Thinking solutions.

Expansion vessels

Reflex, Refix

Pressure maintenance

Pressure maintenance system tasks

Correct pressure ratios are a basic precondition for correct functioning of heating, solar and cooling water systems and pressure booster systems. Like all other substances, the volume of water changes with its temperature. Unlike other liquids, water does not expand proportionately to the temperature. As water cannot be compressed, this means the pressure increases significantly in closed systems as the temperature changes.

Optimum pressure maintenance is achieved with two different pressure maintenance systems depending on the application:

- Static pressure maintenance systems (expansion vessels)
- Dynamic pressure maintenance systems

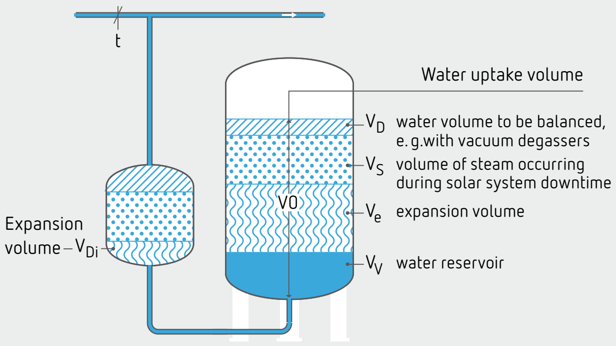
Further information can be found in the brochure: Pressurisation Systems

Essentially, pressure maintenance systems have to fulfil three fundamental tasks:

1. Maintain the pressure within permissible limits at all points in the facility system. This means ensuring the permissible operating pressure is not exceeded but also maintaining a minimum pressure to avoid negative pressures, cavitation and evaporation.
2. Compensating fluctuations in the volume of the facility water as a result of fluctuations in temperature.
3. Balancing systemic water losses using a water reservoir.

Water uptake volume of a pressure expansion vessel

Pressure maintenance is required to compensate fluctuations in volume between the maximum and the minimum system temperature and thus to maintain the pressure within a permissible range. To achieve this, there must be a sufficient water uptake volume which must correspond to the expansion volume V_e and the water reservoir V_V. If devices are installed which extract and feed back a volume of water V_D from the system during operation, such as a vacuum degasser, this must also be taken into consideration. This also applies to volumes of steam V_S which occur during downtimes in solar collectors. If the temperature of the medium drops below 0 °C or exceeds 70 °C at the connection point of the pressure maintenance in the facility system, an auxiliary vessel is to be installed in order to protect the bladder of the expansion vessel.

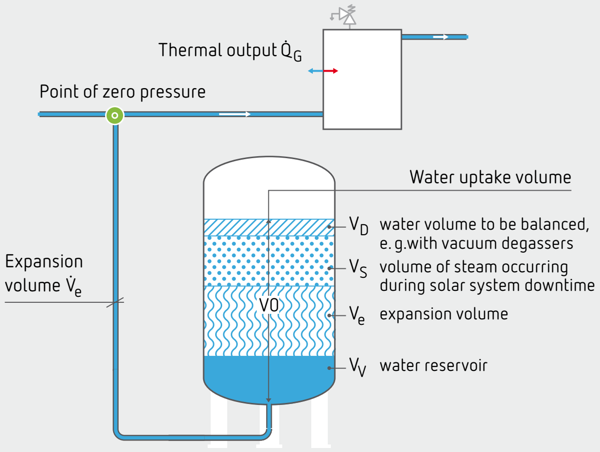


- in heating systems proportion of V_e for t > 70 °C
- in cooling systems proportion of V_e for t < 0 °C

Expansion volume flow and point of zero pressure

A balancing volume flow must be transported via the expansion line between the system and pressure maintenance such that the calculated pressures for the pressure maintenance are produced correctly at the point of zero pressure.

In closed heating, solar and cooling systems, it is assumed that the expansion volume flow $\dot{V}_e$ is the largest possible balancing volume flow. It occurs when the thermal output $\dot{Q}_G$ of heating or cooling sources is switched on or off.



Static pressure maintenance systems

Expansion vessels work as expansion or buffer vessels without electricity, a compressor or pump. Expansion vessels have to balance the volume fluctuations between the greatest and the lowest temperature. Product in the Reflex portfolio are used as expansion vessels in heating, solar and cooling water systems and products in the Refix portfolio are used to save potable water in hot water heating systems.

Buffer and control vessels have to provide an intermediate storage for the difference between the requested and the required volume flow. If the requirement is to reduce the switching frequency of the feed device, this is also known as a control vessel. In principle, the Refix product range is used as a buffer vessel in a pressure booster system while the Reflex range is used as a control vessel in pump-driven pressure maintenance stations.

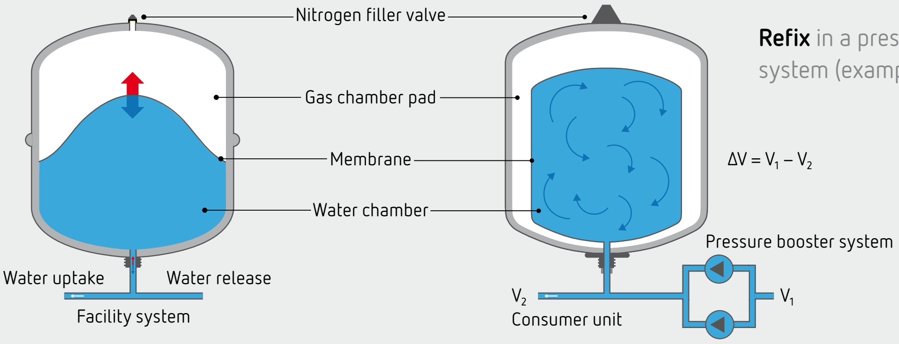
Reflex for closed heating, solar and cooling water systems

Refix for potable and process water systems as well as special applications

Installation and function

Reflex in a heating system (example)

Refix in a pressure booster system (example)



The pressure pad supports the water column in the system and is adjusted accordingly before the vessel is filled with a volume of water. As the system is heated, the pressure increases resulting in the expanding water flowing from the facility system to the water chamber. The pressure pad in the gas chamber is compressed and the pressure increases. As the system cools, the volume decreases and the pressure drops: the expansion water flows out of the water chamber back into the facility system. The pressure pad in the gas changer is adjusted to just under the cut-in pressure of the feed device. When the pressure drops below the cut-in pressure, the pump switches on and feeds the water.
If the consumer units remove a lesser amount, the difference is temporarily stored in the buffer tank until the pressure pad is compressed to the cut-out pressure and the pressure booster system switches off. The resulting pressure drop leads to a reduction in volume. If the consumer units draw water, temporarily stored water is extracted from the buffer tank until the cut-in pressure occurs at the pressure pad and the pressure booster system is switched on again.

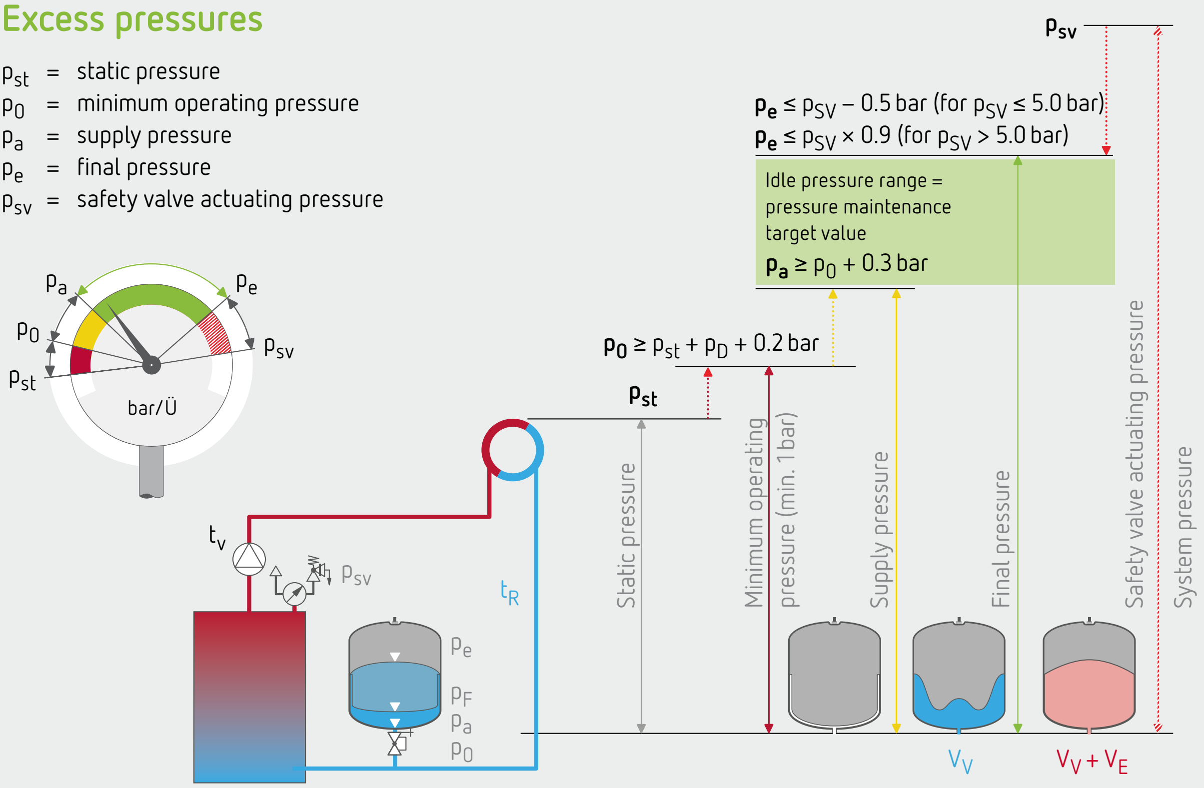
Selection and calculation

Pressures in the system

Valid for supply pressure maintenance in heating, cooling and solar thermal systems

Excess pressures

p_{st} = static pressure
p_0 = minimum operating pressure
p_a = supply pressure
p_e = final pressure
p_{sv} = safety valve actuating pressure



Calculation values

Pressures are given as excess pressures and relate to the connecting pieces for the expansion vessel up to the highest point in the system.

Reflex recommendations

- Set the safety valve operating pressure sufficiently high:
  $p_{SV} \geq p_0 + 1.5$ bar
- If possible, when calculating the inlet gas pressure, select an extra 0.2 bar:
  $p_0 \geq \frac{H\,[m]}{10} + 0.2$ bar
- Select an supply pressure of at least 1 bar on account of the necessary supply pressure for the flow-through pumps — even for rooftop infrastructure centres: $p_0 \geq 1$ bar
- Set the fill or supply pressure on the water side in vented systems in cold condition at least 0.3 bar above the supply pressure to ensure a water reservoir inthe expansion vessel ($V_V = 0.005 \times V_A$ **at least** 3 l for $V_n > 15$ l minimum volume indication according to the standard): $p_F \geq p_0 + 0.3$ bar

Quick selection table for expansion vessels

Heating Systems: 70/50 °C

	Safety Valve p_{SV} [bar]	2.5			3.0				4.0			
	Inlet Pressure p_0 [bar]	0.5	1.0	1.5	0.5	1.0	1.5	1.8	1.5	2.0	2.5	3.0
	V_n [litres]	Contents V_A [litres]										
Reflex	8	107	48	–	133	82	31	–	87	48	8	–
	12	161	71	–	199	122	46	–	131	71	12	–
	18	268	134	–	325	210	96	27	223	134	45	–
	25	424	238	52	504	344	185	89	362	238	114	–
	35	639	387	126	730	536	313	179	561	387	213	–
	50	912	608	238	1,043	782	504	313	811	608	362	114
	80	1,460	973	461	1,668	1,251	834	580	1,298	973	649	263
	100	1,825	1,217	608	2,086	1,564	1,043	730	1,622	1,217	811	362
	140	2,555	1,703	852	2,920	2,190	1,460	1,022	2,271	1,703	1,135	561
	200	3,650	2,433	1,217	4,171	3,128	2,086	1,460	3,244	2,433	1,622	811
	250	4,562	3,041	1,521	5,214	3,910	2,607	1,825	4,055	3,041	2,028	1,014
	300	5,474	3,650	1,825	6,257	4,692	3,128	2,190	4,866	3,650	2,433	1,217
	400	7,299	4,866	2,433	8,342	6,257	4,171	2,920	6,488	4,866	3,244	1,622
	500	9,124	6,083	3,041	10,428	7,821	5,214	3,650	8,110	6,083	4,055	2,028
	600	10,949	7,299	3,650	12,513	9,385	6,257	4,380	9,732	7,299	4,866	2,433
	800	14,599	9,732	4,866	16,684	12,513	8,342	5,839	12,976	9,732	6,488	3,244
	1,000	18,248	12,165	6,083	20,855	15,641	10,428	7,299	16,221	12,165	8,110	4,055

Customised planning with our configuration software

Reflex Solutions **Pro**

rsp.reflex.de/en

Key data

Safety valve p_{SV} = 3 bar

Static height H_{st} = 13 m

Heat generator capacity b = 40 kW

Panel radiators rated temperature T = 70/50 °C

Volume buffer storage tank V_{PH} = 1,000 l

Calculation

Water content (approximately)

Radiators:
$V_A = \dot{Q}[kW] \times 13.5\ l/kW$

Panel radiators:
$V_A = \dot{Q}[kW] \times 8.5\ l/kW$

$V_A = 40\ kW \times 8.5\ l/kW + 1{,}000\ l = 1{,}340\ l$

$$p_0 \geq \frac{H_{st}\,[m]}{10}\ bar + 0.2\ bar$$

$$p_0 \geq \frac{13}{10}\ bar + 0.2\ bar = 1.5\ bar$$

Result

From the table

with p_{SV} = 3 bar
and p_0 = 1.5 bar
V_A = 1.340 l

→ V_n **= 140 l** (for V_A max. 1,460 l)

selected

1 × **Reflex N 140**, 6 bar, → page 11
1 × **cap ball valve**, → page 20

Example calculation
for Reflex N

Heating Systems: 70/50 °C

	Safety Valve p_{SV} [bar]	5.0					6.0					
	Inlet Pressure p_0 [bar]	2.0	2.5	3.0	3.5	4.0	2.0	2.5	3.0	3.5	4.0	5.0
	V_n [litres]	Contents V_A [litres]										
Reflex	8	91	58	26	–	–	118	90	63	35	7	–
	12	136	88	39	–	–	177	136	94	52	10	–
	18	231	158	85	12	–	293	230	167	105	42	–
	25	373	272	170	69	–	459	372	285	197	110	–
	35	576	434	292	150	8	679	574	452	330	208	–
	50	829	664	475	272	69	969	827	684	529	354	6
	80	1,327	1,062	796	515	191	1,551	1,323	1,095	867	639	89
	100	1,659	1,327	995	664	272	1,939	1,654	1,369	1,083	798	145
	140	2,322	1,858	1,393	929	434	2,714	2,315	1,916	1,517	1,118	257
	200	3,318	2,654	1,991	1,327	664	3,878	3,307	2,737	2,167	1,597	424
	250	4,147	3,318	2,488	1,659	829	4,847	4,134	3,422	2,709	1,996	564
	300	4,977	3,981	2,986	1,991	995	5,817	4,961	4,106	3,250	2,395	684
	400	6,636	5,309	3,981	2,654	1,327	7,755	6,615	5,474	4,334	3,193	912
	500	8,295	6,636	4,977	3,318	1,659	9,694	8,269	6,843	5,417	3,992	1,141
	600	9,954	7,963	5,972	3,981	1,991	11,633	9,922	8,212	6,501	4,790	1,369
	800	13,271	10,617	7,963	5,309	2,654	15,511	13,230	10,949	8,668	6,387	1,825
	1,000	16,589	13,271	9,954	6,636	3,318	19,389	16,537	13,686	10,835	7,984	2,281

Selecting expansion lines

Expansion lines are to be sized and installed in accordance with local provisions. DIN EN 12828 requires that, each heat generator is connected to at least one expansion line with one or more expansion vessels. It is essential to ensure frost-free conditions.

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

If the length of the expansion line is **> 10 m,** we recommend selecting the nominal diameter one dimension larger.

Comprehensive calculation and design notes

Before selecting the products, first collate the most important system data for temperature, pressure and water content and calculate the parameters for selecting the products from this information.

Water volume	V_A
Heat output	$\dot{Q}_{ges}$
Expansion volume flow	$\dot{V}_e$
Water uptake volume	V_0
Safety valve actuating pressure	p_{SV}
Minimum operating pressure	p_0
Final pressure	p_E

- The necessary basic data are preferable to be taken from the design documents / manufacturer's data. If these are not available, the data must be collected on site or estimated. Proxy values for calculating and estimating the water volumes are given in the tables. The extreme requirements of industrial heat supply and district heat supply can be accommodated thanks to the Variomat Giga.

Proxy values for calculation

Coefficient of expansion n for anti-freeze additives* z

z	t_{max} °C	30	40	50	60	70	80	90	100	105	110	120	130	140	150
0 %	n %	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
34 %		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

* Values apply for Antifrogen N. We recommend a concentration of 25 to 50 %. Lower doses lead to a risk of corrosion!

Evaporation pressure** p_D for anti-freeze additives* z

z	t_{max} °C	30	40	50	60	70	80	90	100	105	110	120	130	140	150
0 %	p_D bar	−0.96	−0.93	−0.88	−0.80	−0.69	−0.53	−0.3	0.01	0.21	0.43	0.98	1.7	2.61	3.76
34 %				−0.90	−0.80	−0.70	−0.60	−0.40	−0.10	–	0.23	0.70	1.33	2.13	3.15

* Values apply for Antifrogen N. We recommend a concentration of 25 to 50 %. Lower doses lead to a risk of corrosion!

** p_D with respect to ±0 m NN, we recommend an additional 0.1 bar for each 1 km height.

Standard values for sizing expansion lines, make-up pipes and lines to control vessel

DN		20	25	32	40	50	65	80	100
$\dot{V}$ l/h	1	630	1,040	1,830	2,410	3,700	6,960	9,450	14,130
	2	2,500	4,150	7,300	9,600	14,800	27,800	37,800	56,500

$\dot{V}$ permissible volume flow:

1 up to a maximum line length of 30 m

2 for a line length up to 1 m and to reductions, e. g. to vessel connections. Not permissible for pressure controlled devices between pressure sensors and systems

When using anti-freeze, we recommend remaining within 25 – 50 % glycol in order to minimise the risk of corrosion.

Estimating the volume of water in heat generators

The volume of water V_W is calculated from the volume of water v_W and the nominal performance of the heat generator $\dot{Q}_W$ or from the installed collector area in solar panels A_G.

Conventional heat generators	v_W l/kW	
Cast iron boiler with atmospheric burner	1.10	$V_W = v_W \times \dot{Q}_W$
Cast iron boiler with forced-air burner	1.40	
Steel boiler with forced-air burner	1.80	
Solid fuel boiler	2.00	
Wall-mounted condensing boiler	0.15	
Heat exchanger	0.60	
CHP	0.60	
Heat pump	0.60	
Solar panels	v_K l/m²	
Flat panel	2.0	$V_K = v_K \times A_G$
Direct vacuum tube	1.0	
Heat-pipe vacuum tube	3.0	

Estimating the volume of water in heat surfaces and distribution lines

The volume of water V_A is determined from the specific volume of water v_A and the installed output of the heat consumer unit $\dot{Q}_{ges}$. It includes the water content of the heating surfaces, the distribution pipes and the pipelines in the central heating system. Pipelines between the central heating plant and the heating system should be considered separately.

Types of heating surface	$t_{max\,C}$ | t_R °C	90 | 70	70 | 55	70 | 50	55 | 45	45 | 35	35 | 30	
Elements	v_A l/kW	11.5	17.6	18.1	27.7	44.6	83.3	$V_A = v_A \times \dot{Q}_{ges.}$
Pipes		15	23.2	24.1	36.3	59.3	111.5	
Plates		6.5	9.6	9.4	14.9	21.9	41.0	
Convectors		4	5.9	5.4	9.4	13.4	27.1	
Ventilation		3.3	4.7	4.1	7.4	9.8	19.7	
Underfloor heating system		–	–	–	–	21.1	35.6	

Volume of vacuum spray pipe degasser V_D ,which has to be absorbed by pressure maintenance

Degassing	V_D l
Servitec 25…30	1
Servitec 35…120	6
Special Servitec …–2…4	35
Special Servitec …–6…8	70

Specific volume of water V_P in pipelines

The volume of water V_P is determined from the specific volume of water v_P and the length of the installed pipeline L.

Example for steel pipelines

DN	25	32	40	50	60	65	80	100	125	150	200
v_P l/m	0.58	1.01	1.34	2.1	3.2	3.9	5.3	7.9	12.3	17.1	34.2

Example for plastic pipelines (PE_X pipes)

Model	20 × 2	25 × 2.3	32 × 2.9	40 × 3.7	50 × 4.6	63 × 5.8	75 × 6.8	90 × 8.2	110 × 10
d_i in mm	16	20	26	33	41	51	61	74	90
v_P l/m	0.20	0.33	0.54	0.83	1.31	2.07	2.96	4.25	6.36

Expansion vessels in heating systems

Calculation

To DIN 4807 T2 and DIN EN 12828.

Circuit

Usually maintaining suction pressure (→ see sketch page 30) with upstream flow-through pump and expansion vessel in the return flow, i.e. on the suction side after the flow-through pump.

Material values n, p_D

Generally material values for pure water without anti-freeze.

Expansion volume V_e, maximum temperature t_{TR}

Determine the percentage expansion generally between the minimum temperature = fill temperature = 10 °C and the maximumnominal value setting for the temperature controller t_{TR}.

Minimum operating pressure p_0

Particularly in the case of low-rise buildings and roof-mounted systems, the minimum supply pressure for the flow-through pump is to be taken from the manufacturer's specifications due to the low static pressure p_{st}. We also recommend a minimum operating pressure p_0 of no less than 1 bar is selected for lower static heads.

Note: Take care with low-rise buildings and roof-mounted systems Reflex recommendation: $p_0 \geq 1$ bar

Filling pressure p_F, supply pressure p_a

As the the filling temperature of 10 °C is generally the lowest system temperature, the filling pressure = the supply pressure for the expansion vessel. In pressure maintenance stations, it should be noted that the filling and make-up devices may have to run against the final pressure in some circumstances. This is only the case with Reflexomat.

Use Refix for systems where corrosion is a potential risk!

In systems with oxygen-rich water (e.g. geothermal systems or underfloor heating without any impermeable pipes), Refix D, Refix DE or Refix C is used up to 70 °C as all water-bearing parts are corrosion protected.

In order to achieve permanently safe automatic operation in cooling water systems, it is advisable to fit the pressure maintenance devices with make-up systems and to supplement this with Servitec degassing systems. This is particularly important in cooling water systems as there must be no thermal deaeration effects.

Pressure maintenance

Static pressure maintenance with Reflex N, F, S, G also in combination with make-up and degassing systems or as Variomat pressure maintenance station for pressure maintenance, degassing and make-up or as Reflexomat compressor controlled pressure maintenance station.

Degassing, venting, make-up

In order to achieve permanently safe automatic operation of the heating system, it is advisable to fit the pressure maintenance devices with make-up systems and to supplement this with Servitec degassing systems.

Auxiliary vessel

If a temperature of 70 °C is permanently exceeded at the pressure maintenance, an auxiliary vessel must be installed in order to protect the bladders.

Individual protection

According to DIN EN 12828, each heat generator must be connected to at least one expansion vessel. Only secured shut-offs (against unintentional closure) are permitted. If a heat generator is hydraulically blocked (e.g. sequential switching of the boiler), the connection to an expansion vessel must still be guaranteed. In systems with more than one boiler, each boiler is therefore usually secured with its own expansion vessel. This is only calculated for the respective boiler water content.

⚠ Due to the good degassing performance of Variomat pressure maintenance stations, we recommend to install an expansion vessel (e.g. Reflex N) is installed at the heat generator in order to minimise the switching frequency, even on single boiler systems.

Expansion vessel calculation in heating systems

Circuit: Maintaining supply pressure, expansion vessel in the return flow, upstream flow-through pump, follow-up pressure maintenance.

Initial data			see manufacturer's specifications/proxy values for calculation	
Heat generator				
... heat output	$\dot{Q}_W$	[kw]	Total for all heat generators	**$\dot{Q}_{ges}$ = ... kw**
... volume of water	V_W	[l]		
Design				
... inlet temperature	t_V	[°C]		
... return flow temperature	t_R	[°C]	At $t_R > 70$ °C install auxiliary vessel!	
Volume of water	V_A	[l]		**V_A = ... Litres**
Maximum target value setting				
Temperature controller	t_{TR}	[°C]		
Anti-freeze additive		[%]	Percentage expansion n (with anti-freeze additive n*)	**n = ... %**
Safety temperature limiter	t_{STB}	[°C]	Evaporation pressure p_D at > 100 °C (with anti-freeze additive p_D*)	**p_D = ... bar**
Static pressure	p_{st}	[bar]		**p_{st} = ... bar**
Pressure calculation				
Supply pressure	p_0	[bar]	$p_0 = p_{st} + p_D + 0.2$ bar (safety factor) **Reflex recommendation:** **$p_0 \geq 1.0$ bar** Req. Check supply pressure for flow-through pump (NPSH value) from manufacturer's specifications and maintenance of permissible operating pressure.	**p_0 = ... bar**
Safety valve actuating pressure	p_{SV}	[bar]	**Reflex recommendation:** for $p_{SV} \leq 5$ bar: **$p_{SV} \geq p_0 + 1.5$ bar** for $p_{SV} > 5$ bar: **$p_{SV} \geq p_0 + 2.0$ bar**	**p_{SV} = ... bar**
Final pressure	p_e	[bar]	$p_e \leq p_{SV}$ − final pressure differential for $p_{SV} \leq 5$ bar: $p_e \leq p_{SV} - 0.5$ bar for $p_{SV} > 5$ bar: $p_e \leq p_{SV} - 0.1 \times p_{SV}$	**p_e = ... bar**
Expansion vessel				
Expansion volume	V_e	[l]	$V_e = \frac{n}{100} \times V_A$	**V_e = ... litres**
Water reservoir	V_V	[l]	$V_V = 0.005 \times V_A$ **at least 3 l** for $V_n > 15$ l minimum water seal volume to standard	**V_V = ... litres**
Nominal volume	V_n	[l]	for $V_n > 15$ l: $V_n = (V_e + V_V + V_D{*}) \times \frac{p_e + 1}{p_e - p_0}$ for $V_n \leq 15$ l: Water reservoir $V_V \geq 0.2 \times V_n$ $V_n = (V_e + V_V + V_D{*}) \times \frac{p_e + 1}{p_e - p_0}$ **Note:** The pressure factor is used for simplified calculation of the nominal volume, which is larger than the water reservoir + expansion volume by the pressure factor.	**V_n = ... litres**
Control supply pressure	p_a	[bar]	$p_a = \dfrac{p_e + 1}{1 + \dfrac{(V_e + V_D{*})(p_e + 1)(n + n_R)}{V_n (p_0 + 1) 2n}} - 1$ bar **Precondition: $p_a \geq p_0 + 0.25...0.3$ bar, otherwise calculate for larger nominal volume**	**p_a = ... bar**
Result				
Reflex ... / ... bar ...litres			**p_0 = ... bar** Check before commissioning!	
			p_a = ... bar Check make-up setting!	
			p_e = ... bar	

---

* Only applies when using Reflex Servitec in accordance with the 'Degassing' table → see page 25

Expansion vessels in cooling water systems

The calculation is carried out in accordance with DIN EN 12828 and DIN 4807 part 2.

Material values n*

Anti-freeze additives (recommendation: 25–50 % concentration), depending on the lowest temperature of the system,must be taken into consideration when determining the percentage expansion n* according to the manufacturer's specifications.

Expansion volume V_e

Determination of the percentage expansion n* generally between the lowest system temperature (e.g. downtime during winter – 20 °C) and the highest system temperature (e.g. downtime during summer +40 °C).

Minimum operating pressure (supply pressure) p_0

As temperatures do not exceed 100 °C, special factors are not required.

Filling pressure p_F, supply pressure p_a

The lowest system temperature is frequently less than the filling temperature which means the filling pressure is greater than the supply pressure.

Pressure maintenance

Generally used for static pressure maintenance with Reflex, also in combination with Control and Servitec make-up and degassing stations.

Degassing, venting, make-up

In order to achieve permanently safe automatic operation in cooling water systems, it is advisable to fit the pressure maintenance devices with make-up systems and to supplement this with Servitec vacuum spray pipe degassing systems. This is particularly important in cooling water systems as there must be no thermal deaeration effects.

Auxiliary vessels

The Reflex bladders are suitable for temperatures as low as – 20 °C and the vessels to – 10 °C however, this does not mean the bladder will not ‘freeze up’ in the vessel. We therefore recommend an auxiliary vessel is installed in the return flow to the chiller at temperatures ≤ 0 °C.

Individual protection

As with heating systems, we recommend individual protection if there is more than one chiller.

In order to achieve permanently safe automatic operation in cooling water systems, it is advisable to fit the pressure maintenance devices with make-up systems and to supplement this with Servitec degassing systems. This is particularly important in cooling water systems as there must be no thermal deaeration effects.

Expansion vessel calculation in cooling water systems

Circuit: Maintaining supply pressure, expansion vessel on the suction side, flow-through pump, with follow-up pressure maintenance.

Initial data			see manufacturer's specifications/proxy values for calculation	
Return flow temperature	t_R	[°C]	To the chiller; at $t_R > 70$ °C install auxiliary vessel!	
Inlet temperature	t_V	[°C]	From the chiller	
Minimum system temp.	t_{Smin}	[l]	e. g. downtime during winter	
Maximum system temp.	t_{Smin}	[l]	e. g. downtime during summer	
Anti-freeze additive		[%]	Percentage expansion with anti-freeze additive n*	**n* = … %**
Percentage expansion		[%]	Between minimum temperature (−20 °C) and filling temperature (usually 10 °C)	**n*F = … %**
Static pressure	p_{st}	[bar]		**p_{st} = … bar**
Pressure calculation				
Supply pressure	p_0	[bar]	$p_0 = p_{st} + 0.2$ bar (safety factor) **Reflex recommendation:** **$p_0 \geq 1.0$ bar** Check permissible operating pressure is maintained.	**p_0 = … bar**
Safety valve actuating pressure	p_{SV}	[bar]	**Reflex recommendation:** for $p_{SV} \leq 5$ bar: **$p_{SV} \geq p_0 + 1.5$ bar** for $p_{SV} > 5$ bar: **$p_{SV} \geq p_0 + 2.0$ bar**	**p_{SV}= … bar**
Final pressure	p_e	[bar]	$p_e \leq p_{SV}$ − final pressure differential to TRD 721 for $p_{SV} \leq 5$ bar: $p_e \leq p_{SV} - 0.5$ bar for $p_{SV} > 5$ bar: $p_e \leq p_{SV} - 0.1 \times p_{SV}$	**p_e =… bar**
Expansion vessel				
System volume	V_A	[l]	V_A = chiller + cooling coil + pipelines + buffer storage + other	**V_A = … litres**
Water reservoir	V_V	[l]	$V_V = 0.005 \times V_A$ **at least 3 l** for $V_n > 15$ l minimum water seal volume to standard	**V_V = … litres**
Nominal volume	V_n	[l]	for $V_n > 15$ l: $V_n = (V_e + V_V + V_D{}^*) \times \frac{p_e+1}{p_e-p_0}$ for $V_n \leq 15$ l: Water reservoir $V_V \geq 0.2 \times V_n$ $V_n = (V_e + V_V + V_D{}^*) \times \frac{p_e+1}{p_e-p_0}$	**V_n = … litres**
Control supply pressure	p_a	[bar]	$p_a = \dfrac{p_e+1}{1+\dfrac{(V_e+V_D{}^*)\,(p_e+1)}{V_n\,(p_0+1)}} - 1$ bar **Precondition: $p_a \geq p_0 + 0.25…0.3$ bar, otherwise calculate for larger nominal volume**	**p_a = … bar**
Result				
Reflex … / … bar …litres			**p_0 = … bar** Check before commissioning!	
			p_a = … bar Check make-up setting!	
			p_F = … bar Refill the system!	
			p_e =… bar	

* Only applies when using Reflex Servitec in accordance with the 'Degassing' table → see page 25

Expansion vessels in solar systems

The calculation is carried out in accordance with VDI 6002 and DIN 4807 part 2.

Solar systems have a peculiarity in that the maximum temperature cannot be defined by the controller on the heat generator but is determined by the downtime temperature on the panel.

Nominal volume calculation without evaporation in the panel

The percentage expansion n* and the evaporation pressure p_D* are related to the downtime temperature. As a temperature of over 200 °C can be reached on certain panels, this calculation procedure is no longer valid at this point. Some indirectly heated pipe panels (system heat pipe) systems have a limit on the downtime temperature. If a minimum operating pressure of $p_0 \leq$ 4 bar is sufficient to avoid evaporation, the calculation can usually be completed with evaporation. In this variant, it should be noted that increased temperature loading reduces the anti-freeze effect of the heat transfer medium in the long term.

Nominal volume calculation with evaporation in the panel

Evaporation cannot be excluded in panels with downtime temperatures over 200 °C. The evaporation pressure is only taken into consideration up to the required evaporation point (110 – 120 °C). In this instance, the total panel volume V_K is taken into consideration in addition to the expansion volume V_e and the water reservoir V_V when determining the nominal volume of the expansion vessel. This variant is preferred as the lower temperature places less strain on the heat transfer medium and the frost protection effect has a longer duration.

Material values n*, p_D*

Anti-freeze additives of up to 40 % are to be taken into consideration when establishing the percentage expansion n* and the evaporation pressure p_D* in accordance with manufacturers' specifications. If evaporation is included in the calculation, the evaporation pressure p_D* is taken into account up to the boiling point of 110 °C or 120 °C. The percentage expansion n* is then determined between the lowest external temperature (e. g. −20 °C) and the boiling temperature. If evaporation is not included in the calculation, the evaporation pressure p_D* and the percentage expansion n* are dependent on the downtime temperature of the panel.

Supply pressure p_0, minimum operating pressure

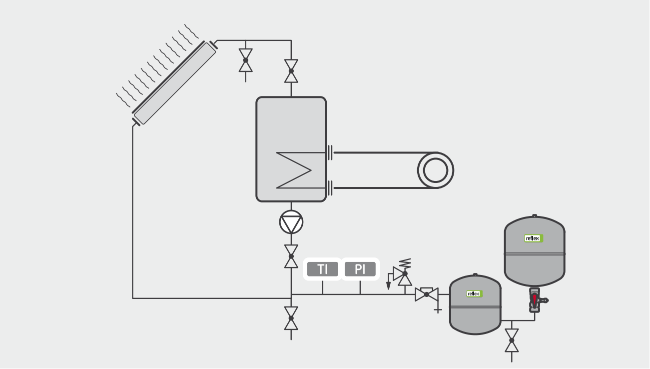
Depending on the calculation method, the minimum operating pressure (= supply pressure) is adjusted to the downtime temperature in the panel (= without evaporation) or the boiling temperature (= with evaporation). In both cases, the usual circuit for the circulating pump Δp_P stated above is to be taken into consideration as the expansion vessel is connected downstream of the flow-through pump on the pressure side (follow-up pressure maintenance).

Filling pressure p_F, supply pressure p_a

The filling temperature (10 °C) is usually well above the minimum system temperature which means the filling pressure is greater than the supply pressure.

Auxiliary vessels

If a stable return flow temperature of ≤ 70 °C cannot be guaranteed on the consumer side, an auxiliary vessel is to be installed on the expansion vessel.



Expansion vessel calculation in solar systems

Circuit: follow-up pressure maintenance, expansion vessel in the return flow to the panel.

Initial data			see manufacturer's specifications / proxy values for calculation	
Panels Volume of water	V_K	[l]	Total of all panels	**V_{Kges} = … litres**
Maximum inlet temp. Minimum external temp. Anti-freeze additive	t_V t_a	[°C] [°C] [%]	(110 °C or 120 °C for solar systems with evaporation) -20 °C Percentage expansion with anti-freeze additive n* and evaporation pressure with anti-freeze additive p_D*	 **n* = … %** **p_D* = … bar**
Percentage expansion		[%]	Between minimum temperature (−20 °C) and filling temperature (usually 10 °C)	**n*F = … %**
Static pressure	p_{st}	[bar]		**p_{st} = … bar**
Differential at the flow-through pump	Δp_P	[bar]	Evaporation pressure p_D at > 100 °C (For anti-freeze additive p_D*) Req. Check supply pressure forflow-through pumps according to manufacturers' specifications.	**Δp_P = … bar**
Pressure calculation				
Supply pressure	p_0	[bar]	$p_0 = p_{st} + \Delta p_D + p_D{}^*$ Check permissible operating pressure is maintained.	**p_0 = … bar**
Safety valve actuating pressure	p_{SV}	[bar]	Reflex recommendation: for $p_{SV} \leq 5$ bar: **$p_{SV} \geq p_0$ + 1.5 bar** for $p_{SV} > 5$ bar: **$p_{SV} \geq p_0$ + 2.0 bar**	**p_{SV} = … bar**
Final pressure	p_e	[bar]	$p_e \leq p_{SV}$ – final pressure differential to TRD 721 for $p_{SV} \leq 5$ bar: $p_e \leq p_{SV}$ − 0.5 bar for $p_{SV} > 5$ bar: $p_e \leq p_{SV} - 0.1 \times p_{SV}$	**p_e = … bar**
Expansion vessel				
System volume	V_A	[l]	V_A = cooling coil + pipelines + buffer storage + other	**V_A = … litres**
Expansion volume	V_e	[l]	$V_e = \quad \times V_A$	**V_e = … litres**
Water reservoir	V_V	[l]	$V_V = 0.005 \times V_A$ **at least 3 l** for $V_n > 15$ l minimum water seal volume to standard	**V_V = … litres**
Nominal volume	V_n	[l]	for $V_n > 15$ l: $V_n = (V_e + V_V + V_{Kges}{}^*) \times \frac{p_e + 1}{p_e - p_0}$ for $V_n \leq 15$ l: Water reservoir $V_V \geq 0.2 \times V_n$ $V_n = (V_e + V_V + V_{Kges}{}^*) \times \frac{p_e + 1}{p_e - p_0}$	**V_n = … litres**
Control Supply pressure	p_a	[bar]	$v_{pa} = \dfrac{p_e + 1}{1 + \dfrac{(V_e + V_{Kges}{}^*)\,(p_e + 1)}{V_n\,(p_0 + 1)\,2n}} - 1\text{ bar}$ Precondition: $p_a \geq p_0$ + 0.25…0.3 bar, otherwise calculate for larger nominal volume	**p_a = … bar**
Filling pressure	p_F	[bar]	$p_F = V_n \times \quad - 1$ bar	**p_F = … bar**
Result				
Reflex S / … bar … litres			**p_0 = … bar** Check before commissioning!	
			p_a = … bar Check make-up setting!	
			p_F = … bar Refill the system!	
			p_e =… bar	

* Only applies when using Reflex Servitec in accordance with the 'Degassing' table → see page 25

Installation and commissioning

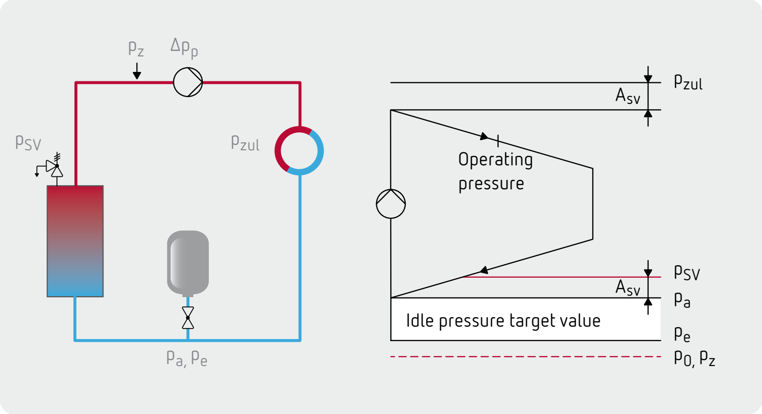
Hydraulic integration

- Integration should preferably be on the suction side of the flow-through pump and in the return flow to the boiler, solar panel or chiller
- At return temperatures of > 70 °C a V auxiliary vessel is required, at return temperatures of < 0 °C, it is recommended.
- Provide a secured shut-off with drain to DIN EN 12828 (applies to all hydraulic systems) for maintenance work (order separately). In larger systems, it is also possible to arrange the drain and shut-off separately.

> The relevant assembly and operating instructions are to be taken into consideration when installing and commissioning.

- Expansion lines are to be sized and installed in accordance with local provisions. DIN EN 12828 requires that each heat generator is connected to at least one expansion line with one or more expansion vessels. It is essential to ensure frost-free conditions.
- Make-up pipes are to be integrated into the flow-through facility water, not into the expansion line.

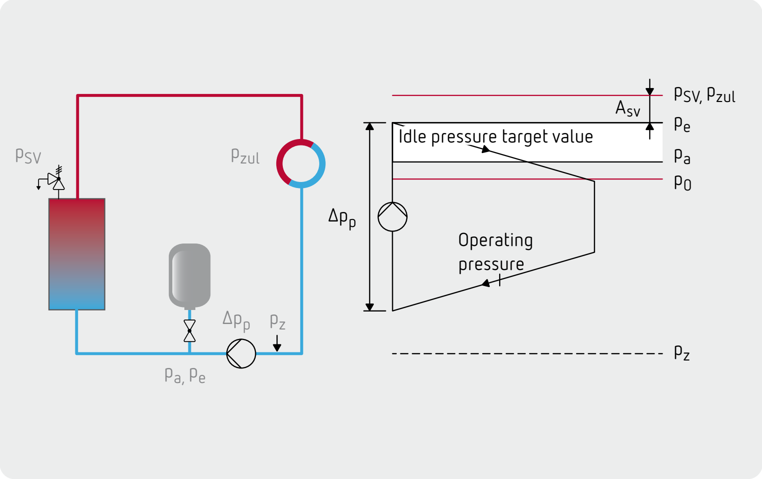
Supply pressure maintenance (suction pressure maintenance)



The pressure maintenance is integrated **upstream** of the flow-through pump, i.e. on the suction side. This method is used almost exclusively because it is the easiest to control.

- **Benefits**:
  - + low idle pressure level
  - + working pressure → idle pressure, therefore no risk of vacuum formation
- **Disadvantages:**
  - – at high flow-through pump pressure (large systems) with high working pressure, observe the network load p_{zul}

Follow-up pressure maintenance



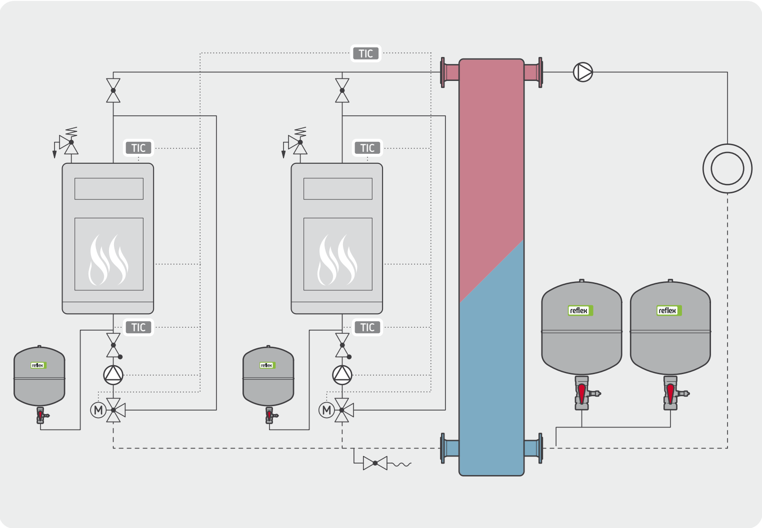
Pressure maintenance is integrated **downstream** of the flow-through pump, i.e. on the pressure side. When determining the idle pressure, a facility-specific differential pressure component for the flow-through pump (50 ... 100 %) must be included in the calculation. For use in only a limited number of cases → solar systems.

- **Benefits**:
  - + low idle pressure level providing the entire pump pressure does not have to be loaded
- **Disadvantages:**
  - – high idle pressure
  - – greater attention to maintaining the required supply pressure p_Z in accordance with manufacturers' specifications

Integrating multi-boiler systems

It is possible to have either individual protection for each boiler with an expansion vessel or overall boiler and system protection. Care should be taken to ensure the relevant boiler remains connected to at least one expansion vessel when shutting off the boiler's sequential switching. Always agree the best switching sequence with the boiler manufacturer. The system pressure and the medium characteristics (glycol component) must be the same in both circuits.

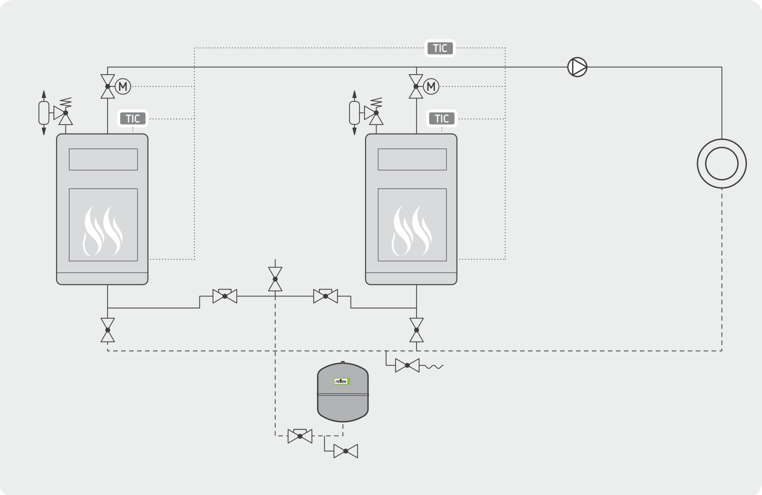
Reflex N serial circuit in a multi-boiler system with individual protection



The serial circuit of several Reflex N 6 or 10 bar vessels generally produces economical alternatives to Reflex G large vessels.

With the burner, the corresponding boiler circuit pump is switched off via the temperature control TIC and the motor valve Ⓜ is closed. The boiler remains connected to its Reflex vessel. The most frequent switching occurs with boilers with minimum return temperature. Switching the burner off reliably prevents circulation via the boiler.

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



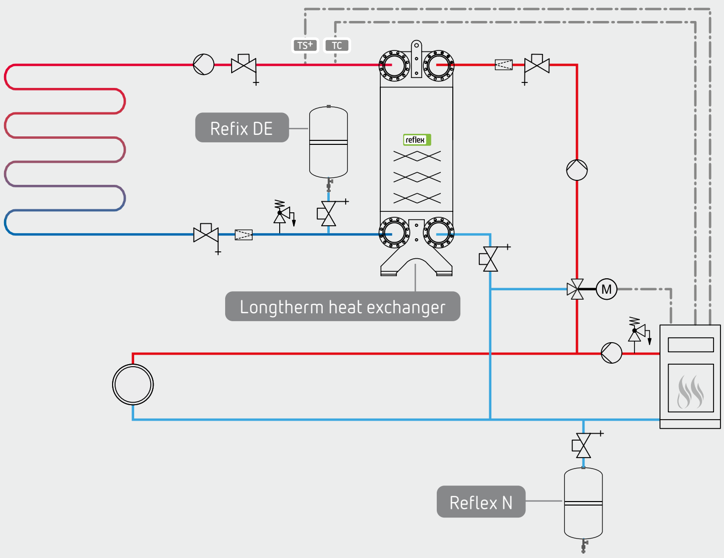
When the burner is switched off, the final control element Ⓜ is closed by the temperature controller TIC preventing incorrect circulation via the shut-off boiler. Joining the boiler expansion line above the centre of the boiler prevents gravity circulation. Preferred inset in systems without minimum boiler return flow temperature (e.g. condensing boiler systems).

The diagrams serve only as illustrations of the connections.

They are to be amended to local conditions and to be made more specific.

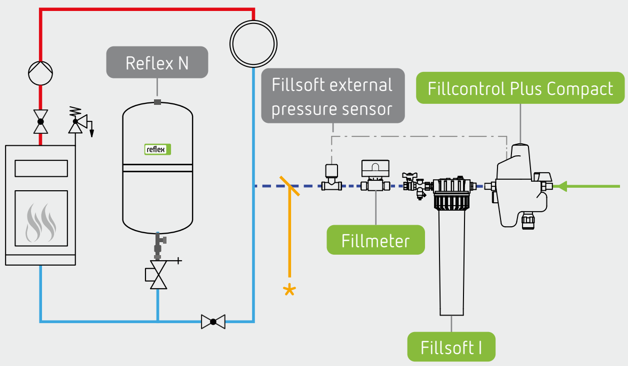
Systems with pipework at risk of corrosion

Underfloor heating without any impermeable pipes



- In systems with oxygen-rich water such as underfloor heating without any impermeable pipes, we recommend the systems are separated (separate the boiler heating circuit medium from the oxygenrich underfloor heating circuit medium) using a Longtherm heat exchanger.
- A Refix expansion vessel is used in underfloor heating circuits due to the risk of corrosion (corrosion protection for all water-bearing parts).

Maintaining VDI 2035



* DN 15 < 2 m connection pipe
DN 20 < 10 m connection pipe
DN 25 > 10 m connection pipe

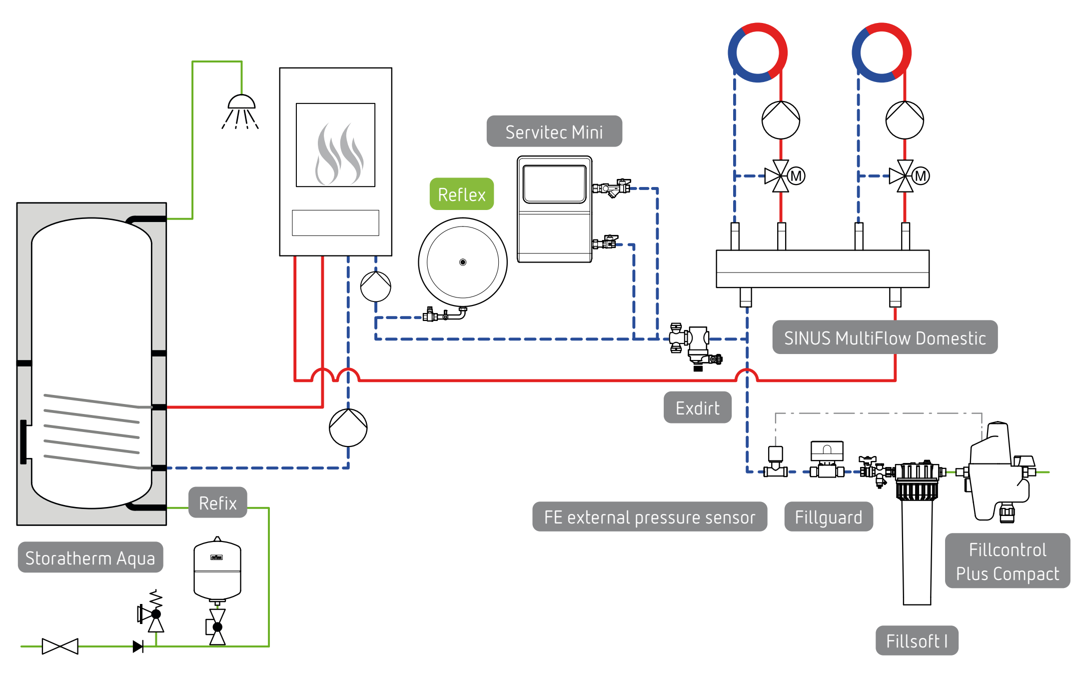
- To ensure compliance with VDI 2035, use a Fillsoft housing with a softening or demineralising cartridge (depending on the quality of the water or the specifications of the operator/boiler manufacturer).
- The Fillcontrol Plus Compact automatic make-up station which also has a system separator for the potable water supply system ensures an adequate water reservoir.

The directive VDI 2035 describes the state of the art for water quality in hot water heating systems and contributes to minimising damage due to corrosion and scale deposits in these systems. The Fillsoft series of Reflex products comply with this directive. Further information can be found in our Make-up and Water Treatment brochure.

Installation examples

Reflex vessel with automatic make-up

Solution № 01

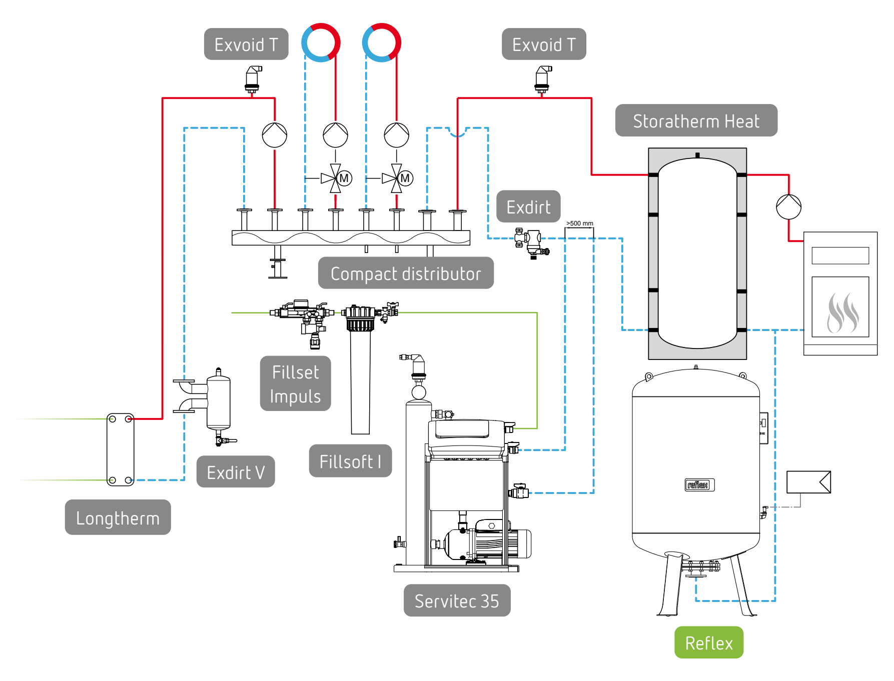


We recommend the use of an automatic make-up such as Reflex Fillcontrol Plus Compact combined with static pressure maintenance in order to ensure an adequate water seal.

Servitec vacuum spray pipe degassing and the dirt and sludge separators remove disruptive factors such as gasses and dirt from the facility water.

Reflex with flaw detector

Solution № 04



Reflex vessel with flaw detector for monitoring the bladder (from 1,000 litres and Ø 1,000 mm).

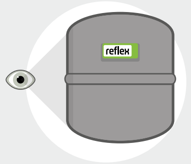
A Longtherm heat exchanger is used to separate the heating and potable water circuit.

Fillset Impuls acts as a system separator to the potable water supply system. The contact water meter for determining filling and make-up quantities is connected with the Servitec controller and evaluated by it.

Operation & Maintenance

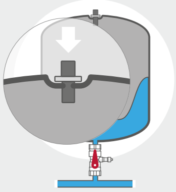
Industrial Safety Regulations require expansion vessels to be checked on an annual basis. The relevant notes for installers and operators in the Reflex Assembly, Operating and Maintenance Instructions are to be observed.

1. Visual inspection



- Inspect vessel for damage, corrosion, etc.
  In the event of damage, complete repairs or replace and determine the possible cause.
- Match vessel suitability to on-site use.

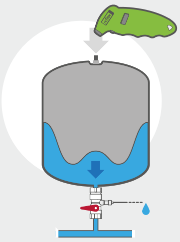
2. Check bladder



Briefly activate the gas filling valve. If water leaks out:

- For vessels which do not have a facility for replacing the bladder, replace the expansion vessel.
- for vessels which have a facility for replacing the bladder, replace the bladder or alternatively contact Reflex Service for further advice.

3. Setting gas supply pressure



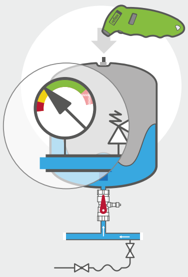
Isolate the Reflex vessel from the system using the cap valve and empty on the water side (check system pressure).
Measure supply pressure p_0 at the gas filling valve and if necessary reset to the required minimum operating pressure for the system.

$$p_0\,[\text{bar}] = p_{st} + 0{,}2\,\text{bar} + p_D^{*} + \Delta p_p^{**}$$

* Evaporation pressure p_D only relevant for hot water systems >100 °C.
** Used to maintain follow-up pressure maintenance (expansion vessel downstream of the pump on the pressure) e.g. In solar thermal systems.

- If the pressure is too high, blow off the gas with the gas filling valve.
- If the pressure is too low, refill with nitrogen from a pressurised container.
- Enter the reset or corrected supply pressure p_0 on the type plate.

4. Functional inspection during operation

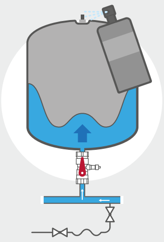


- Close drain at the cap valve and carefully open cap valve.
- Note system pressure and do not allow it to fall below p_0.
- Fill the system up to the filling pressure p_F in accordance with the system temperature.

$$p_F\,[\text{bar}] \geq p_0 + 0{,}3\,\text{bar}$$ (at filling temperature 10 °C)

- Checking gas pressure during operation: the gas pressure must now be the same as the system pressure (working vessel).

5. Gas filling valve leak test



Remove optional aids for filling and measuring at the gas filling valve and inspect with leak test spray to see whether the gas filling valve leaks after use. Finally, refit the cap valve, which provides the seal, on the gas filling valve.

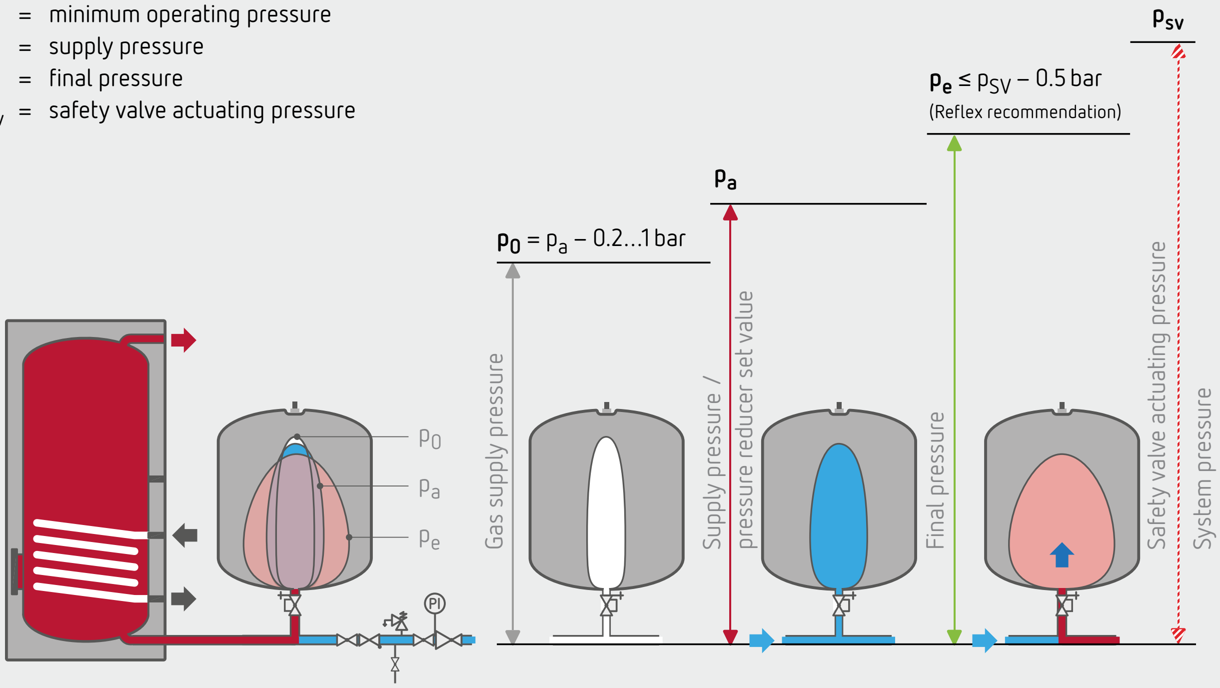
Selection and calculation

Pressures in the system

Applies to expansion vessels in hot water heating systems

Excess pressures

p_{st} = static pressure
p_0 = minimum operating pressure
p_a = supply pressure
p_e = final pressure
p_{sv} = safety valve actuating pressure



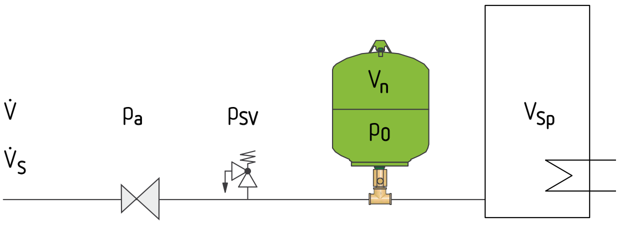
Application limits according to DVGW

The following design parameters in accordance with DIN 4708 part 5 are decisive when using MAG-W:

Potable water heater capacity	V_{Sp}	in l
Nominal volume of the MAG-W	V_n	in l
Safety valve actuating pressure	p_{sv}	= 6.0 or 10.0 bar
Working pressure differential	d_{pA}	= 20 % of p_{SV} in bar
Facility pressure ($p_e = p_{SV} - d_{pA}$)	p_e	= 4.8 or 8.0 bar
Supply pressure in the MAG-W	p_0	= $p_a - 0.2$ in bar
Supply pressure p_a (idle pressure behind the pressure reducer)	p_a	in bar
Cold water temperature	t_w =	10 °C constant
Hot water temperature	t_{ww}=	60 °C constant
Water expansion	n =	1.67 %

Refix quick selection

Selection by nominal volume V_n



10 °C Cold water feed temperature

60 °C Vessel temperature

- Gas supply pressure p_0 = 3.0 bar
- Pressure reducer preset pressure p_a ≥ 3.2 bar

- Gas supply pressure p_0 = 4.0 bar = standard
- Pressure reducer preset pressure p_a ≥ 4.2 bar

	Gas inlet pressure p_0 [bar]	3.0				4.0 = standard			
	Pressure reducer set-point pressure p_a [bar]	≥ 3.2				≥ 4.2			
	Safety Valve p_{SV} [bar]	6	7	8	10	6	7	8	10
	V_{sp} [litres]	V_n [litres]							
Refix	90	8	8	8	8	8	8	8	8
	100	8	8	8	8	12	8	8	8
	120	8	8	8	8	12	8	8	8
	130	8	8	8	8	12	8	8	8
	150	8	8	8	8	18	12	8	8
	180	12	8	8	8	18	12	8	8
	200	12	12	8	8	18	12	12	8
	250	12	12	12	8	25	18	12	12
	300	18	18	12	12	25	18	18	12
	400	25	18	18	18	33	33	15	25
	500	25	25	18	18	60	33	25	25
	600	33	25	25	18	60	60	33	25
	700	33	33	25	25	60	60	33	25
	800	60	33	33	25	80	80	60	25
	900	60	60	33	25	80	60	60	33
	1,000	60	60	33	33	100	60	60	60
	1,500	80	80	60	60	200	100	80	60
	2,000	100	100	80	80	200	200	100	80
	3,000	100	100	100	100	300	200	200	100

Key data

Vessel volume V_{sp} = 900 litres

Hot water temperature T_{ww} = 60 °C

Pressure reducer preset pressure p_a = 4.2 bar

Selection

Safety valve p_{sv} = **10.0 bar**

Expansion (60 °C/10 °C) n = **1.7 %**

Supply pressure p_0 = **4.0 bar**

Result

From the table

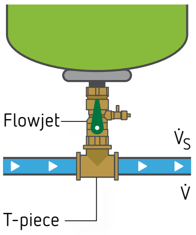
Vessel volume → V_n = **31.5 litres**

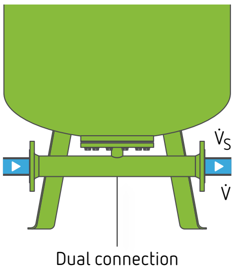
Selection example

Selection by peak volume flow V_s

In potable water expansion vessels with flow-through, determining just the nominal volume V_n is not enough. Further checks are to be carried out to establish whether the maximum recommended peak volume flow V_s has not been exceeded as well as the pressure drop Δp.

Once the nominal volume of the Refix has been selected, checks must be carried out on vessels with flow-through to establish whether the peak volume flow $\dot{V}_S$, resulting from the calculation of the pipe network in accordance with DIN 1988 can be implemented on the Refix vessels. If a larger nominal connection diameter is required, for Refix DD, a 60 litre Refix DT is to be used instead of the 8–33 litre vessel for greater flow.





10 °C Cold water feed temperature

60 °C Vessel temperature

Available connections		recommended max. peak volume flow $\dot{V}_S$*	actual pressure loss at volume flow $\dot{V}$
Refix DD	**8–33 l**		
with or without Flowjet	Rp ¾" = standard	≤ 2.5 m³/h	$\Delta p = 0.03\,\text{bar} \times \left(\frac{\dot{V}\,\text{m}^3/\text{h}}{2.5\,\text{m}^3/\text{h}}\right)^2$
passing T-piece	Rp 1" (on-site)	≤ 4.2 m³/h	negligible
Refix DT	**60–500 l**		
with Flowjet Rp 1¼"		≤ 7.2 m³/h	$\Delta p = 0.04\,\text{bar} \times \left(\frac{\dot{V}\,\text{m}^3/\text{h}}{7.2\,\text{m}^3/\text{h}}\right)^2$
Refix DT	**80–3.000 l**		
Dual connection DN 50		≤ 15 m³/h	$\Delta p = 0.14\,\text{bar} \times \left(\frac{\dot{V}\,\text{m}^3/\text{h}}{15\,\text{m}^3/\text{h}}\right)^2$
Dual connection DN 65		≤ 27 m³/h	$\Delta p = 0.11\,\text{bar} \times \left(\frac{\dot{V}\,\text{m}^3/\text{h}}{27\,\text{m}^3/\text{h}}\right)^2$
Dual connection DN 80		≤ 36 m³/h	negligible
Dual connection DN 100		≤ 56 m³/h	negligible
Refix DE, DC			
(no medium circulating)		unlimited	Δp = 0

* determined for a speed of 2 m/s

Comprehensive calculation and design notes

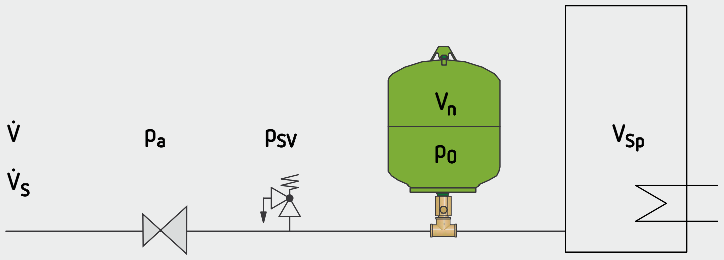
Potable water is a food stuff. Expansion vessels in potable water installations therefore have to meet specific requirements to DIN 4807 part 5. Only vessels with flow-through are permitted.

Refix in water heating systems

Calculation

The calculation is completed in accordance with DIN 4807 part 5 → see next page

Circuit



The safety valve is usually installed directly at the cold water inlet on the water heater. On Refix DD and DT, the safety valve may also be installed immediately upstream of the flow through, shut-off and drain valve when viewed from the direction of flow if 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
Refix DT flow-through fitting:	Rp 1¼"	max. 5,000 l water heater

Material values n, p_D

Usually determined between cold water temperature 10 °C and maximum hot water temperature 60 °C.

Thermal disinfection

With thermal disinfection, the entire hot water network is heated to > 70 °C. As expansion vessels are installed in the cold water feed, they are not affected by the increased temperature. If thermal disinfection is included, this must only be included in the calculation.

Supply pressure p_0, minimum operating pressure

The minimum operating pressure or supply pressure p_0 in the expansion vessel must be at least 0.2 bar less than the minimum flow pressure. Depending on the distance between the pressure reducer and the Refix, supply pressure settings of 0.2 to 1.0 bar less than the preset pressure on the pressure reducer are required.

Supply pressure p_a

This is identical to the preset pressure on the pressure reducer. Pressure reducers to DIN 4807 part 5 are required in order to achieve a stable supply pressure and therefore the full capacity of the Refix.

Expansion vessel

In potable water systems to DIN 1988, only Refix vessels with flow-through to DIN 4807 part 5 may be used. Refix with a connection may be used for non-potable water.

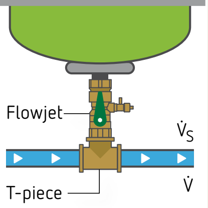
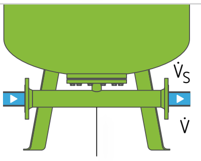
Initial data			see manufacturer's specifications / proxy values for calculation	
Vessel volume	V_{Sp}	[l]		
Heat output	$\dot{Q}_W$	[kW]		
Water temperature	t_{WW}	[°C]	Depending on the controller setting 50 … 60 °C	
Percentage expansion		[%]		n = … %
Pressure reducer	p_a	[bar]	Setting pressure	p_a = … bar
Safety valve	p_{SV}	[bar]	**Reflex recommendation:** 10 bar	p_{SV} = … bar
Peak flow	$\dot{V}_S$	[m³/h]		$\dot{V}_S$ = … [m³/h]

Selection by nominal volume V_n

Supply pressure p_0 [bar]	$p_0 = p_a - (0.2 \ldots 1.0\,\text{bar})$ Set supply pressure 0.2 … 1.0 bar less than pressure reducer (depending on distance between pressure reducer and Refix)	p_0 = … bar
Nominal volume V_n [l]	$V_n = V_{Sp} \times \frac{n \times (p_{sv} + 0.5)\,(p_0 + 1.2)}{100 \times (p_0 + 1)\,(p_{sv} - p_0 - 0.7)}$	V_n = … litres

Selection by peak volume $\dot{V}_S$

Once the nominal volume of the Refix has been selected, checks must be carried out on vessels with flow-through to establish whether the peak volume flow $\dot{V}_S$, resulting from the calculation of the pipe network in accordance with DIN 1988 can be implemented on the Refix vessels. If this is the case, for Refix DD, a 60 litre Refix DT is to be used instead of the 8 – 33 litre vessel for greater flow. Alternatively, a Refix DD with a suitably larger T-piece can be used whereby it should be noted that the flow-through insert of the DD vessel protrudes into the full bore of the T-piece.

	Available connections		recommended max. peak volume flow $\dot{V}_S$*	actual pressure loss at volume flow $\dot{V}$	
Refix DD 8 – 33 l	mit oder ohne Flowjet	Rp ¾" = Standard	≤ 2,5 m³/h	$\Delta p = 0{,}03\,\text{bar} \times \left(\frac{\dot{V}\,\text{m}^3/\text{h}}{2{,}5\,\text{m}^3/\text{h}}\right)^2$	
	Durchgang T-Stück	Rp 1" (bauseits)	≤ 4,2 m³/h	vernachlässigbar	
Refix DT 60 – 500 l	mit Flowjet Rp 1¼"		≤ 7,2 m³/h	$\Delta p = 0{,}04\,\text{bar} \times \left(\frac{\dot{V}\,\text{m}^3/\text{h}}{7{,}2\,\text{m}^3/\text{h}}\right)^2$	
Refix DT 80 – 3.000 l	Duo-Anschluss DN 50		≤ 15 m³/h	$\Delta p = 0{,}14\,\text{bar} \times \left(\frac{\dot{V}\,\text{m}^3/\text{h}}{15\,\text{m}^3/\text{h}}\right)^2$	 Dual connection
	Duo-Anschluss DN 65		≤ 27 m³/h	$\Delta p = 0{,}11\,\text{bar} \times \left(\frac{\dot{V}\,\text{m}^3/\text{h}}{27\,\text{m}^3/\text{h}}\right)^2$	
	Duo-Anschluss DN 80		≤ 36 m³/h	vernachlässigbar	
	Duo-Anschluss DN 100		≤ 56 m³/h	vernachlässigbar	
Refix DE, Refix DC	(nicht durchströmt)		unbegrenzt	Δp = 0	

* ermittelt für eine Geschwindigkeit von 2 m/s

Δp = … bar

G = …

Result

Refix DT5 …… l	V_n = … l
Refix DD …… l G = …… (Standard Rp 3/4" incl.)	p_0 = … bar
Refix DT5 …… l	

Refix in pressure booster systems

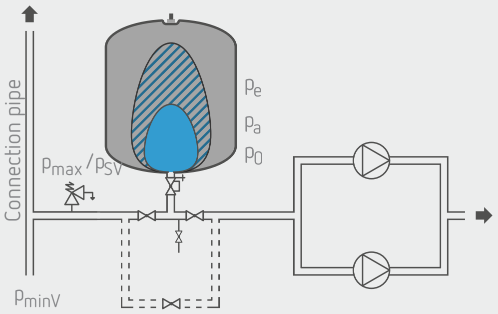
Potable water is a food stuff. Expansion vessels in potable water installations therefore have to meet specific requirements to DIN 4807 part 5. Only vessels with flow-through are permitted.

Calculation

The calculation is completed in accordance with DIN 1988 part 5, Codes of practice for drinking water installations, pressure boosting and pressure reduction.

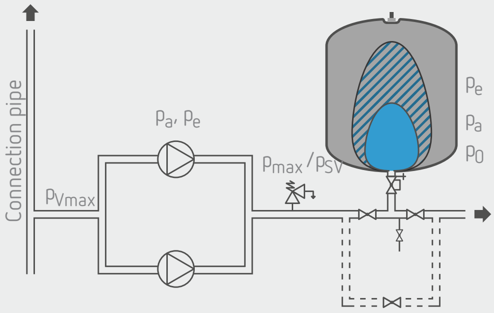
Circuit

Refix in pressure booster systems
Suction side



On the **upstream side of a pressure boosting system (DEA)**, Refix expansion vessels relieve the pressure on the connection pipe and the supply network. Installation is to be agreed with the water supply company.

Refix in pressure booster systems
Pressure side



On the **downstream side of a pressure booster system (DEA)** the switching frequency is reduced when installing Refix, particularly in cascade controlled systems. Installation on both sides of the DEA may be necessary.

Supply pressure p_0, supply pressure p_a

The minimum operating pressure or the supply pressure p_0 in the Refix must be set to approximately 0.5 to 1 bar less than the minimum supply pressure when installed on the suction side and 0.5 to 1 bar less than the cut-in pressure on the pressure side of a DEA. As the supply pressure pa is at least 0.5 bar greater than the supply pressure, there is always an adequate water reservoir available which is an important precondition for low-wear operation.

In potable water systems to DIN 1988, only Refix vessels with flow-through to DIN 4807 part 5 may be used. Refix with a connection may be used for non-potable water.

⚠ Care should be taken to ensure the pressure surges do not exceed the maximum permissible operating pressure.

Suction side circuit: Refix on the upstream side of the DEA

Installation is to be agreed with the relevant water supply company. This is necessary if the following criteria cannot be met:

- if a pump fails in the DEA, the flow speed in the connection pipe of the DEA may not alter by more than 0.15 m/s
- if all the pumps fail, by not more than 0.5 m/s
- when the pump is in operation, the minimum supply pressure p_{minV} may not drop below 50 % and must be at least 1 bar

Initial data	see manufacturer’s specifications/proxy values for calculation	
min. supply pressure p_{minV} [bar] max. feed flow $\dot{V}_{maxP}$ $[m^3/h]$	Selection in accordance with DIN 1988 part 5	**V_n = ... litres**
Supply pressure p_0 [bar]	$p_0 = p_{minV} - 0.5$ bar	**p_0 = ... bar**
Result		
Refix DT5 l	**V_n = ... l**	
with twin connection DN 50	**p_0 = ... bar**	
Refix DT5 l		

max. feed flow $\dot{V}_{maxP}$ / m^3/h	Refix DT with twin connection V_n / litre	Refix DT V_n / litre
≤ 7	300	300
> 7 ≤ 15	500	600
> 15	–	800

Pressure side circuit Refix on the downstream side of the DEA

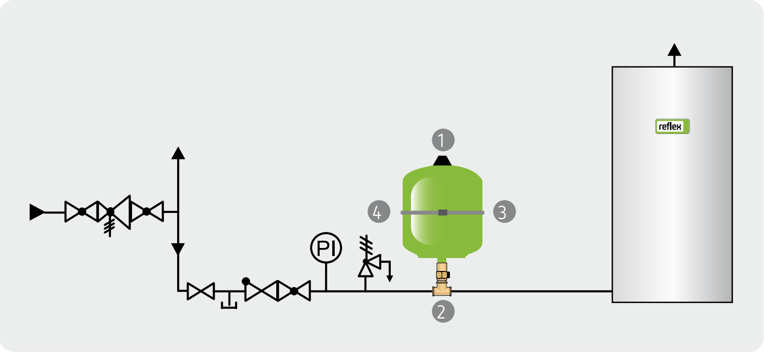
Initial data	see manufacturer’s specifications/proxy values for calculation	
For limiting the switching frequency in pressure-controlled systems		
Max. pump head for the DEA H_{max} [mWs] Max. supply pressure p_{max} [bar] Cut-in pressure p_E [bar] Cut-out pressure p_A [bar] Max. feed flow $\dot{V}_{maxP}$ [l/h] Switching frequency s [1/h] No. of pumps n [pieces] Electrical power of the more powerful pump P_{el} [kW]		
Nominal volume V_n [l]	$V_n = 0,33 \times V_{maxP} \dfrac{p_A + 1}{(p_A - p_E) \times s \times n}$	**V_n = ... litres**
For storing the minimum feed quantity V_e between On and Off for the DEA		
Cut-in pressure p_E [bar] Cut-out pressure p_A [bar] Refix supply pressure p_0 [bar] Feed quantity V_e [l]	**Reflex recommendation:** for $p_0 = p_E - 0{,}5$ bar	**p_0 = ... bar**
Nominal volume V_n [l]	$V_n = V_e \dfrac{(p_E + 1)\ (p_A + 1)}{(p_0 + 1)\ (p_A - p_E)}$	**V_n = ... litres**
Check permissible operating excess pressure p_{max} [bar]	$p_{max} = \leq 1{,}1\ p_{zul} \dfrac{H_{max}\,[mWs]}{10}$	**p_{max} = ... bar**
Initial data		
Refix DT5 l	**V_n = ... l**	
with twin connection DN 50	**V_n = ... l**	
Refix DT5 l	**p_0 = ... bar**	

s – Switching frequency	1/h	20	15	10
Pump output	kW	≤ 4.0	≤ 7.5	≤ 7.5

Installation examples

Refix in water heating systems – installation examples

Refix DD, DT 60–500 with Flowjet flow through, shut-off and drain valve



- The **complete solution** with Flowjet flow through, shut-off and drain valve
- **Benefits:** Flowjet is easy to fit and DIN-compliant Guaranteed shut off, drainage and flow-through for Refix.

① Refix DD or Refix DT 60–500

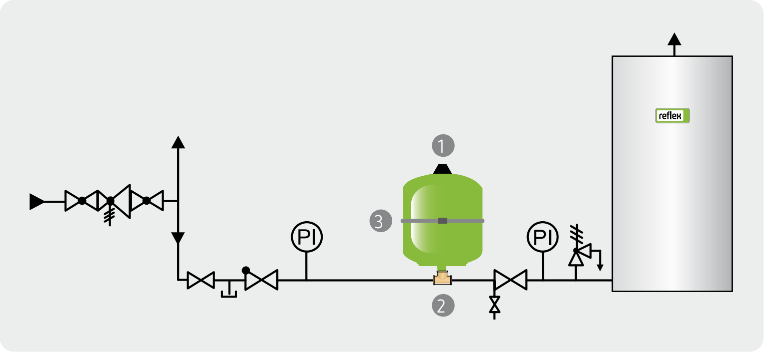
② Flowjet flow through, shut-off and drain valve optional accessory for Refix DD:
  - standard with T-piece Rp ¾", $\dot{V}$ ≤ 2. 5 m^3/h
  - for T-piece Rp 1" $\dot{V}$ ≤ 4.2 m^3/h

  for Refix DT 60–500' with Flowjet:
  - standard with Rp 1¼" $\dot{V}$ ≤ 7.2 m^3/h

③ Reflex wall-hung holder for 8–25 litres (33 l with butt straps, DT with feet)

④ A safety valve may also be fitted upstream in the direction of flow of the Refix DD or the DT5 with Flowjet provided the nominal diameter of the required S_V ≤ than the downstream storage feed.

Refix DD without Flowjet flow through, shut-off and drain valve



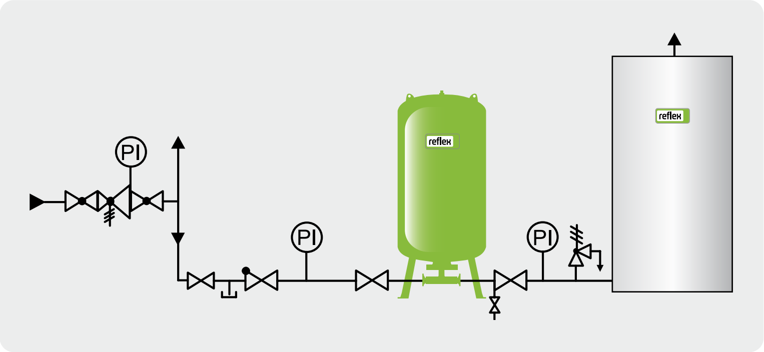
- If no Flowjet flow through, shut-off and drain valve is fitted, the feed to the water heater must be shut-off during maintenance work and the Refix DD drained via an on-site fitting.

① Refix DD

② T-piece Rp ¾", $\dot{V}$ ≤ 2.5 m^3/h
For T-piece Rp 1" $\dot{V}$ ≤ 4.2 m^3/h

③ Reflex wall-hung holder for 8–25 litres (33 l with butt straps feet)

Refix DT with twin connection



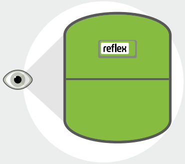
- Additional fittings are required when shutting off and draining the Refix DT with twin connection.
- The safety valve can not be shut off at the cold water inlet on the vessel.

⚠ Vessel charging systems are sometimes subjected to high temperatures. Please contact your Reflex representative.

Operation & Maintenance

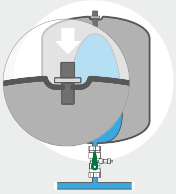
Industrial Safety Regulations require expansion vessels to be checked on an annual basis. The relevant notes for installers and operators in the Reflex Assembly, Operating and Maintenance Instructions are to be observed.

1. Visual inspection



- Inspect vessel for damage, corrosion, etc.
  In the event of damage, complete repairs or replace and determine the possible cause.
- Match vessel suitability to on-site use.

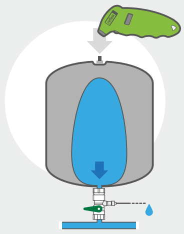
2. Check bladder



Briefly activate the gas filling valve. If water leaks out:

- For vessels which do not have a facility for replacing the bladder, replace the expansion vessel.
- for vessels which have a facility for replacing the bladder,replace the bladder or alternatively contact Reflex Service for further advice.

3. Setting gas supply pressure



Isolate the Reflex vessel from the system using the cap valve (Flowjet) and empty on the water side.

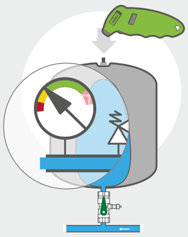
Measure supply pressure p_0 at the gas filling valve and if necessary reset to the required minimum operating pressure for the system.

p_0 [bar] = p_a – 0,2 bar*

* At greater distances (pressure loss) to the pressure reducer, increase the difference to p_a to up to 1 bar.

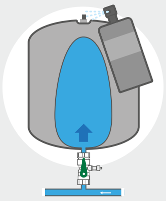
- If the pressure is too high, blow off the gas with the gas filling valve.
- If the pressure is too low, refill with nitrogen from a pressurised container.
- Enter the reset or corrected supply pressure p_0 on the type plate.

4. Functional inspection during operation



- Close drain at the cap valve and carefully open cap valve (Flowjet).
- Checking gas pressure during operation the gas pressure must now be the same as the system pressure (compare with pressure gauge on the pressure reducer) then the vessel is operational.
- If the vessel has heated up, the pressure in the vessel may be approximately 0.5 bar less than the safety valve actuating pressure.

5. Gas filling valve leak test



Remove optional aids for filling and measuring at the gas filling valve and inspect with leak test spray to see whether the gas filling valve leaks after use. Finally, refit the cap valve, which provides the seal, on the gas filling valve.

→ The Refix expansion vessel is now ready to be used again.