessive gases from the system. Circulation disturbance caused by accumulating gases in the form of bubbles or gas cushions is also a thing of the past due to this central degassing. The combination of Servitec and Reflex expansion vessels implement in principle the same functions as Variomat pressure maintenance stations and represents a genuine more economic alternative, particularly in the capacity range below 500 kW.

Calculation Reflex expansion vessels P. 12

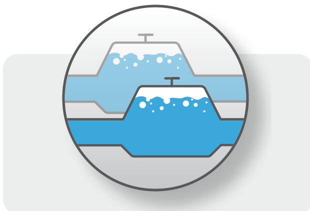
Servitec according to the table below

Set values

p_0 = ... bar
p_{sv} = ... bar

Servitec in Levelcontrol mode in combination with pressure maintenance stations

The function is similar to that of Servitec in Magcontrol mode, except that here make-up of the pressure maintenance station occurs dependent on the fill level in the expansion vessel. This requires communication between the pressure maintenance station and degassing system in the form of a switched electrical signal. The system pressure is monitored independently by the integral pressure maintenance station, e.g. Reflexomat.



→ Traditional air separators can be omitted — you save installation and maintenance costs.

Make-up quantity, system volume

The Servitec throughput volumes depend on the installed pumps and the corresponding overflow/nozzle section. The following table shows the values for standard systems with default factory settings with reference to types. The recommended maximum system volumes apply, subject to the entire network volume being degassed in the partial flow at least once every two weeks. According to our experience, this is sufficient, even for extremely loaded networks. It must be noted that Servitec can only be operated in the specified operating pressure range. Therefore the specified operating pressure values must neither be exceeded nor undershot at the Servitec connection point. We recommend special systems in case of deviating conditions.

	Type	System volume V_{sys} [m³]		p_{fin} [bar]
		Water	Water-glycol	
60 °C	Servitec Mini	1	1	0.5 – 2.5
70 °C	Servitec S	6	4	0.5 – 4.5
90 °C	Control Basic			
	Servitec 35	220	50	0.5 – 2.5
	Servitec 60	220	50	0.5 – 4.5
	Servitec 75	220	50	1.3 – 5.4
	Servitec 95	220	50	1.3 – 7.2
90 °C	Control Touch			
	Servitec 35 T	220	50	0.5 – 2.5
	Servitec 60 T	220	50	0.5 – 4.5
	Servitec 75 T	220	50	1.3 – 5.4
	Servitec 95 T	220	50	1.3 – 7.2
	Servitec 120 T	220	–	1.3 – 9.0
	Servitec 120 GL T	–	50	1.3 – 9.0

* Selection criterion for the Servitec is, in addition to the system content, the required working pressure for the medium used, which the Servitec must apply as a maximum. This must be ≥ the final pressure p_{fin} at the connection point.

→ The working pressure must be at least as high as the highest possible final pressure at the hydraulic connection point of the Servitec.

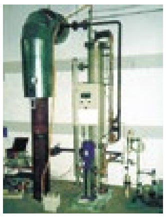
Servitec Mini Servitec S Servitec 60

*V_{sys} = max. system volume after continuous degassing over 2 weeks

→ Servitec for higher system volumes and temperatures up to 90 °C upon request.

Results from joint research with the Technical University of Dresden

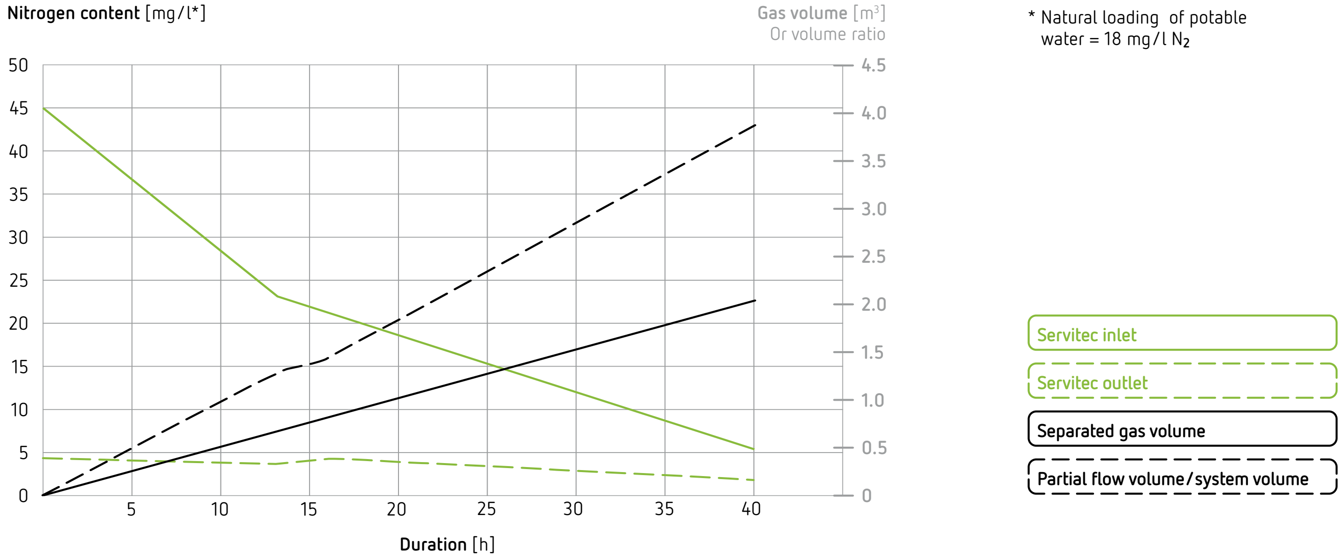
Many heating and cooling systems have a high gas enrichment resulting from poor pressure maintenance and/or from the use of permeable materials, e.g. plastic pipes. In-depth research in collaboration with the Institute for Energy Technology at the Technical University of Dresden has shown that nitrogen is a major cause of circulation disturbance. Measurements on existing systems demonstrated nitrogen concentrations between 25 and 50 mg/l. This is well above the natural concentration in potable water (18 mg/l). Our Servitec unit reduces the concentration to almost ~0 mg/l in almost no time.



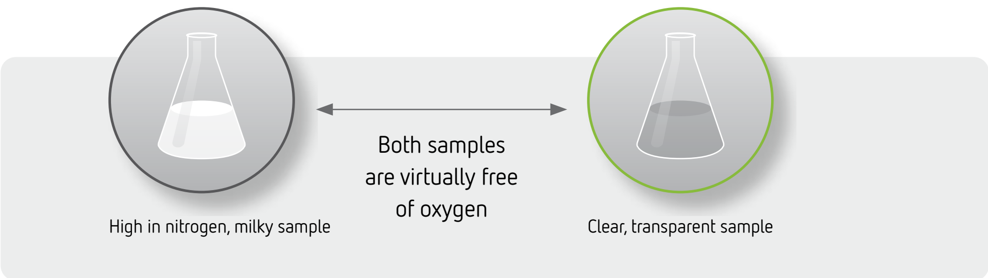
Servitec test facility in a heat transfer station of the energy supply hall

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

Nitrogen reduction by Servitec partial flow degassing in a test facility of the energy supply hall



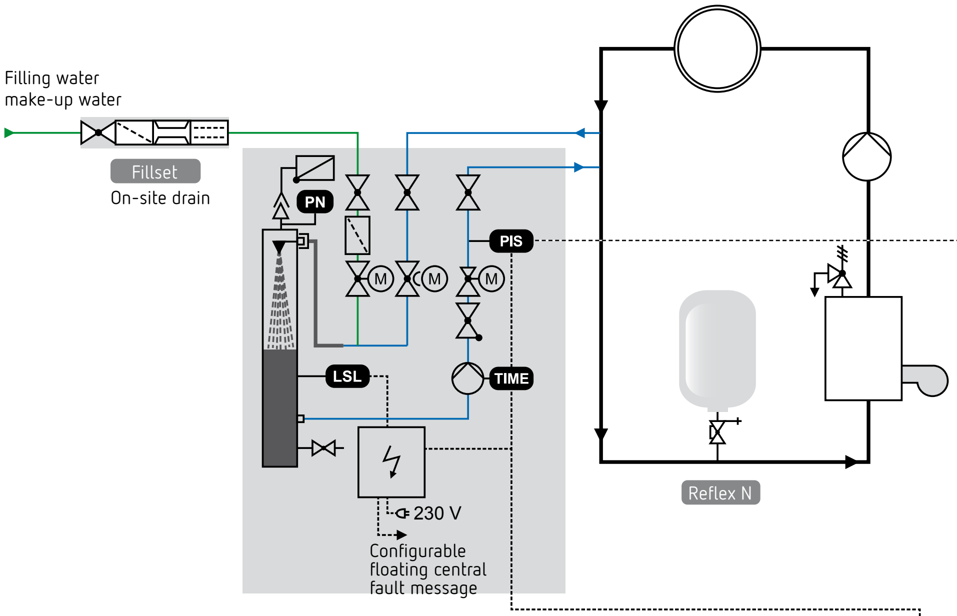
* Natural loading of potable water = 18 mg/l N_2



Servitec has reduced the N_2 content to almost 10% of the initial value in 40 hours and in doing so eliminated 4 m³ of nitrogen. Air problems in high-rise buildings have been eliminated.

Installation examples Servitec

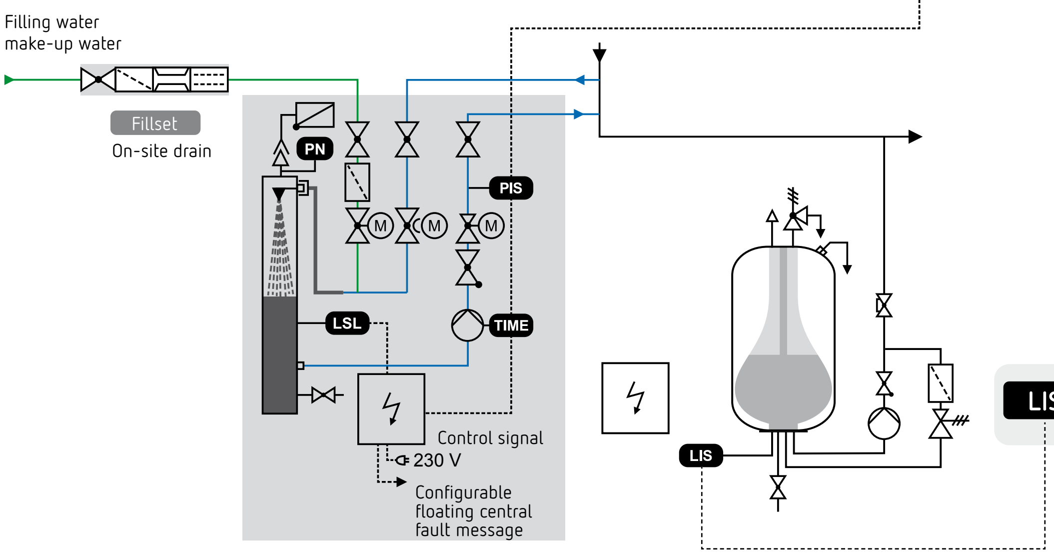
Servitec
in Magcontrol mode for systems with expansion vessels



PIS **Filling — pressure-dependant make-up — Magcontrol**

- The pressure is shown on the display.
- Out of range pressure signals are generated.
- Automatic, controlled make-up if the minimum operating pressure $p_0 \geq 0.2$ bar is undershot.
- Servitec degassing of the make-up and filling water.

Servitec
In Levelcontrol mode for systems with pump- or compressor-controlled pressure maintenance stations



TIME **Degassing**

- Vacuum degassing of a partial flow of the circulating water according to an optimised schedule with selectable degassing mode.
- Continuous degassing (after commissioning).
- Interval degassing (automatically activated after the continuous degassing time has elapsed).

LIS **Level-dependant make-up — Levelcontrol**

- Automatic, controlled make-up if the water level drops below the minimum water level in the expansion vessel of the pump- or compressor-controlled pressure maintenance station.
- Servitec degassing of the make-up water.

Installation examples Servitec

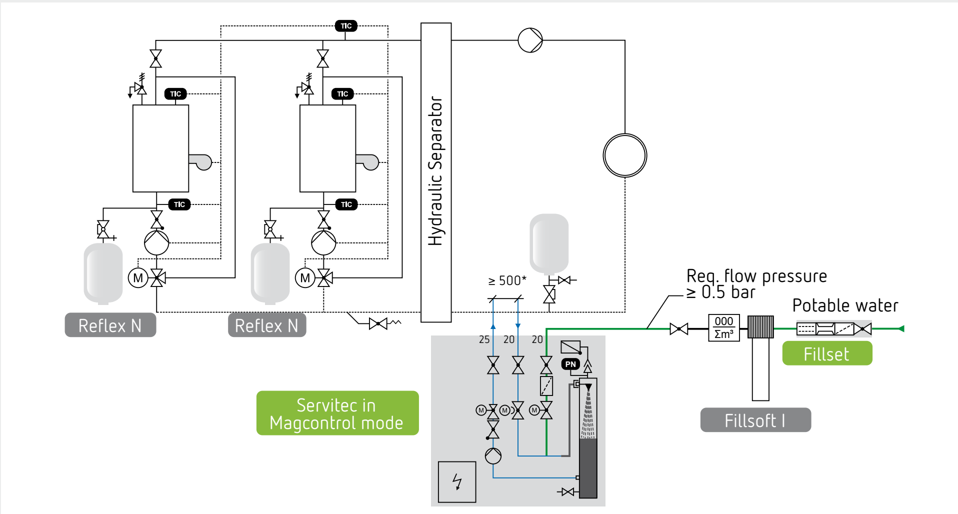
Servitec degassing stations solve "gas problems" in three ways:

- No direct intake of air by control of pressure maintenance
- No circulation problems caused by free bubbles in the circuit water
- Reduced corrosion risk due to oxygen removal from fill and make-up water

Note for the installer

- If possible install the Servitec on the system side so that the temperature loading remains ≤ 70 °C.
- When using water softening systems, they must be installed between Fillset and Servitec.
- The partial flow gas remains functional if an optional shut-off between the Servitec connection points is closed when the circulating pumps are shut down.

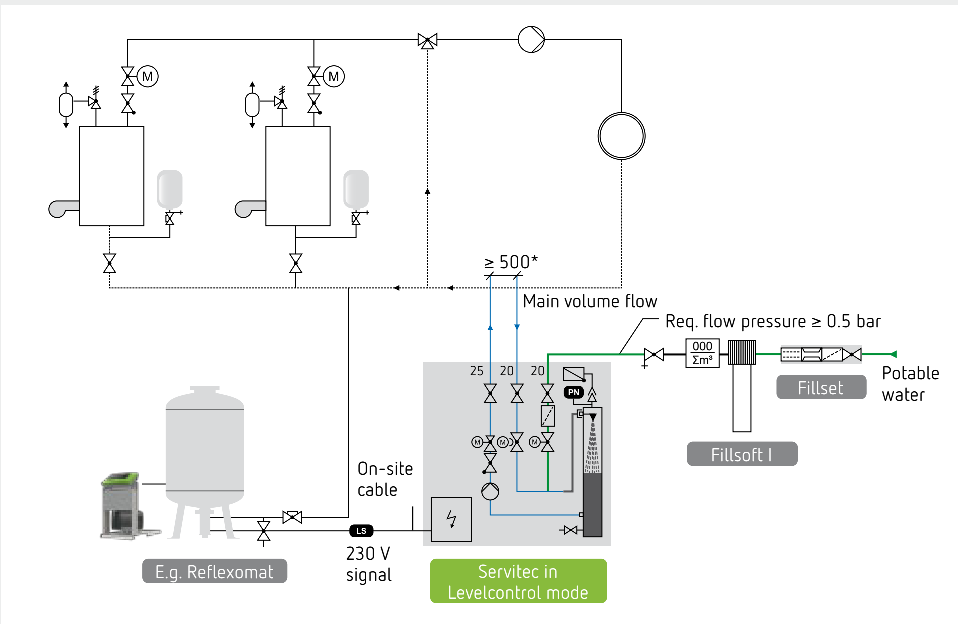
Servitec Magcontrol (expansion vessel control) mode of a multi-boiler system with a Hydraulic Separator and an expansion vessel



Note for the installer

- The combination of Servitec with compressor-controlled pressure maintenance stations is to be particularly recommended, e.g. E.g. Reflexomat. The system degassed by the Servitec, is gently cushioned by the Reflexomat.
- The water level in the expansion vessel is monitored by the control unit of the pressure maintenance station. The 230 V make-up signal LS of the pressure maintenance station initiates the make up process with degassing.
- By connection of Servitec into the main volume flow of the circulation water, an optimal degassing function is guaranteed.
- When pump-controlled pressure maintenance stations are combined with Servitec we always recommend individual boiler protection with an expansion vessel (e.g. Reflex).

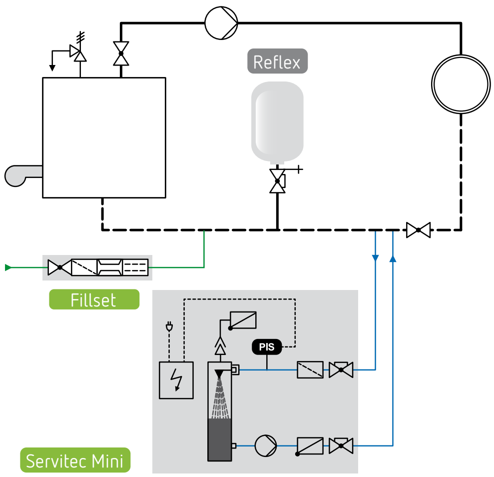
Servitec Levelcontrol mode and compressor pressure maintenance — an ideal combination



The diagrams are solely to illustrate the connections. They must be matched to the local conditions and substantiated.

Installation examples Servitec S and Mini

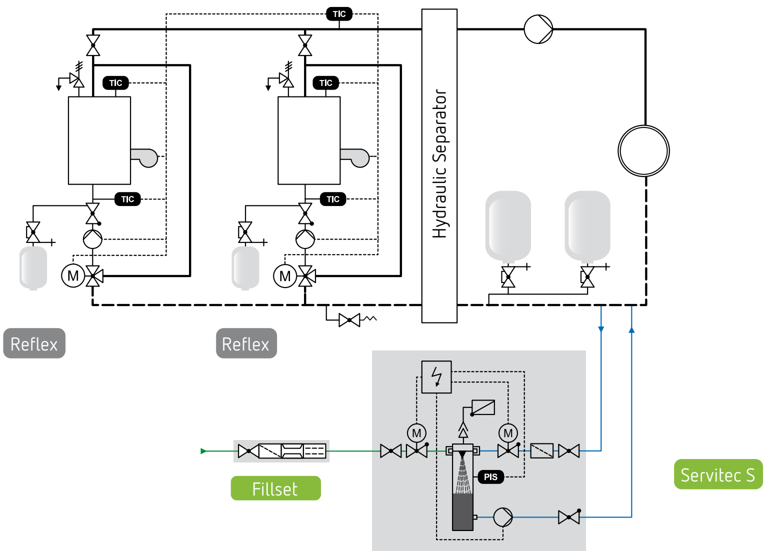
Servitec Mini
in a heating system with expansion vessel and manual make-up



Note for the installer

- Gas-free operation according to proven principle for smaller systems up to 1 m³ content and safety valve trigger pressure up to 3 barg.
- Minimum pressure monitoring with Servitec. Make-up indication for the user via LED.
- Simple, clearly laid-out installation.
- Simple installation and commissioning thanks to plug-and-play functionality and app control.

Servitec S
in a heating system with multiple heat generators and a Hydraulic Separator



Note for the installer

- Pressurisation, degassing make-up—a combination of the proven reliability of the Reflex expansion vessel and the functional extension provided by Servitec.
- Servitec principle with automatic make-up for medium-sized even more complex systems with up to 6 m³ water content.
- Wall-mounted Servitec with small footprint.
- Easy to install.
- Simple installation and commissioning thanks to plug-and-play functionality and app control.

The diagrams are solely to illustrate the connections. They must be matched to the local conditions and substantiated.

Heat transfer

Heat transfer systems*

Heat balances

The purpose of a heat exchanger is to transfer a certain amount of heat from the hot to the cold side. Here the transfer performance is not a device-specific quantity, rather it is always dependent on the stipulated temperatures. Thus there is no x kW heat exchanger, rather the unit can transfer x kW at specified temperature differences.

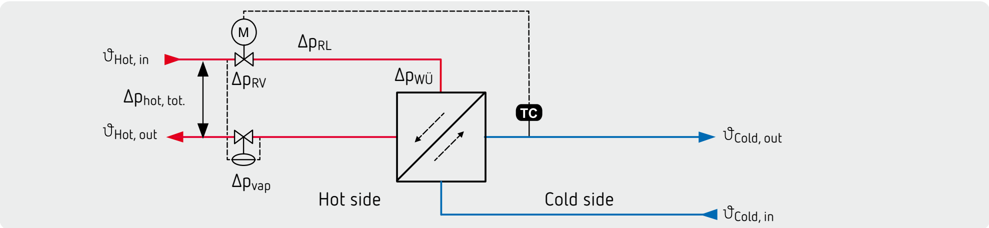
* Heat exchanger can be used as a synonym for calorifier

Application areas

- System separation of media that must not be mixed, e.g.
  - heating and potable water
  - Heating water and solar system water
  - Water and oil circuits
- Separation of circuits with different operating parameters, e.g.
  - Operating overpressure of side 1 exceeds the permitted operating pressure of side 2
  - Water content of side 1 is much greater than that of side 2
- Minimisation of the mutual interaction of the separated circuits

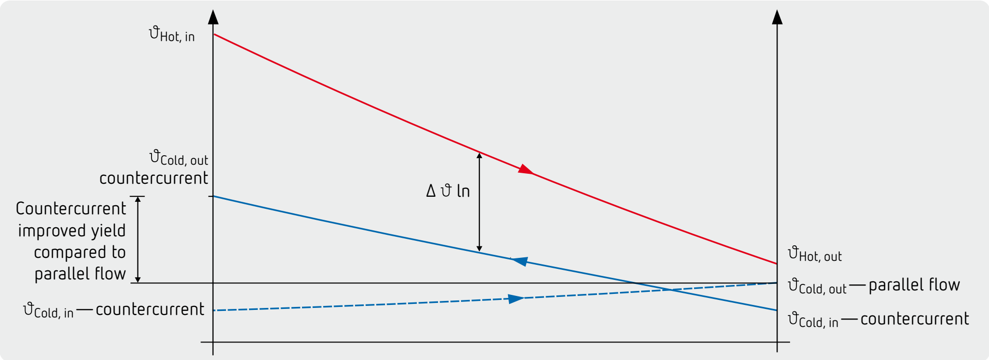
Typical examples:

- Indirect district heating connections
- Underfloor heating
- Potable water heating
- Solar thermal systems
- Machinery cooling



Counter-current

As a rule, heat exchangers should be always connected following the countercurrent principle, to ensure full capacity utilisation. When connecting in parallel flow, potentially significant capacity losses will be experienced.



Hot and cold side

Depending on the application, the assignment of both system circuits as the primary and secondary side varies. For heating systems, the hot side is usually designated the primary side. For cooling systems and chillers, this is the cold side. The distinction between hot and cold sides is clearer and independent of the application.

Inlet/outlet

When dimensioning the heat exchangers, the terms flow and return always cause problems because the configuration software does not make a correction if the inlet and outlet are mixed up. A clear distinction must be made between the hot heating flow on the outlet side of the heat exchanger and the inlet in the plate heat exchanger that comes cooled from the heating system. Inlet always means the flow for the plate heat exchanger in the Reflex configuration software (the analogous principle applies to the outlet).

Thermal length

The efficiency or operating characteristics of a plate heat exchanger is described by the ratio of actual cooling of the hot side to the theoretical maximum cooling up to the inlet temperature of the cold side.

Operating characteristics =

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

The term "thermal length" is often used for a qualitative description of the efficiency. This is a device-specific property and depends on the structure of the heat exchanger plates. The flow turbulence between the plates is increased by strong profiling and narrow channels. The device is "thermally longer" and can transfer more capacity or better match the temperatures of both media.

Mean logarithmic temperature difference

A measure for the driving force of the heat transfer is the temperature difference between the hot and cold media. As it involves a non-linear curve, this driving force is linearised under the term "mean logarithmic temperature difference $\Delta\vartheta ln$".
The smaller this driving temperature difference, the more area must be provided, which causes very large devices particularly in cold water networks.

$\Delta\vartheta ln$ =

$$\frac{(\vartheta_{hot,\,off} - \vartheta_{cold,\,on}) - (\vartheta_{hot,\,on} - \vartheta_{cold,\,off})}{\ln \frac{(\vartheta_{hot,\,off} - \vartheta_{cold,\,on})}{(\vartheta_{hot,\,on} - \vartheta_{cold,\,off})}}$$

Temperature difference

The term "temperature difference" is often used when dimensioning heat exchangers. It specifies to what extent the outlet temperature of side 2 is matched to the inlet temperature of side 1. The smaller this temperature difference should be, the greater the transfer area to be provided which makes up the price of the device. For heating systems, a temperature difference ≥ 5 K is reasonable. For cooling systems, temperature differences of 2 K are required that can only be implemented with very large units. A critical consideration of the temperature difference therefore pays out in hard cash!

Temperature difference =

$$\vartheta_{hot,\,off} - \vartheta_{cold,\,on}$$

Pressure losses

An important criterion for the dimensioning of a heat exchanger is the permitted pressure loss. Similar to the temperature difference, a very small pressure loss is often only realised with very large heat exchangers. In this case, the volume flow to be circulated and thus also the pressure loss can be reduced over the heat exchanger due to the increase in the temperature difference. If a higher pressure loss is available in the system, for example in district heating systems, it makes sense to allow a slightly higher pressure loss to significantly reduce the unit size.

Flow properties

The flow conditions in the media are of vital importance for the size of a heat exchanger. The more turbulent the heat exchanger media that flows through the unit, the higher the transferable capacity but also the greater the pressure losses. This relationship between power, unit size and flow properties is described by the heat transition coefficient.

Area margin

To determine the unit size of a heat exchanger, the necessary transfer area is first determined from the boundary conditions. In the process, devices with sometimes significant area margin can be designed, e.g. by specifying a maximum pressure loss. This over-design area margin is a theoretical quantity. When operating plate heat exchangers, the temperatures of both heat exchanger media match each other to such an extent until the excess area is removed. As a rule, the target temperature is specified at a controller in a heating circuit. A theoretically identified area margin is removed by reducing the heating mass flow via the controller. As a result, the temperature at the outlet side of the hot medium reduces accordingly. The reduced mass flow is to be considered when dimensioning the control valves so that they are not oversized.

Physical principals

Heat balances

The heat to be transferred can be determined from the specified temperature difference and the circulating mass flow using the equation.

The heat transfer coefficient k [W/m²K] is a medium and device-specific quantity, which includes flow properties, the properties of the transfer surface and the type of heat transfer media. The more turbulent the flow, the higher the pressure loss and thus also the heat transfer coefficient. The average logarithmic temperature difference DJ_{ln} is a pure system variable, which results from the set temperatures.

Using a complicated calculation algorithm, the heat transfer coefficient is first determined from the specified boundary conditions and then the required apparatus size is determined based on the required transfer area.

Thermal emission and absorption of the heat transfer media:

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

Heat transport through the heat exchanger plates:

$$\dot{Q} = k \times A \times DJ_{ln}$$

Start data

The following quantities must be known for the dimensioning of a heat exchanger:

- Media type (water, water-glycol mixture, oil)
- Material data for media deviating from water (e.g. concentrations, density, thermal conductivity and capacitance, viscosity)
- Inlet temperatures and required outlet temperatures
- Capacity to be transferred
- Permissible pressure losses

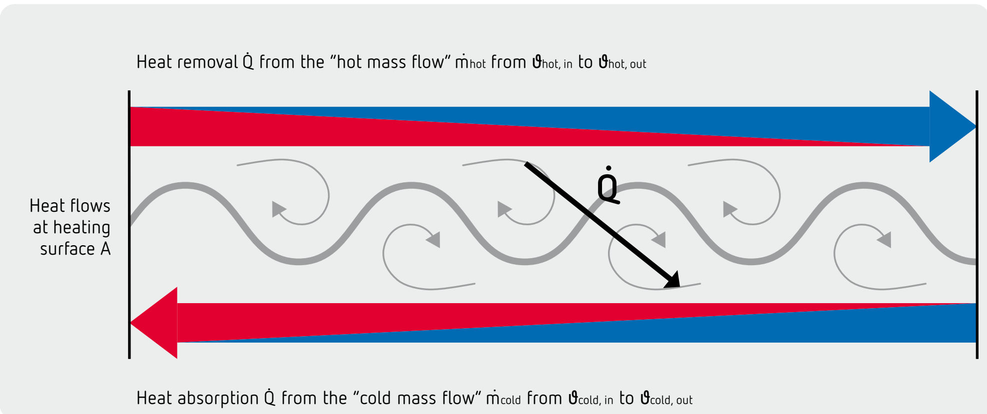
If, depending on the season, the systems are operated under very different conditions, such as in district heating networks, the heat exchangers must also be sized for these boundary conditions.

Calculation program

For computer-aided calculation of pressurisation systems and heat exchangers, our calculation program is available online under www.reflex-winkelmann.com/en!

Find your ideal solution, both quickly and easily.

Heat flows



Longtherm system equipment

Safety technology

The following are some of the regulations governing the safety equipment of heat exchangers as indirect heat generators:

- DIN 4747 for remote heating stations
- DIN EN 12828 for water heating systems, see section "Safety technology" from P. 68
- DIN 1988 and DIN 4753 for potable water heating systems

The following notes on system equipment should assist you in the dimensioning and also help you to avoid common problems during system operation and prevent equipment failures right from the dimensioning phase.

Control valve

The dimensioning of the control valve is of utmost importance for the stable operation of a heat exchanger. It should not be oversized and must also ensure steady control behaviour in the low-load range.

One selection criterion is the valve authority. This describes the ratio of the pressure loss across the control valve when it is fully opened to the maximum available pressure drop with the control valve closed. If the valve authority is too small, the control effect of the valve is too low.

Valve authority ≥ 30...40 %

$$\frac{\Delta p_{RV} \text{ (100 \% stroke)}}{\Delta p_{hot,\,tot.}}$$

With the pressure drop across the control valve determined in this way, the k_{VS} value (flow capacity) can now be determined. This must relate to the actual mass flow of the circuit being controlled.

$k_{VS} \geq k_V = V_{hot} =$

$$\sqrt{\frac{1\text{ bar}}{\Delta p_{RV}}}\ \frac{\dot{m}_{hot}}{\rho_{hot}}\ \sqrt{\frac{1\text{ bar}}{\Delta p_{RV}}}$$

The k_{VS} value (flow capacity) of the selected control valve should not be significantly greater than the calculated value (do not apply safety margins!). Otherwise, there is a risk that the system will run unsteadily and cycle, especially in the low and partial load range, one of the most common causes of failure of plate heat exchangers.

→ do not oversize the control valve!

Temperature sensors, temperature controllers

Temperature sensors should be fast and almost inertia-free and should always be installed in the immediate vicinity of the plate heat exchanger outlet so that the control system responds as promptly as possible to changing boundary conditions or control quantities. With slow sensors and controllers positioned far away from the plate heat exchanger, there is a risk of periodic overshoot above the target temperatures and the resultant cycling of the control system. Such unstable control behaviour can result in failure of the plate heat exchanger. If additional control loops, e.g. for secondary heating circuit control, are connected downstream of the heat exchanger control loop, they must communicate with each other.

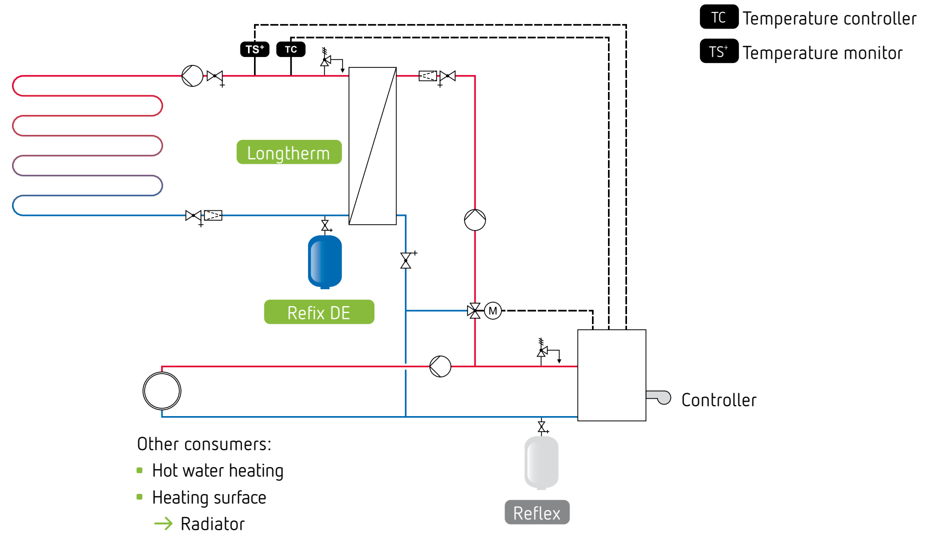
Attention!
Controllers and control valves must be selected with the greatest care. Incorrect dimensioning can lead to unstable operation and thus to impermissible dynamic material loads.

Longtherm installation examples

Note for the installer

- When retrofitting Longtherm for system separation in "old" systems, always flush the underfloor circuit and boiler circuit beforehand.
- Control on the boiler side allows for low return temperatures for efficient condensing technology.
- Use corrosion-protected Refix DE expansion vessel in the underfloor heating system.

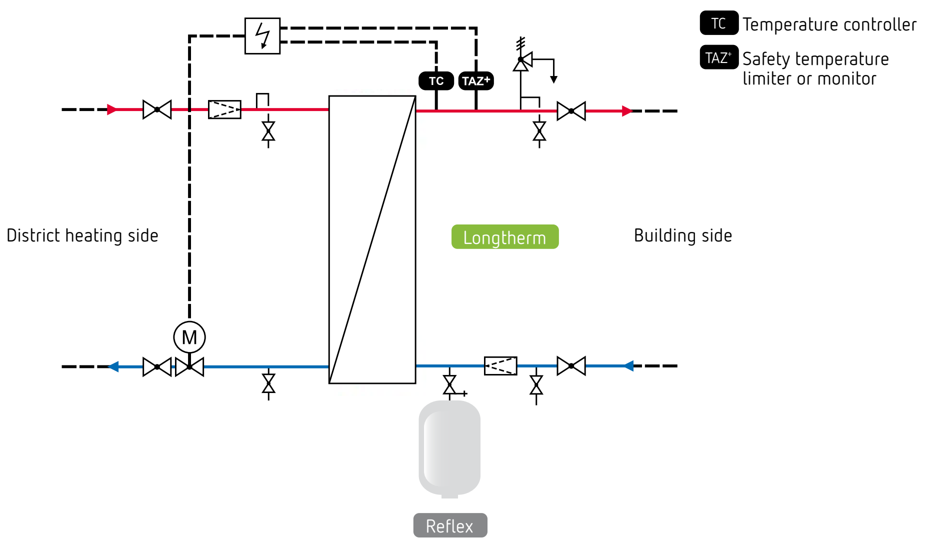
Longtherm
For system separation in an underfloor heating system



Note for the installer

- The specific technical connection conditions of the heat supplier must be taken into account.
- Due to the often high temperature and pressure loads and changing operation, ensure absolute compliance with the installation, operation and maintenance instructions.
- When connecting constant heat consumers (e.g. potable water heating, industrial requirement), always be aware of the summer temperatures of the district heating network.

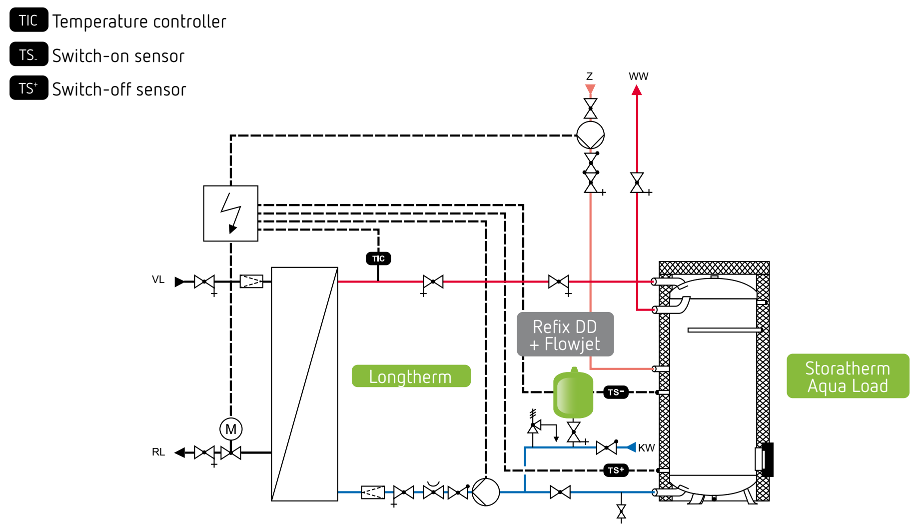
Longtherm
For system separation in a district heating transfer station



The diagrams are solely to illustrate the connections. They must be matched to the local conditions and substantiated.

Longtherm installation examples

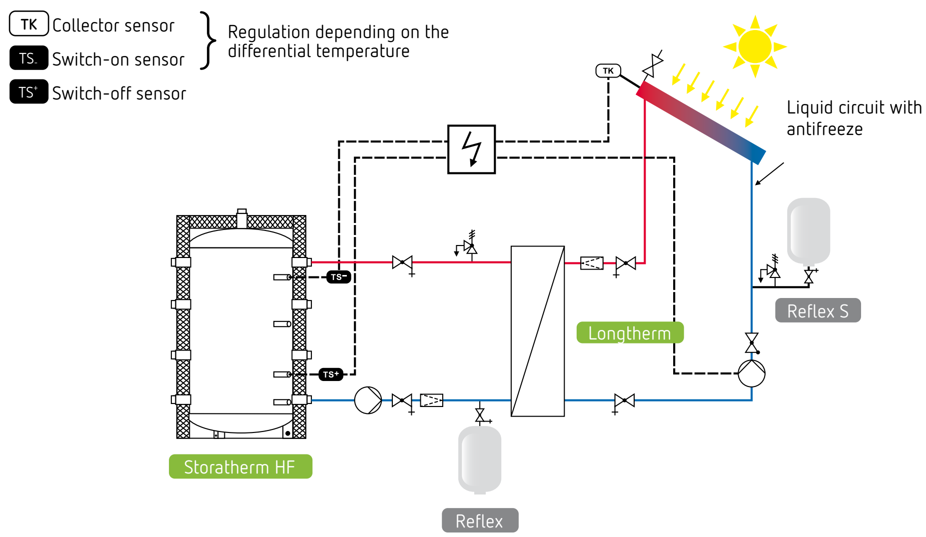
Longtherm
In a hot water storage tank-charging system for potable water heating



Note for the installer

- Select a potable water outlet temperature ≤ 60 °C if possible to minimise the risk of limescale formation (heating medium temperature ≤ 70 °C).
- For a continual flow-through on the potable water side, the limescale risk is lower; if necessary, incorporate the circulation line on the cold water side after the primary pump.
- Attention: For the dimensioning of the heat exchanger, the sum of the maximum potable water volume flow ($\dot{V}_{Charge}$) and the circulation volume flow ($\dot{V}_{Circ}$) is to be used.
- If used as an instantaneous water heater without downstream hot water storage tank, always use quick controllers.

Longtherm
In a solar system with buffer tank



Note for the installer

- According to DIN EN 12953 or based on TRD 402, 18.6: “With pressure expansion vessel and collecting vessels, the actually occurring operating temperature can be used as the calculation temperature.”
- TRD 604 Sheet 2, 1.3.: “With an expansion vessel, it is not necessary to fit a water level limiter, if a minimum pressure limiter fitted to the expansion vessel triggers when the level falls below the lowest permissible water level.”
- **We recommend:**
  Reflex V intermediate vessel > 120 °C with unattended operation expansion vessel valve train each with a maximum / minimum pressure limiter PAZ+ / PAZ and monitor PAS / PAS as well as a safety temperature limiter TAZ+ for on-site installation.

The diagrams are solely to illustrate the connections. They must be matched to the local conditions and substantiated.

Equipment, accessories, safety technology, review

Safety valves*

For the purposes of directives and regulations, the equipment includes all the equipment accessories required for operation and safety, such as connecting pipes, valves and control devices. The safety equipment is regulated in standards. Essential equipment accessories are described below. See P. 76 – P. 79 for a summary of heat generation systems with operating temperatures up to 105 °C in accordance with DIN EN 12828 and water heating systems according to DIN 4753.

Safety valves protect heat and / or cold generators, expansion vessels and the entire system from impermissible excess pressures. They must be designed taking into account possible load cases (e.g. heat supply with shut-off heat generators, pressure increase caused by pumping).

Hot water generators

DIN EN 12828: "Each heat generator of a heating system shall be served by at least one safety valve in order to protect the system against exceeding the maximum operating pressure."
Safety valves on directly heated heat generators must be designed for saturated steam relative to the rated heating capacity $\dot{Q}$ in order to ensure safe and satisfactory discharge. Above 300 kW heat generation power, an expansion trap should be connected downstream to separate steam and water phases. In the case of indirectly heated heat generators (heat exchangers), the determination of the size of the water outlet is possible if the discharging of steam is excluded by the prevailing temperature or pressure conditions. Based on experience, sizing corresponding to a liquid outlet flow of 1 l / (hkW) is acceptable. According to DIN EN 12828, if more than one safety valve is used, the smaller one must be designed for at least 40% of the total discharge volume flow.

The technical specifications below refer in part to rules applied in the past for better comparability with existing systems. For precisely this reason, the current European regulations, such as EN ISO 4126-1 for safety valves, are provided with a national appendix in Germany to explain the connection to former regulations. Therefore, we also refer to the previously available valves and their design bases. As safety-relevant components all valves must carry a CE marking according to PED 2014 / 68 / EU or the prior 97 / 23 / EC regulation and should be type-tested. The following safety valve (SV) below refer to the valves currently on the market. Currently, valves are sized and labelled in accordance with DIN ISO 4126 Part 1. Dimensioning must then be carried out accordingly.

SV code letter H (heating)

These safety valves are generally known as "membrane safety valves" with 2.5 and 3.0 bar actuating pressures. In accordance with TRD 721, H-valves in Germany could be used up to a maximum triggering pressure of 3 bar. The performance is defined independently of the manufacturer. For simplicity, the discharge performance for steam and water is set the same, regardless of the actuation pressure (2.5 or 3.0 bar).

SV Code letter D / G / H (steam, gas, hot water), currently (S / G / L for steam, gas, liquid)

If the actuating pressures differ from 2.5 to 3.0 bar or if a power of 900 kW is exceeded, D / G / H safety valves are used. The discharge capacities are specified on a manufacturer-specific basis according to the permitted coefficient of discharge.

Water heating systems

Only safety valves with code letter W are permitted in water heating systems based on DIN 4753. In some cases, combined valves W / F (F – liquids) are offered. The performance values are specified in TRD 721.

Solar thermal systems

Solar thermal systems in accordance with VDI 6002 must be equipped with H or D / G / H safety valves, intrinsically safe systems also with F safety valves (discharge only for liquids). If solar thermal systems are designed according to the specifications in this document, they are classed as intrinsically safe.

Cold water systems

For cold water systems in which evaporation can be excluded, F-safety valves according to the manufacturer can be used. The load cases are dependent on the connection and must be determined on an object-related basis.

Expansion vessels

If the permissible operating overpressure of expansion vessels is lower than the permissible operating pressure of the system, a self-protection device is required. The load cases must be determined on a case-by-case basis. Suitable valves are H, D / G / H and safety valves, according to the AD datasheet A2 (e.g. F). Reflex expansion vessels for pump-controlled pressure maintenance stations are depressurised during normal operation, nevertheless a pressurisation must be allowed for in the event of incorrect operation. They are therefore protected with F-valves via the control unit. The maximum possible volume flow must be discharged at the discharge pressure (5 bar). This generally occurs with 1 l / (hkW) related to the connected total heating capacity.

*Reflex does not supply safety valves.

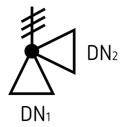
Safety valves on heat generators according to DIN EN 12828, (TRD 721***), PED, EN ISO 4126

Code letter H, discharge pressure p_{SV} 2.5 and 3.0 bar

Inlet connection thread [G] – Outlet connection thread [G]	½ - ¾	¾ - 1	1 - 1¼	1¼ - 1½	1½ - 2	2 - 2½
Discharge capacity for steam and water/kW	≤ 50	≤ 100	≤ 200	≤ 350	≤ 600	≤ 900

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

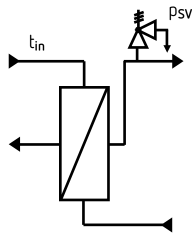
DN1xDN2	20x32	25x40	32x50	40x65	50x80	65x100	80x125	100x150	125x200	150x250	20x32	25x40
p_{SV}/bar	Steam discharge ⟵ Discharge capacity/kW ⟶										Water discharge	
2.5	198	323	514	835	1,291	2,199	3,342	5,165	5,861	9,484	9,200	15,100
3.0	225	367	583	948	1,466	2,493	3,793	5,864	6,654	10,824	10,200	16,600
3.5	252	411	652	1,061	1,640	2,790	4,245	6,662	7,446	12,112	11,000	17,900
4.0	276	451	717	1,166	1,803	3,067	4,667	7,213	8,185	13,315	11,800	19,200
4.5	302	492	782	1,272	1,966	3,344	5,088	7,865	8,924	14,518	12,500	20,200
5.0	326	533	847	1,377	2,129	3,621	5,510	8,516	9,663	15,720	13,200	21,500
5.5	352	574	912	1,482	2,292	3,898	5,931	9,168	10,403	16,923	13,800	22,500
6.0	375	612	972	1,580	2,443	4,156	6,322	9,773	11,089	18,040	14,400	23,500
7.0	423	690	1,097	1,783	2,757	4,690	7,135	11,029	12,514	20,359	15,800	25,400
8.0	471	769	1,222	1,987	3,071	5,224	7,948	12,286	13,941	22,679	16,700	27,200
9.0	519	847	1,346	2,190	3,385	5,759	8,761	13,542	15,366	24,998	17,700	28,800
10.0	563	920	1,462	2,378	3,676	6,253	9,514	14,705	16,686	27,146	18,600	30,400



Max. primary flow temperature t_{in} 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_{in}/°C	≤ 138	≤ 143	≤ 147	≤ 151	≤ 155	≤ 158	≤ 161	≤ 164	≤ 170	≤ 175	≤ 179	≤ 184

The water discharge table may be used for **heat exchangers** if the adjoining conditions are met.



Safety valves on water heaters according to DIN 4753 and EN ISO 4126, (TRD 721)

Code letter W, discharge pressure p_{SV} 6, 8, 10 bar, e.g. SYR Type 2115*

Inlet connection G	Tank volume litre	Max. heat input capacity kW
½	≤ 200	75
¾	> 200 ≤ 1000	150
1	> 1000 ≤ 5000	250
1¼	> 5000	30,000

Safety valves in solar thermal systems according to VDI 6002, DIN 12976/77, (TRD 721), EN ISO 726

Code letters H, D/G/H, F (intrinsically safe systems)

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

→ During selection, the system-specific conditions must be compared with the manufacturer's valve specifications (e.g. temperature load).

Safety valves in cooling systems and expansion vessels

Code letter F (only for guaranteed liquid discharge), e.g. SYR type 2115*

Inlet connection	½	¾	1	1¼	1½	2
p_{SV}/bar	Discharge capacity/m³/h					
4.0	2.8	3.0	9.5	14.3	19.2	27.7
4.5	3.0	3.2	10.1	15.1	20.4	29.3
5.0	3.1**	3.4	10.6**	16.0	21.5	30.9
5.5	3.3	3.6	11.1	16.1	22.5	32.4
6.0	3.4	3.7	11.6	17.5	41.2	50.9

* Contact the manufacturer for the latest values.

** Protection of Reflex expansion vessels in pressure maintenance stations

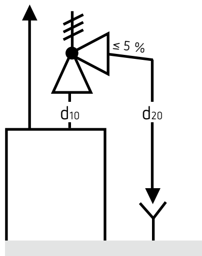
Vessel up to 1000 litre, Ø740 mm, G ½ = 3100 kW = 3,100 l/h

from 1000 litre, Ø1000 mm, G 1 = 10600 kW = 10,600 l/h

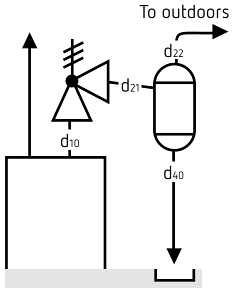
*** If safety valves based on DIN ISO 4126 are used, the corresponding design principles must be applied.

Discharge pipes of safety valves, expansion traps

Discharge pipes must be designed according to the requirements of the rules governing the application. For example DIN EN 12828, DIN EN 12953 Part 6, PED, TRD 721 or VDI 6002 for solar systems. In accordance with DIN EN 12828, safety valves must be installed in such a way that the pressure loss in the connection pipe to the heat generator does not exceed 3% and in the discharge pipe does not exceed 10% of the nominal pressure of the safety valve. For a practical implementation, these requirements are summarised in several tables for simplification purposes. In individual cases, a computer calculation may be necessary.



Expansion traps, installation
Expansion traps are installed in the discharge line of safety valves and are used to separate the steam and water phases. A water drain pipe must be connected at the low point of the expansion trap that can safely and easily remove escaping heating water. The steam discharge line must be routed from the high point of the expansion trap to the outside.



Necessity
According to DIN EN 12828 for heat generators with a rated heating capacity > 300 kW. For indirectly heated heat generators (heat exchangers), expansion traps are not required if the safety valves can be sized for water discharge, i.e. there is no risk of steam formation on the secondary side.
Safety valves on heat generators P. 69

Discharge pipes and Reflex expansion traps in systems according to DIN EN 12828

Safety valve code letter H, discharge 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		Heat generator nominal rating	Discharge line			Supply line SV				Pipe SV – T			Discharge line			Water drain pipe
d_1 DN	d_2 DN	Q kW	d_{20} DN	Length m	Number of elbows	d_{10} DN	Length m	Number of elbows	Type T	d_{21} DN	Length m	Number of elbows	d_{22}* DN	Length m	Number of elbows	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 code letter D/G/H, discharge pressure p_{SV} ≤ 10 bar

		SV without T-expansion trap				SV with or without T-expansion trap					SV with T-expansion trap						
Safety valve		Discharge line				Supply line SV					Pipe SV – T			Discharge line			Water discharge pipe
d_1 DN	d_2 DN	d_{20} DN	Length m	Number of elbows	discharge pressure	d_{10} DN	Length m	Number of elbows	Type T	discharge pressure	d_{21} DN	Length m	Number of elbows	d_{22} DN	Length m	Number of elbows	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 merging several pipes, the cross-section of the header pipe must be at least as large as the sum of the cross-sections of the individual pipes.

Pressure limiters

Pressure limiters are electromechanical switching devices and are classified as safety-relevant equipment according to the Pressure Equipment Directive 2014/68/EU, previously 97/23/EC (PED). The limiters used must therefore bear a CE marking and should be type-tested. If the pressure is exceeded or undershot, the heating is immediately switched off and locked.

→ Reflex does not supply pressure limiters.

Maximum pressure limiter DB_{max}/PAZ^{+}

DIN EN 12828: "Each heat generator with a nominal heating capacity of $\dot{Q}_{max}$ of more than 300 kW shall be served by a pressure limiter."

In general, pressure limiters are set at 0.2 bar below the safety valve actuating pressure.

For heat exchangers (indirect heating), pressure limiters can be omitted.

Minimum pressure limiter DB_{min}/PAZ_{-}

DIN EN 12828 as the standard for systems with operating temperatures $T_R \leq 105$ °C does not in general require a minimum pressure limiter. It is only provided as a replacement for the water level limiter on directly heated heat generators.

For systems with pressurisation systems that are not supported by an automatic make-up system, a minimum pressure limiter can also be used for function monitoring.

Expansion lines, shut-offs, drains

Expansion lines, in heat generation systems
DIN EN 12828: "Expansion lines must ... be sized so that their flow resistance Δp ... can only cause a pressure increase ... that does not actuate the pressure limiter (PL_{max}) and safety valves (p_{SV})."

A volume flow of 1 litre / (hkW) relative to the nominal heating capacity of the heat generator $\dot{Q}$ is to be taken as a basis.

With prepressure maintenance, the permissible pressure loss Δp essentially results from the difference between the safety valve actuating pressure p_{SV} and the set pressure of the pressure limiter PL_{max} and the final pressure p_{fin}, minus a tolerance. Calculation of the pressure loss is based on the equation

$$\Delta p\ (1\ \text{litre}/(\text{hkW})) = \Sigma\ (R \times l + Z)$$

Reflex N Reflex G

The calculation can be omitted if the following table values are used. With Variomat pressure maintenance stations, the expansion lines are also sized according to the degassing capacity.

Expansion line	DN 20 ¾"	DN 25 1"	DN 32 1¼"	DN 40 1½"	DN 50 2"	DN 65	DN 80	DN 100
$\dot{Q}$ in kW Length ≤ 10 m	350	2,100	3,600	4,800	7,500	14,000	19,000	29,000
$\dot{Q}$ in kW Length > 10 m ≤ 30 m	350	1,400	2,500	3,200	5,000	9,500	13,000	20,000

Moreover, it is permissible and also usual for expansion lines at the connection nozzles of expansion vessels or pressure maintenance stations to be reduced to smaller sizes.

Expansion lines in potable water installations
In water heating and booster systems, the connection pipes for flow-through vessels are determined according to the peak volume flow V_S according to the rules of DIN 1988 - 300. The size of bypass lines for repair purposes (closed during operation) with Refix DT from 80 litre is generally chosen a size smaller than the main line. A bypass (open during operation) is already integrated in Refix DT units with a flow through valve. If Refix is to be used for water hammer damping, separate calculations are required.

Flowjet flow through valve

Shut-offs, drains for pressurisation systems
To be able to carry out the work required for maintenance and inspection purposes in a correct and professional manner, the water chambers of expansion vessels must be configured so that they can be shut-off from the heating / cooling system. The same applies for expansion vessels in potable water systems. This simplifies or indeed enables the system-related annual inspection of the pressurisation system (e.g. gas prepressure test on expansion vessels).

In accordance with DIN EN 12828, low-pressure, cap ball valves with a sleeve connection and integrated draining, as well as quick release couplings are available to prevent accidental closure.

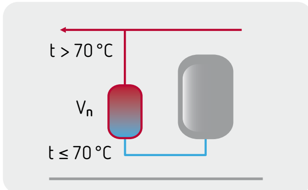
For the Refix DT 60 – 500 litre, a Flowjet RP 1¼ flow through valve is supplied for on-site installation that combines shut-off, draining and bypass.
For Refix DD 8 – 33 litre, our Flowjet flow through valve RP ¾ with secured shut-off and draining is optionally available as an accessory. The supplied T-piece for the flow-through is supplied as the RP ¾ version with Refix DD. Larger T-pieces are to be supplied on-site.
For Refix DT 80 – 3000 litre, the valves must be provided on-site. Here it makes sense to use the valves for the installation that are in any case supplied.

Refix DT with flow through valve Refix DD with T-piece

Intermediate vessels

Intermediate vessels protect the membrane of expansion vessels from unacceptable temperature loading. The possible temperature loading of the expansion vessels used must be checked and matched to the possible conditions on site. For example, according to DIN EN 13831, the continuous temperature at the membrane must not exceed 70 °C. A temperature ≤ 0 °C in the cold water systems must be avoided.

In heating systems
In general, heating systems are operated with return temperatures ≤ 70 °C. Installation of intermediate vessels is not necessary. In old and industrial systems, return temperatures > 70 °C may not be avoided.



A general formula for sizing the intermediate vessel cannot be specified.
The decisive factor is what water quantity is heated to above 70 °C. As a rule, it will generally be about 50% of the system volume. In systems with heat storage tanks, up to 100 % is possible.

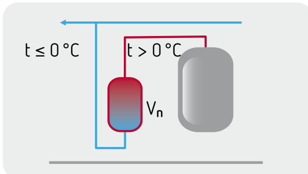
$$V_n = \frac{\Delta n^{1)}}{100} \times V_{sys}\ (0.5...1.0)$$

→ 0.5 if return flow 50% of V_{sys}
→ 1.0 if hot water storage tank with 100% V_{sys}
→ For safety reasons, allow for a factor of 1

Δn see material values for auxiliary variables P. 7
→ V_{sys} system volume

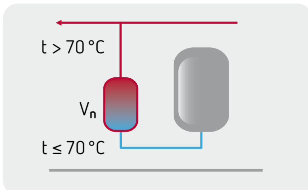
1) $\Delta n = n_{RL} - n_{70\,°C}$

In cooling circuits
If the temperature falls below ≤ 0 °C, we recommend that the intermediate vessel be sized as follows.



$$V_n = 0.005 \times V_{sys}$$

In solar thermal systems



Without evaporation

$$n = \frac{\Delta n}{100} \times V_{sys}$$

With evaporation

$$V_n = \frac{\Delta n^{2)}}{100} \times V_{sys} + V_C + x \times V_R^{3)}$$

→ n_{ST} = Material value for expansion at stagnation or pump cut-off temperature (stagnation temperature)

2) $\Delta n = n_{RL} - n_{ST}$

3) $x \times V_R$ = Steam spread in the piping system
$x = (0.1 - 1.0)$

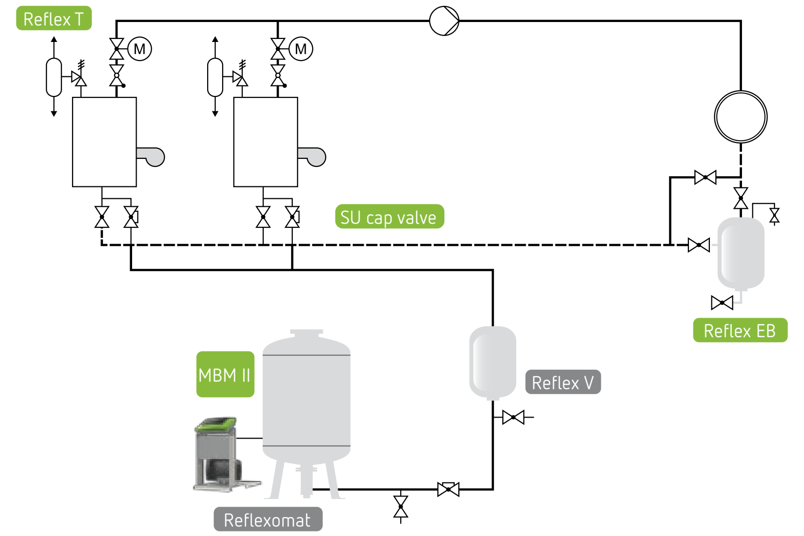
Accessory installation examples

Note for the installer

- "It must be possible to drain the water chamber of expansion vessels."
  → A drain is integrated with an expansion vessel connection set and SU cap valve
- For heat generators with a nominal heating capacity of more than 300 kW, an expansion trap must be located in the immediate vicinity of each safety valve.
  → Reflex T Expansion trap
- Especially for old systems, we recommend the installation of a Reflex EB dirt collector or an Exdirt sludge separator.
- Optionally, the use of a MBM II membrane flaw detector is possible for Reflexomat vessels and Refix DT potable water expansion vessels.

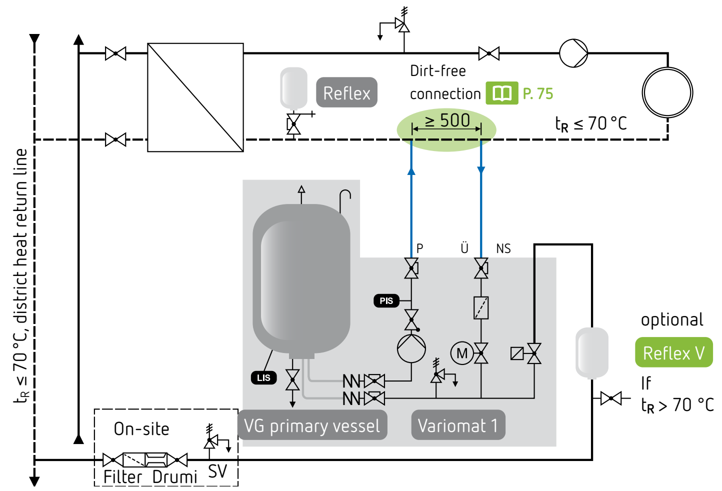
Reflex accessories

In a heating system with return temperature > 70 °C and boiler individual capacity > 300 kW



Accessory installation examples

Reflex V
In a district heating house substation with primary/secondary make-up



Agree the make-up connection at the district heating return pipe with the heat supplier

Generator and system protection pressurisation, degassing and make-up

Note for the installer

- In general district heat water is ideally suited as make-up water. Water treatment is not necessary.
- Agreement with the heat supplier is necessary! Observe the connection requirements!
- A bypass can be provided for Reflex V maintenance purposes.

DIN EN 12828:
All expansion vessels must be configures so that they can be shut-off from the heating system.
Expansion vessel connection set, SU cap valve

DIN EN 13831:
"In continuous operation, the temperature at the membrane must not exceed 70 °C."
Install Reflex V intermediate vessel upstream of the expansion vessel

Safety equipment for hot water-based heating systems

According to DIN EN 12828, operating temperatures up to 105 °C

	Direct heating (Heated with oil, gas, coal or electricity)		Indirect heating (Heat generators heated with liquids or steam)	
Temperature protection				
Temperature measuring device	Thermometer, display range[3] 120 % of the maximum operating temperature			
Safety temperature limiter, safety temperature monitor according to EN 60730-2-9	Safety temperature limiter Overshoot temperature max. 10 K		Safety temperature limiter with $t_{PR} > t_{dSec}$ (p_{SV}), safety temperature limiter not required, if primary temperature ≤ 105 °C, or use of a safety temperature monitor if $t_{PR} > t_{Smax}$[1]	
Temperature controller[2]	From heating medium temperatures > 100 °C, target value ≤ 60 °C, maximum value 95 °C (not applicable for Gr. I)			
Low water switch - Bottom of boiler	$\dot{Q}_n \leq 300$ kW Not necessary because if there is a low water state there is no impermissible heating	$\dot{Q}_n > 300$ kW LWS or safety pressure limiter$_{min}$ or flow restrictor	To ensure controllability, a **minimum volume flow** across the heat exchanger must be ensured.[3]	
- Boiler in roof units	LWS or safety pressure limiter$_{min}$ or flow restrictor or suitable fittings		---	
- Heat exchanger with heating that is unregulated or cannot be turned off quickly (solid fuel)	Emergency cooling (e.g. thermally activated safety valve, safety heat consumer) with safety temperature limiter, so that it is possible to intervene if the maximum operating temperature is exceeded by more than 10 K		---	
Pressure protection				
Pressure measurement instrument	Pressure gauge, display range ≥ 150 % of the maximum operating pressure			
Safety valve according to prEN 1268-1 or prEN ISO 4126-1, TRD 721	Rated for steam discharge		$t_{PR} > t_{dSec}$ (p_{SV})[3] Sizing for steam discharge with $\dot{Q}_n$	$t_{PR} \leq t_{dSec}$ (p_{SV})[3] water discharge 1 l/(hkW)
Expansion trap per SV	'T' for $\dot{Q}_n > 300$ kW alternatively additional 1 safety temperature limiter + 1 safety pressure limiter$_{max}$ (PAZ+)			---
Pressure limiter max. TÜV tested	Per heat generator with $\dot{Q}_n > 300$ kW, safety pressure limiter$_{max}$ = p_{SV} - 0.2 bar		---	---
Pressure maintenance Expansion vessel	▪ Pressure regulation within the limits p_{ini} ... p_{fin} as expansion vessel or expansion vessel with external pressure generation ▪ It should be possible to safely isolate and drain expansion vessels for maintenance purposes.			
Filling equipment	▪ Safeguarding the operational minimum water reserve V_{res}, automatic make-up with water meter ▪ Connections to potable water systems must comply with prEN 806-4 or DIN 1988-100 or DIN EN 1717			
Heating				
			Primary shut-off valve, if $t_{PR} > t_{dSec}$ (p_{SV}) Recommendation: Primary shut-off valve also for $t_{PR} > t_{perm.\ sec}$	

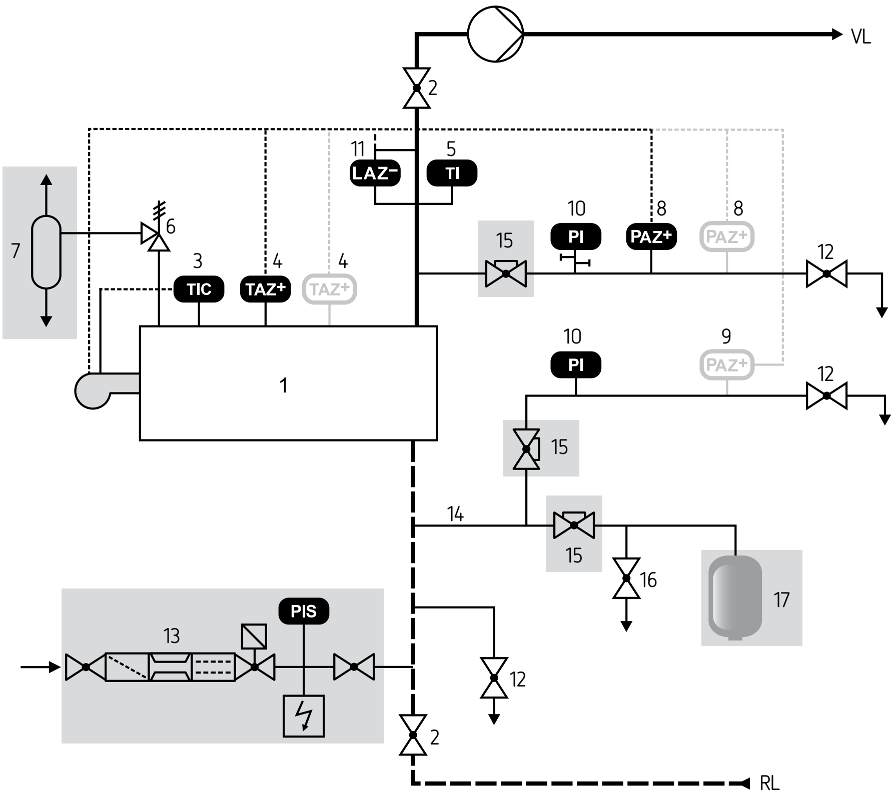
[1] Safety temperature limiter is recommended because if a safety temperature monitor is used, if the temperature falls below the limit value, it automatically re-enables heating and in so doing "sanctions" the incorrect performance of the controller.

[2] If the temperature controller is not type-tested (e.g. DDC without a structural block for the maximum target temperature), then with direct heating, an additional type-tested temperature limiter must be provided.

[3] Based on invalid DIN 4751 Part 2.

According to DIN EN 12828, operating temperatures up to 105 °C

Example: direct heating



Legend

1	Heat generator
2	Shut-off valves flow / return
3	Temperature controller
4	Safety temperature limiter (STB)
5	Temperature measuring device
6	Safety valve
7	Expansion trap ('T') > 300 kW[1) 2)]
8	Safety pressure limiter$_{max}$[1)], Q > 300 kW
9	Safety pressure limiter$_{min}$, as optional replacement for low water switch
10	Pressure gauge
11	Low water switch, up to 300 kW also replaceable by safety pressure limiter$_{min}$ or flow monitor or other approved measures
12	Boiler drain & fill valve / BDF valve
13	Automatic make-up
14	Expansion line
15	Secured shut-off valve
16	Venting / draining upstream of expansion vessel
17	Expansion vessel

→ Code letters, symbols P. 5

Optional components

Reflex product range

[1)] Not necessary for indirect heating, if SV can be designed for water discharge. P. 38

[2)] Can be omitted if an additional safety temperature limiter and safety pressure limiter$_{max}$ are fitted.

Safety equipment for potable water heating systems according to DIN 4753 Part 1

Requirements for potable water heating systems

potable water heater closed, indirectly heated

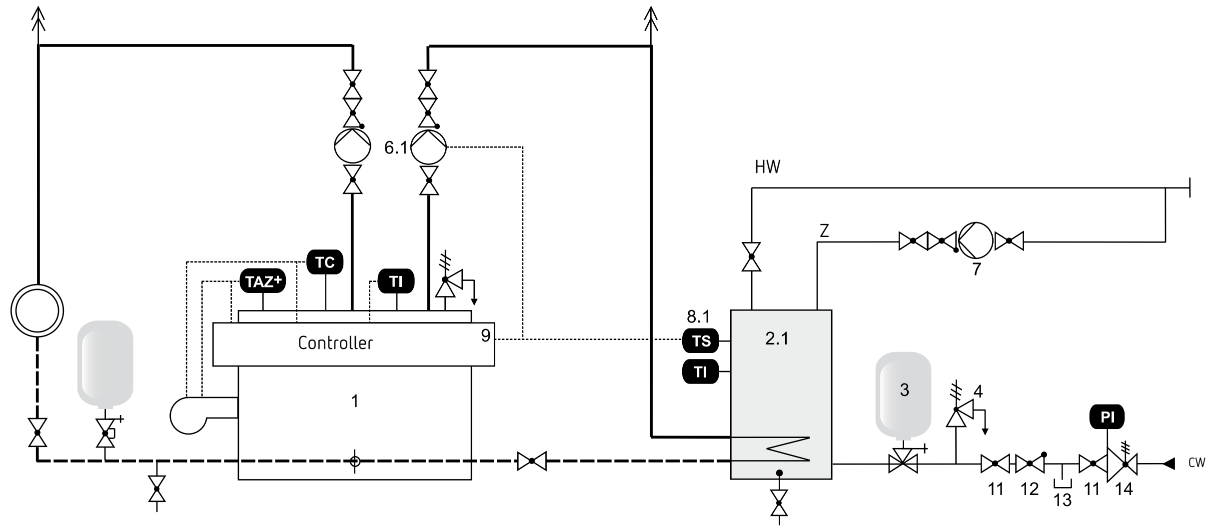
Group assignment according to DIN 4753 Part 1: Gr. I p x I ≤ 300 bar x litre and simultaneously Q ≤ 10 kW or V ≤ 15 l and Q ≤ 50 kW
Gr. II if the limit for Gr. I is exceeded

Temperature protection	DIN 4753 Part 1, DIN 1988-200, DIN 4747
Thermometer	May be part of the controller, not applicable for Gr. I
Temperature controller type-tested	From heating medium temperatures > 100 °C, target value ≤ 60 °C, maximum value 95 °C (not applicable for Gr. I)
Safety temperature limiter According to DIN 3440	From heating medium temperatures > 110 °C, target value ≤ 95 °C, maximum value 110 °C for V < 5.000 l and $\dot{Q}$ ≤ 250 kW, no intrinsic safety necessary according to DIN 3440; In district heating systems, control valve with safety function according to DIN 32730
Pressure protection	**DIN 4753 Part 1, DIN 1988-200**
pressure gauge	Specified for tanks > 1000 l, general installation close to safety valve, recommended in cold water systems
Safety valve	■ Arrangement in the cold water pipe ■ No shut-offs and impermissible constrictions between water heater and safety valve

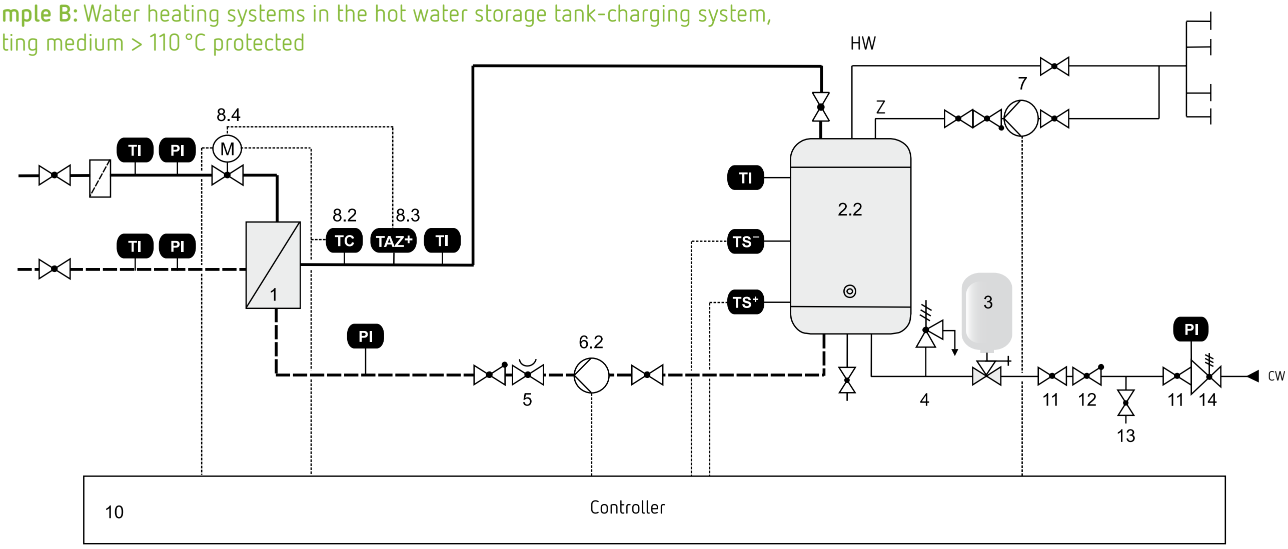
Nominal volume water space	Max. heating capacity	Connection nominal diameter
≤ 200 l	75 kW	DN 15
≤ 1,000 l	150 kW	DN 20
≤ 5,000 l	250 kW	DN 25
> 5,000 l	Selection according to the maximum heating input capacity	

Pressure reducer DVGW tested	Necessary: ■ If the pressure of the cold water line > 80 % of the safety valve opening pressure ■ If expansion vessels are installed (MAG-W according to DIN 4807 Part 5) to ensure a constant idle pressure upstream of the vessel
Expansion vessels MAG-W according to DIN 4807 Part 5	■ Requirements according to DIN 4807 Part 5: Through flow under defined conditions Colour green Membrane and non-metallic parts at least according to KTW-C Installation of a pressure reducer ■ Secured shut-off of the expansion vessel ■ Preliminary pressure setting 0.2 bar less than the pressure reducer
potable water protection	**DIN 1988 Part 2, Part 4 or DIN EN 1717**
Back flow preventer DVGW tested	Specified for domestic hot water heaters > 10 litre, can be shut-off on both sides, checking device provided after first isolating device
Type of potable water heater According to DIN 1988 Part 2 for hot water heating medium Cl. 3 according to DIN EN 1717 (without or with only slightly toxic additives e.g. ethylene glycol, copper sulphate solution), other media and types see DIN	**Version type B** , corrosion-resistant heating surfaces and lining (CU, stainless steel, enam-elled) e.g. Longtherm plate heat exchanger Permissible for max. operating pressure on the heating side ≤ 3 bar Type C = B + no detachable connections, the quality of the non-detachable connections must be proven by a procedure test (e.g. the AD-leaflets, HP series), e.g. tube heat exchangers also permitted for max. operating pressure on the heating side > 3 bar

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



Example B: Water heating systems in the hot water storage tank-charging system, heating medium > 110 °C protected



Legend

1	Heat generator (boiler, heat exchanger)
2.1	Hot water storage tank with integral heating surface
2.2	Hot water storage tank without heating surface
3	Membrane expansion vessel for potable water P. 39 – P. 43
4	Membrane SV, code letter W
5	Quantity adjustment valve
6.1	Charge pump heater side
6.2	Charge pump potable water side
7	Circulating pump
8.1	Thermostat for activation of the charge pump 6.1
8.2	Type-tested temperature controller
8.3	Type-tested temperature limiter
8.4	Control valve with safety function
9	Boiler control unit with hot water preparation actuation option
10	Heating circuit control unit with actuation option for a primary store system
11	Isolation valve
12	Backflow preventer
13	Test facility
14	Pressure reducer

11–14: Can also be used as a combined valve in conjunction with safety valve 4

→ Code letters, symbols P. 5

Review and maintenance of systems and pressure vessels

Why review is performed
Pressure vessels may be expansion vessels, pre-cooling vessels, desludging vessels but also heat exchangers or boilers. They are inherently dangerous, essentially due to the pressure, volume, temperature and medium itself.

Legally regulated special requirements apply for the production, commissioning and operation of pressure vessels and complete systems.

Manufacture according to the PED
The Pressure Equipment Directive (**PED**) 2014/68/EU (until 31/05/2015: 97/23/EC) has applied to the manufacture and **initial review** at the manufacturer's premises and the bringing to market of pressure equipment since 01/06/2002.

CE Reflex expansion vessels comply with the Directive 2014/68/EU **(PED)** and are marked with 0045.

"0045" stands for TÜV Nord as a named inspection body.

Since the publication of the Pressure Equipment Directive in 2003 the manufacturer certificate created according to the steam boiler or pressure vessel regulations has been replaced by a **conformity declaration.** P. 84

For Reflex pressure vessels, the conformity declaration forms part of the supplied installation, operating and maintenance instructions.

Operation according to the Ordinance on Industrial Safety and Health (BetrSichV)
Operation means, within the sense of the regulations, the installation, operation, **review prior to commissioning** and the **periodic review** of the systems requiring monitoring.

With the Industrial Safety Directive and the directive on pressure vessels, since 01/01/2003 there has been a harmonised body of regulations available which permanently replaces the previously valid pressure vessel and boiler regulations.

The necessity for tests prior to commissioning and periodic tests, as well as the body which can carry out the review, are defined dependent on the hazard potential according to **BetrSichV**. This involves a division into categories based on medium (fluid), pressure, volume and temperature. You can find an analysis relating to the Reflex product range in tables 1, 2 and 3 (P. 82 – P. 83). The specified maximum time limits shall apply for the case of compliance with the requirements in the Reflex installation, operating and maintenance instructions.

While for the conformity assessment by the **manufacturer in accordance with the PED**, the maximum permissible parameters relative to the vessel apply, for the assessment by the **operator according to BetrSichV**, the maximum occurring parameters relative to the system are used. Thus in the assessment and classification in categories for the pressure P_S the maximum possible pressure P_B is to be used, which may also occur under extreme operating conditions, malfunction conditions and incorrect operation according to the pressure protection of the system or the system component. The fluid group must be selected according to the actual medium.

Section 15 Review prior to commissioning

- Assembly, installation
- Installation conditions
- Safe function

Section 16 Periodic tests

- Organisation check
- Technical check
  - External inspection
  - Internal inspection
  - Strength test

The operator itself must specify the intervals between periodic tests based on a safety evaluation taking into consideration the specified maximum intervals. (Tables 1, 2 and 3, P. 82 – P. 83)

If the system is to be commissioned by a ZÜS approved review body, then the responsible authority must be informed of the review intervals specified by the operator and must agree them with it.
In the safety assessment a differentiation must be made between

- The **overall system**, which may comprise several pressure devices and maybe set up with defined pressure and temperature limits, e.g. hot water boiler with pressure expansion vessel, secured via the safety valve and safety temperature limiter of the boiler,
- And the **system components**, e.g. hot water boiler and pressure expansion vessel, which may belong to different categories and therefore be assessed differently from a safety point of view.

If the overall system consists solely of system parts that can be tested by a competent person, then the entire system can also be tested by a competent person (cp).

For the external and internal inspections, inspections can also be performed using other suitable equivalent procedures and for strength tests the static pressure tests replaced by equivalent, non-destructive methods.

Transitional regulations
For systems with pressure equipment which was first commissioned prior to 01/01/2003, a transition period applied until 31/12/2007.

Since 01/01/2008 the regulations of BetrSichV apply without limitation for systems subject to monitoring.

Maintenance
While the regulations of the PED and BetrSichV are primarily aimed at the safety aspects in respect of health and safety, regular maintenance also helps to ensure optimum, fault-free and energy-saving operation. Implementation is performed by a **specialist** on behalf of the operator. This may be either an installer or also the Reflex service department.

The maintenance of expansion vessels must be performed according to the manufacturer's specifications and thus on an annual basis and consists essentially of the checking and setting of the vessel prepressure and the system filling or initial pressure. P. 10

We also recommend annual maintenance of our pressurising, make-up and degassing systems, analogously to the expansion vessels.

Reflex offers installation, operating and maintenance instructions (P. 84) with the necessary instructions for the installer and operator.

Table 1:

Review of reflex pressure vessels according to BetrSichV, Issue 03/02/2015 with validity from 01/06/2015/ version 30/04/2019 for operation according to the Reflex installation, operating and maintenance instructions

Applicable to all

- Reflex, Refix, Variomat, Variomat Giga, Reflexomat, Reflexomat Silent Compact vessels and the Servitec spray tube and
- Pre-cooling vessels, desludging vessels and Longtherm brazed plate heat exchangers at permissible operating temperatures > 110 °C of the facility system (e.g. safety temperature limiter adjustment)

Classification in fluid group 2 (water, air, nitrogen = non-explosive, non-toxic, not easily inflammable).

Test group/evaluation BetrSichV 2015 According to Sections 4, 5.8 tables 1 and 4	Before commissioning, section 15	Periodic checks, section 16			
		Maximum intervals in years			
	Inspector	Inspector	Outer[1)]	Inner[2)]	Strength[2)]
V≤ 1 litre and $P_B \leq 1000$ bar $P_B \times V \leq 50$ bar × litre	No special requirements, control is the responsibility of the operator in accordance with the current state of the art and the specifications in the operating instructions[3)]				
Reflex, Refix, pre-cooling, desludging, Longtherm, Variomat, Variomat Giga, Reflexomat, Reflexomat Silent Compact vessels					
$P_B \times V > 50 \leq 200$ bar × litre	cp	cp	---	5/10*	10/15*
$P_B \times V > 200 \leq 1{,}000$ bar × litre	ZÜS**	cp	---	5/10*	10/15*
$P_B \times V > 1000$ bar × litre	ZÜS**	ZÜS**	---	5/10*	10/15*

For pressure equipment which must be periodically checked by a competent person, the maximum test interval may be up to 10 years. Additionally the interval for strength review can optionally be extended to 15 years insofar that proof can be provided of safe operation. (BetrSichV 2015/2019, Annex 2, Sections 4, 5.9)

* **Recommended:**
For Reflex and Refix as well as Variomat and Variomat Giga vessels with intact bladder membrane it may even be possible to eliminate the periodic review, if the spacing can be reliably checked for leaks. (BetrSichV 2015/2019, Annex 2, Section 4, 7.7, 7.11)

** **Important note - When using in heating and cooling systems:**
With indirectly heated heat generators (Longtherm) with a heating medium temperature of no more than 120 °C (e.g. safety temperature limiter setting) and expansion vessels (Reflex, Refix, Variomat, Variomat Giga, Reflexomat or Reflexomat Silent Compact vessels) in heating and chilling/cooling systems with water temperatures of up to 120 °C, the checks can be performed by a competent person (cp). (BetrSichV 2015/2019, Annex 2, Sections 4, 7.3)

Table 2:

Review of Reflex pressure vessels according to BetrSichV, Issue 03/02/2015 with validity from 01/06/2015/ version 30/04/2019 for operation according to the Reflex installation, operating and maintenance instructions

Applicable to all

- Pre-cooling vessels, desludging vessels and Longtherm brazed plate heat exchangers at permissible operating temperatures ≤ 110 °C of the facility system (e.g. safety temperature limiter adjustment)

Classification in fluid group 2 (water = non-explosive, non-toxic, not easily inflammable).

Test group/evaluation BetrSichV 2015/2019 According to Sections 4, 5.8 tables 1 and 6	Before commissioning, section 15	Periodic checks, section 16			
		Maximum intervals in years			
	Inspector	Inspector	Outer[1)]	Inner[2)]	Strength[2)]
$P_B \leq 10$ bar or $P_B \times V < 10000$ bar · litre at $P_B \leq 1000$ bar	No special requirements, control is the responsibility of the operator in accordance with the current state of the art and the specifications in the operating instructions[3)]				
$10 < P_B \leq 500$ bar and $P_B \times V > 10000$ bar · litre	ZÜS	cp	---	5*	10*

Table 3:

Review of Reflex pressure vessels according to BetrSichV, Issue 03/02/2015 with validity from 01/06/2015/version 30/04/2019 for operation according to the Reflex installation, operating and maintenance instructions

Classification in fluid group 1 (e.g. petrol = explosive, highly flammable, toxic, oxidising).
This fluid group is only permitted for Longhtherm!
Applications for permissible operating temperatures $t > t_{Boil}$ at atmospheric pressure + 0.5 bar.

Test group/evaluation BetrSichV 2015 According to Sections 4, 5.8 tables 1 and 3	Before commissioning, section 15	Periodic checks, section 16 Maximum intervals in years			
	Inspector	Inspector	Outer[1]	Inner[2]	Strength[2]
V≤ 1 litre and $P_B \leq 200$ bar $P_B \times V \leq 25$ bar × litre	No special requirements, control is the responsibility of the operator in accordance with the current state of the art and the specifications in the operating instructions[3]				
$P_B \times V > 25 \leq 1{,}000$ bar × litre $P_B \leq 200$ bar	cp	cp	---	5	10
$P_B \times V > 200 \leq 1{,}000$ bar × litre $P_B \leq 200$ bar	ZÜS	cp	---	5	10
$P_B \times V > 1000$ bar × litre	ZÜS	ZÜS	---	5	10

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

Note: If a number of categories are entered in the column Evaluation/Category without "AND" logic combinations, then as soon as one of the criteria is exceeded, the corresponding higher category must be used.

P_B maximum possible gauge pressure in bar that can result from the system properties and mode of operation

n Expansion coefficient for water

V Nominal volume in litre

t Operating temperature of the fluid

t_{Boil} Boiling temperature of the fluid at atmospheric pressure

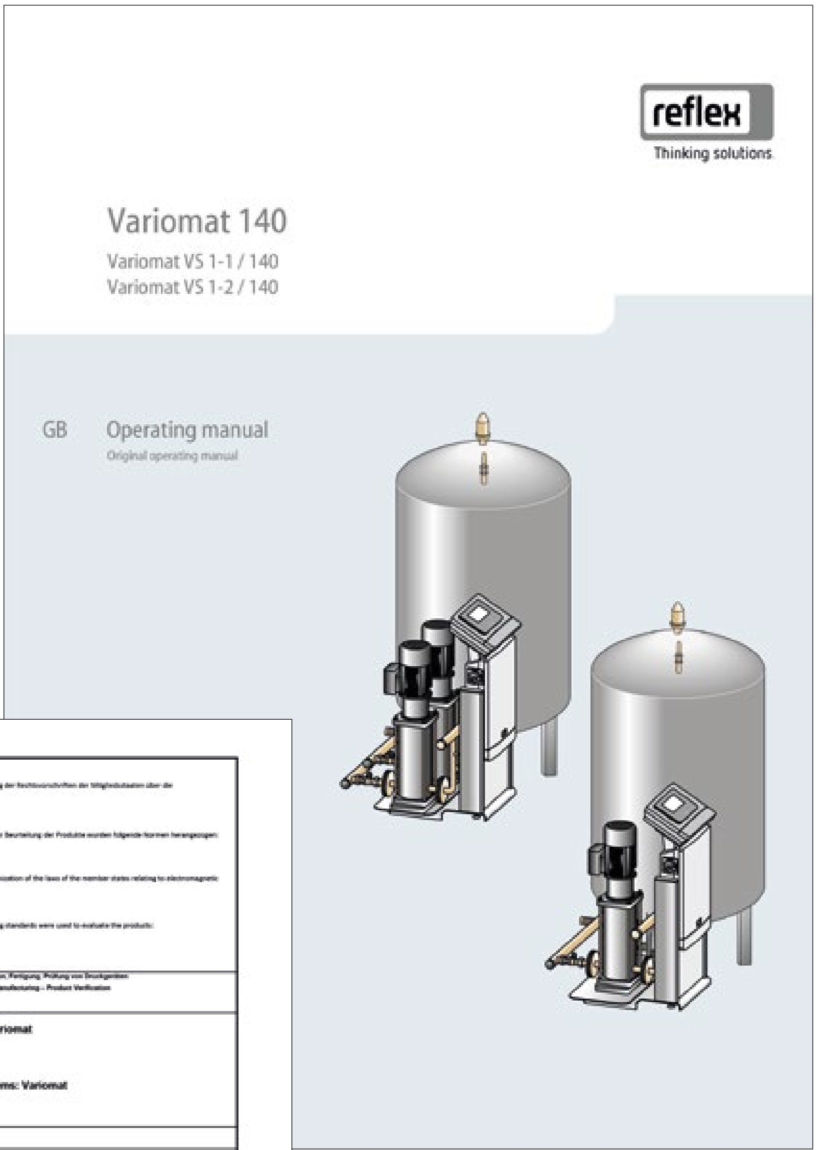
cp Competent person according to BetrSichV, Section 1, Para. 2, (6) and Annex 2, Section 4, 3., who through professional training, their vocational experience and their recent professional activities have the necessary expertise to test the resources (pressure equipment)

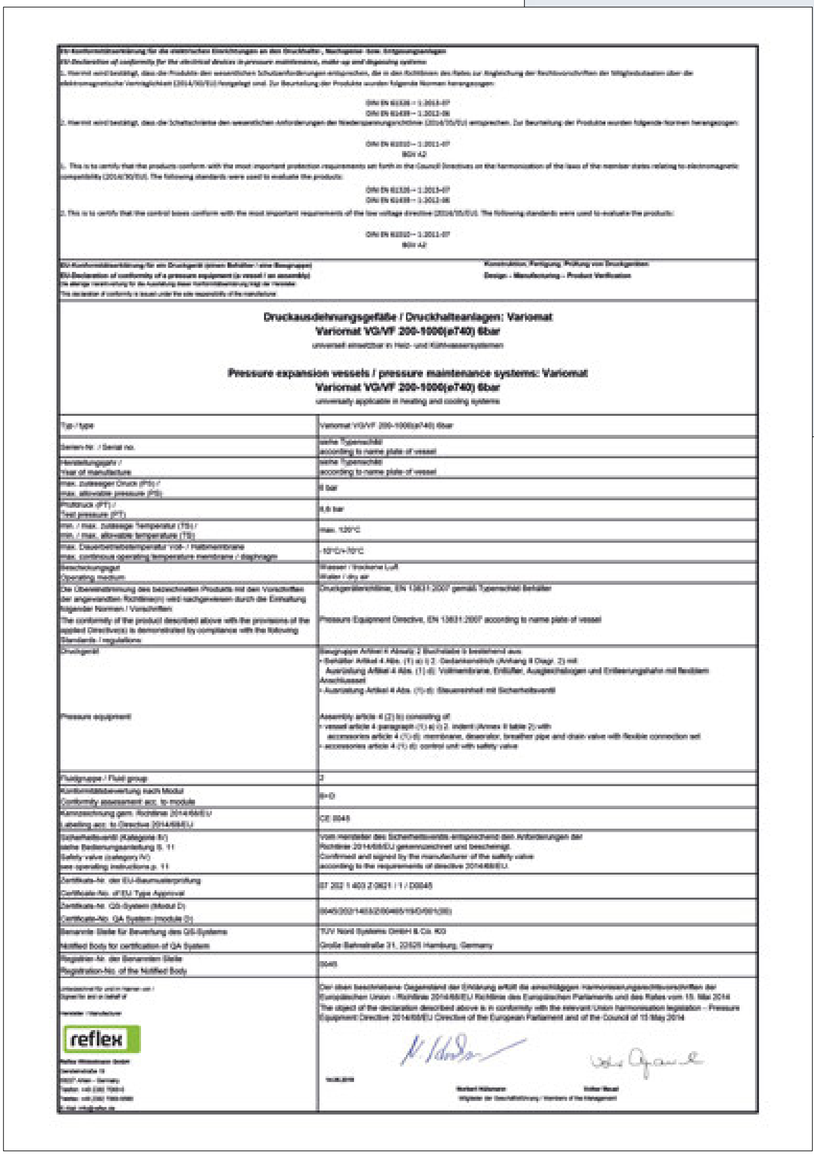
ZÜS Approved review body according to BetrSichV , Section 1, Para. 2, (14) and Annex 2, Section 1.

[1] External inspections every 2 years can be omitted for the usual Reflex applications. Only necessary, if the pressure equipment is flame-heated, exhaust gas heated or electrically heated. (BetrSichV Annex 2, Section 4, 5.8 Table 1)

[2] Inspections and strength tests can be replaced by equivalent non-destructive test methods in accordance with BetrSichV, Annex 2, Section 4, 5.7.

[3] Relative to the permissible operating overpressure of the device, this relates to the following products:
Reflex up to N 12 litre/3 bar, Servitec type ≤ 120
Longtherm rhc 15, rhc 40 ≤ 50 plates, rhc 60 ≤ 30 plates





DIN EN 61326 – 1:2013-07
DIN EN 61439 – 1:2012-06

DIN EN 61010 – 1:2011-07
BGV A2

DIN EN 61326 – 1:2013-07
DIN EN 61439 – 1:2012-06

DIN EN 61010 – 1:2011-07
BGV A2

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

Druckausdehnungsgefäße / Druckhalteanlagen: Variomat
Variomat VG/VF 200-1000(ø740) 6bar
universell einsetzbar in Heiz- und Kühlwassersystemen

Pressure expansion vessels / pressure maintenance systems: Variomat
Variomat VG/VF 200-1000(ø740) 6bar
universally applicable in heating and cooling systems

Typ / type	Variomat VG/VF 200-1000(ø740) 6bar
Serien-Nr. / Serial no.	siehe Typenschild according to name plate of vessel
Herstellungsjahr / Year of manufacture	siehe Typenschild according to name plate of vessel
max. zulässiger Druck (PS) / max. allowable pressure (PS)	6 bar
Prüfdruck (PT) / Test pressure (PT)	8,6 bar
min. / max. zulässige Temperatur (TS) / min. / max. allowable temperature (TS)	max. 120°C
max. Dauerbetriebstemperatur Voll- / Halbmembrane max. continuous operating temperature membrane / diaphragm	-10°C/+70°C
Beschickungsgut Operating medium	Wasser / trockene Luft Water / dry air
Die Übereinstimmung des bezeichneten Produkts mit den Vorschriften der angewandten Richtlinie(n) wird nachgewiesen durch die Einhaltung folgender Normen / Vorschriften The conformity of the product described above with the provisions of the applied Directive(s) is demonstrated by compliance with the following Standards / regulations	Druckgeräterichtlinie, EN 13831:2007 gemäß Typenschild Behälter Pressure Equipment Directive, EN 13831:2007 according to name plate of vessel
Druckgerät Pressure equipment	Baugruppe Artikel 4 Absatz 2 Buchstabe b bestehend aus: - Behälter Artikel 4 Abs. (1) a) i) 2. Gedankenstrich (Anhang II Diagr. 2) mit Ausrüstung Artikel 4 Abs. (1) d): Vollmembrane, Entlüfter, Ausgleichsbogen und Entleerungshahn mit flexiblem Anschlussset - Ausrüstung Artikel 4 Abs. (1) d): Steuereinheit mit Sicherheitsventil Assembly article 4 (2) b) consisting of: - vessel article 4 paragraph (1) a) i) 2. indent (Annex II table 2) with accessories article 4 (1) d): membrane, deaerator, breather pipe and drain valve with flexible connection set - accessories article 4 (1) d): control unit with safety valve
Fluidgruppe / Fluid group	2
Konformitätsbewertung nach Modul Conformity assessment acc. to module	B+D
Kennzeichnung gem. Richtlinie 2014/68/EU Labeling acc. to Directive 2014/68/EU	CE 0045
Sicherheitsventil (Kategorie IV) siehe Bedienungsanleitung S. 11 Safety valve (category IV) see operating instructions p. 11	Vom Hersteller des Sicherheitsventils entsprechend den Anforderungen der Richtlinie 2014/68/EU gekennzeichnet und bescheinigt. Confirmed and signed by the manufacturer of the safety valve according to the requirements of directive 2014/68/EU.
Zertifikats-Nr. der EU-Baumusterprüfung Certificate-No. of EU Type Approval	07 202 1 403 Z 0821 / 1 / D0045
Zertifikats-Nr. QS-System (Modul D) Certificate-No. QA System (module D)	0045/202/1403/Z/00465/15/D/001(00)
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
Unterzeichnet für und im Namen von / Signed for and on behalf of Hersteller / Manufacturer reflex	Der oben beschriebene Gegenstand der Erklärung erfüllt die einschlägigen Harmonisierungsrechtsvorschriften der Europäischen Union - Richtlinie 2014/68/EU Richtlinie des Europäischen Parlaments und des Rates vom 15. Mai 2014 The object of the declaration described above is in conformity with the relevant Union harmonisation legislation – Pressure Equipment Directive 2014/68/EU Directive of the European Parliament and of the Council of 15 May 2014

Example:
Variomat Installation, operation and maintenance instructions with declaration of conformity according to PED

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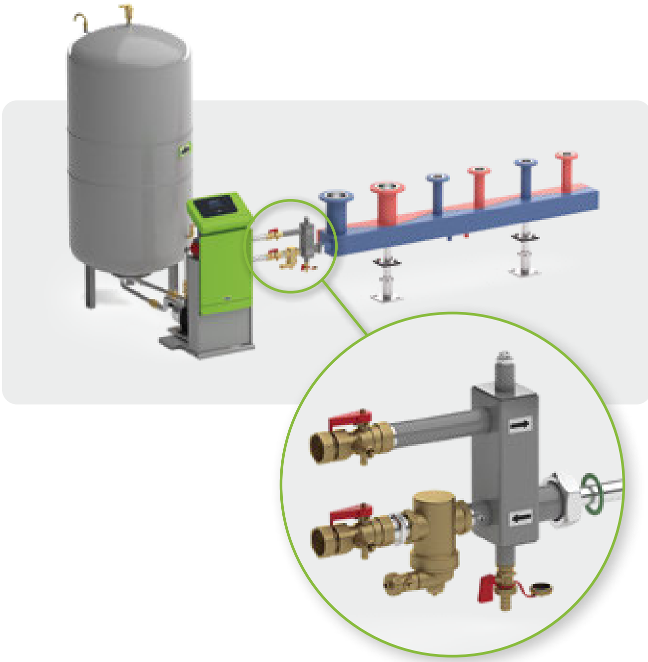
SINUS EasyFixx

The connection between Reflex & SINUS

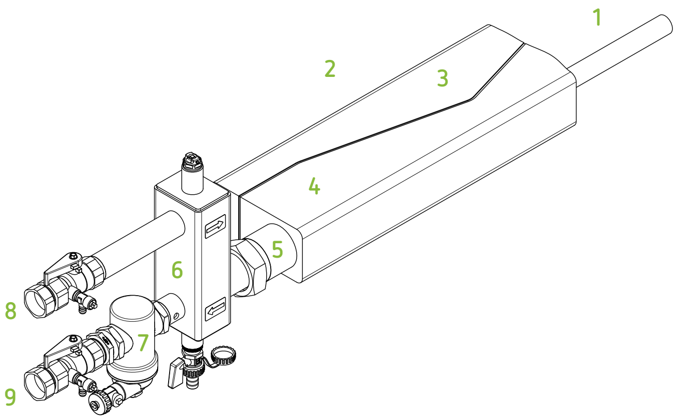
- Predefined connections for the simple connection of a Variomat, Reflexomats or a Servitec
- Easy to install, simple and safe installation
- Compliance with the minimum distance thanks to pipe-in-pipe guide
- No installation errors at the site
- Integrated sludge and magnetite separator for protection of pressure maintenance and degassing components
- Optimal interface between Reflex and SINUS components



Installation / connection

The SINUS EasyFixx is connected directly in the return of the manifold, buffer tank or SINUS MultiFlow Center and defines the connection pipe for Variomat, Reflexomat or Servitec. Thanks to the pipe-in-pipe system, the minimum distance of 500 mm for drawing water and returning water is complied with.

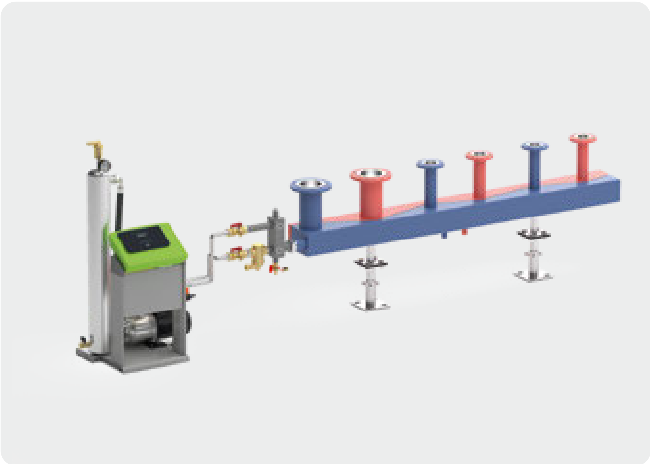
The integrated sludge and magnetite separator protects the pressure maintenance and degassing components, and separates out the dirt particles and ferromagnetic substances present in the system water. The separator can be cleaned during operation. The cap valves fitted on the SINUS EasyFixx enable shut-off of the pressurisation and degassing units.



1. Immersion pipe
2. Compact manifolds
3. Flow chamber
4. Return chamber
5. 2" connection on the manifold
6. SINUS EasyFixx
7. Sludge and magnetite separator
8. Return from pressure maintenance / degassing
9. Flow to pressure maintenance / degassing

Variomat directly connected to a manifold

The SINUS EasyFixx offers the optimum interface between heating and cooling water networks and dynamic pressure maintenance. The flow and return lines can be connected side by side to the heating/cooling circuit manifold via the defined connections.
The position on the manifold is selected so that the water of the main return flow is accepted and returned to the boiler in the direction of flow. In this way, the functions of dynamic pressure maintenance in combination degassing at atmospheric pressure are thus optimally integrated and ensured.



Servitec directly connected to a manifold

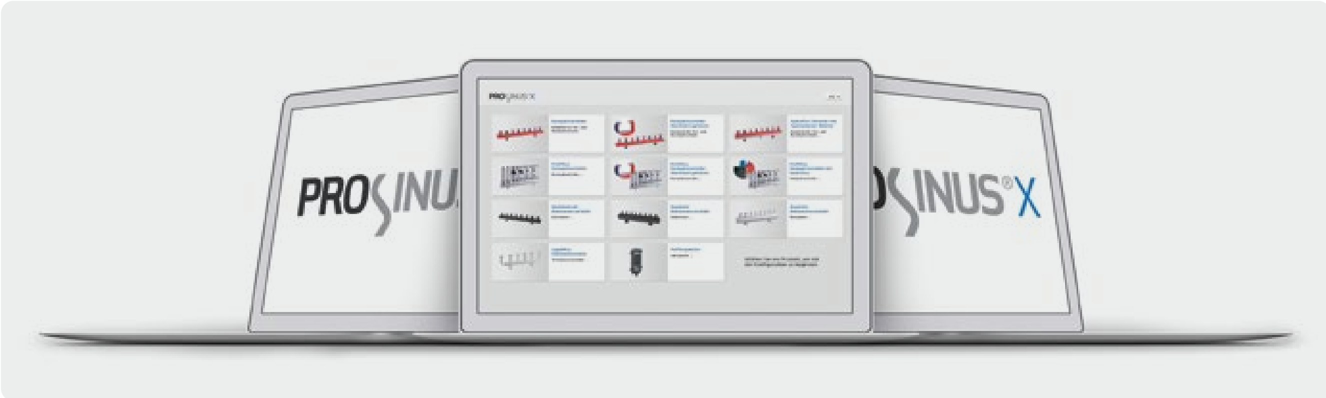
For this installation situation, the SINUS EasyFixx offers the optimum interface between the heating and cooling water grid and the vacuum spray pipe degassing. The flow and return lines (gas-rich and low-gas) can be connected directly to the heating/cooling circuit manifold via the defined connections without major installation effort.
The positioning on the manifold is selected so that the connection conditions are automatically adhered to. In this way, the gas-rich water is taken from the main return, fed via the Servitec, and then fed back in a low-gas state to the system in the direction of flow ready to absorb new gas. In addition, this connection is used to provide the tried and tested make-up of almost gas-free make-up water to the system network via the Servitec.

Reflexomat, & make-up unit directly connected to a manifold

In addition to the connection situations described above, the SINUS EasyFixx also makes it possible to connect Reflexomat compressor pressure maintenance unit and automatic make-up unit via the two defined connections into the system.
The connection pipe of the Reflexomat is connected to the system via an SINUS EasyFixx connection. The second nozzle of the SINUS EasyFixx can be used to connect a suitable automatic make-up unit.

SINUS EasyFixx		
Suitable for	Compact manifold	180/110, 200/120, 250/150, 280/180, 300/200
	Thermally isolated compact manifold	250/151, 151/181, 300/201
	SINUS HydroFixx	180/180, 200/200, 280/320, 300/350
	Single chamber manifold	Round pipe up to and including DN 250
	Rectangular manifold	120/80 up to and including 200/120
	SINUS MultiFlow Center and buffer tank	on request
Max. operating pressure	6 bar	
Set components	SINUS EasyFixx, Exdirt D 1 M, blanking plugs, two cap valves	

ProSinusX product configurator



A good configurator should be easy to understand, easy to use, convenient and fast. And provide optimal support for the skilled tradesman and planner. Just like the ProSinusX product configurator. As a reliable and competent supplier of innovative heating manifolds for both domestic and commercial/industrial applications, Sinusverteiler has been recognised in the market for more than three decades — with small 30 kW manifolds and larger manifolds with capacities of over 9,000 kW as well as custom-made heating manifolds.

With the ProSinusX product configurator, a planner can design even the most complex of manifold layouts and other hydraulic components to match their own requirements in just a few steps. The finished design can then be transferred to the user's CAD system over any of the most common interfaces. Components of SINUS are a perfect match for the efficient solutions of Reflex Winkelmann GmbH in heating centres and cooling systems.

- Easy and quick configuration of your desired products
- Online access to your projects from anywhere in the world
- Export formats: DXF, 3D DWG, STP
- Tender documentation in GAEB for example

→ Manifolds — Quality certified according to DIN EN ISO 9001

Log in now and start your design and dimensioning for free!

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Training at Reflex takes place in an appealing atmosphere. Our Reflex Training Center is located at the Grosse-Kleimann manor house, away from the hubbub of everyday life, but still in the direct vicinity of our main plant in Ahlen.

Enjoy the ambience of the Westphalian manor house in a typical Münsterland setting, while, working in small groups, you focus on your vocational training. The Reflex Training Center has a state-of-the-art practical training facility in addition to various large, newly designed lecture rooms. Here, functional Reflex systems are available, on which you can put your newly acquired skills from our training into practice. The lecture rooms are equipped with modern lecture technology and offer state-of-the-art building technology in a rustic and relaxing environment.

Our site team — experts for your success

The Reflex training team consists of experts from different disciplines with many years of training experience and practical competence. Depending on the topic, our training courses are delivered by technical trainers and specialist speakers from our extended pool of experts.

Our training philosophy

Training is an investment for your future success

The market for water-conveying supply technology is developing rapidly and makes ever-increasing demands on planners, specialist retailers and wholesalers as well as operators. In-depth knowledge of new products and technologies as well as the application of the latest standards, guidelines and regulations are expected by customers. So it's good to know that with the support of the Reflex training team you can keep up with the demands.

Whether design, consulting, installation or operation, Reflex Training is aimed at all partners who want to get first-hand information on the state of the art, the latest standards and guidelines as well as about the provision of an all-inclusive service. Through knowledge and competence, you can steal a march on your competitors and ensure the success of your day-to-day work.

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→ www.reflex4experts.com/en/training/face-to-face-training

For more information and online registration for online courses:
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Our classroom courses

She expects a balance of theoretical and practical components in our newly expanded Reflex Training Center in Ahlen, Westphalia. Modern lecture and training rooms in a unique atmosphere offer plenty of space for theoretical knowledge transfer, supplemented by training options with functional models and therefore of pronounced practical relevance.

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General information

Reflex Winkelmann GmbH has compiled all the texts in this document with great care. Nevertheless, errors cannot be excluded. Any liability on the part of the issuer, regardless of the legal reason, is excluded.

Compilation: Technical Training

2nd Edition 2021

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Quick selection table for Reflex N and Reflex S

Heating systems: 90/70 °C

For detailed calculations please use our configuration software, which is available online under www.reflex-winkelmann.com/en.

Safety valve p_{sv} bar	2.5			V_n	3.0				V_n	4.0				V_n	5.0					V_n	6.0					
Prepressure p_0 bar	0.5	1.0	1.5	litre	0.5	1.0	1.5	1.8	litre	1.5	2.0	2.5	3.0	litre	2.0	2.5	3.0	3.5	4.0	litre	2.0	2.5	3.0	3.5	4.0	5.0
Content V_{sys} litre	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	1,120	840	440	260	80	870	650	410	120	80	890	710	530	320	95	80	1,060	900	750	600	430	90
	1,230	620	210	100	1,400	1,050	540	330	100	1,090	820	430	150	100	1,110	890	670	420	120	100	1,320	1,130	940	750	560	100
	1,720	870	300	140	1,960	1,470	760	460	140	1,530	1,140	610	200	140	1,560	1,250	940	510	170	140	1,850	1,580	1,320	1,060	790	140
	2,450	1,240	420	200	2,800	2,100	1,090	660	200	2,180	1,630	870	290	200	2,230	1,780	1,340	720	240	200	2,640	2,260	1,890	1,510	1,130	210
	3,060	1,550	530	250	3,500	2,630	1,360	820	250	2,720	2,040	1,090	370	250	2,790	2,230	1,670	900	300	250	3,300	2,830	2,360	1,890	1,410	260
	3,680	1,860	630	300	4,200	3,150	1,630	990	300	3,270	2,450	1,300	440	300	3,340	2,670	2,010	1,080	360	300	3,960	3,390	2,830	2,260	1,700	310
	4,900	2,480	850	400	5,600	4,200	2,180	1,320	400	4,360	3,270	1,740	580	400	4,460	3,570	2,670	1,440	480	400	5,280	4,520	3,770	3,020	2,260	410
	6,130	3,100	1,060	500	6,920	5,250	2,720	1,650	500	5,450	4,080	2,170	730	500	5,570	4,460	3,340	1,800	600	500	6,600	5,660	4,710	3,770	2,830	520
	7,350	3,720	1,270	600	8,400	6,300	3,260	1,980	600	6,540	4,900	2,610	880	600	6,680	5,350	4,010	2,170	730	600	7,920	6,790	5,660	4,520	3,390	620
	9,800	4,970	1,690	800	11,200	8,400	4,350	2,640	800	8,710	6,540	3,480	1,170	800	8,910	7,130	5,350	2,890	970	800	10,560	9,050	7,540	6,030	4,520	830
	12,250	6,210	2,120	1,000	13,830	10,500	5,440	3,300	1,000	10,890	8,170	4,350	1,460	1,000	11,140	8,910	6,680	3,610	1,210	1,000	13,200	11,310	9,430	7,540	5,660	1,030

Selection example

p_{SV} = 3 bar
H = 13 m
$\dot{Q}$ = 40 kW (plates 90/70 °C)
V_{PH} = 1,000 l (V buffer tank)

calculate:

→ V_{sys} = 40 kW x 8.5 l/kW + 1,000 = 1,340 l

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

From the table:

with p_{SV} = 3 bar, p_0 = 1.5 bar,
V_{sys} = 1,340 l
→ **V_n = 250 l** (for V_{sys} max. 1,360)

Selected:

1 x Reflex N 250, 6 bar P. 4
1 x SU R1 cap ball valve P. 8

→ approximate water content:

Radiators	Panel-type radiator
$V_{sys} = \dot{Q}$ [kW] x 13.5 l/kW	$V_{sys} = \dot{Q}$ [kW] x 8.5 l/kW

Reflex recommendations:

- Select a sufficiently high safety valve actuation pressure: $p_{sv} \geq p_0 + 1.5$ bar
- If possible, select an additional safety allowance of 0.2 bar when calculating the gas prepressure: $p_0 \geq \frac{H\,[m]}{10 m/bar} + 0.2$ bar
- Select at least 1 bar inlet pressure for roof units because of the required prepressure for the circulating pumps: $p_0 \geq 1$ bar
- Set the water-side filling or initial pressure to at least 0.3 bar above the prepressure with the system vented and cold: $p_{fill} \geq p_0 + 0.3$ bar

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