Expansion vessels

556 - 568 - 5557 series

CALEFFI

01079/13 GB

ISO 9001 FM 21654 ISO 9001 No. 0003

Function

Expansion vessels are devices designed to accommodate the increase in the volume of water due to the raising of its temperature, both in heating systems and in domestic hot water production systems.
They are also used as hydro-pneumatic well in domestic water distribution systems.

CE 0045

CE 1370

Product range

556 series Welded expansion vessel for heating systems, CE certified capacity (litres): 8, 12, 18, 25, 35, 50, 80, 100, 140, 200, 250, 300, 400, 500, 600

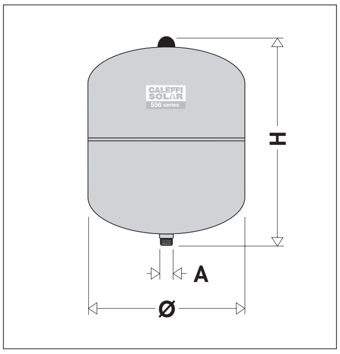
568 series Welded expansion vessel for domestic water systems and hydro-pneumatic well applications, CE certified capacity (litres): 8, 12, 18, 25, 33, 50, 60, 80, 100, 200, 300, 400, 500

5557 series Welded expansion vessel for domestic water systems, CE certified capacity (litres): 2, 5, 8

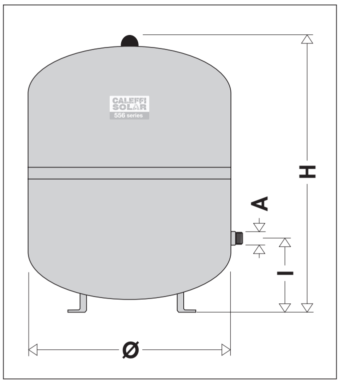
Technical specifications

series	556	568	5557
Materials:			
Body:	steel	steel	steel
Membrane:	SBR	8–33 l, butyl 50-500 l, EPDM	2–8 l, butyl
Type of membrane:	diaphragm	bladder (can be replaced for volumes from 60 to 500 l)	bladder
Pipe connection:	galvanised steel	galvanised steel	galvanised steel
Protection for pipe connection:	-	8–33 l, plastic insert 50-500 l, epoxy coating	plastic insert
Colour:	red	blue	white
Performance:			
Medium:	water, glycol solutions	water	water
Max. percentage of glycol:	50%	not applicable	not applicable
Max. working pressure:	6 bar	10 bar	10 bar
Pre-charge pressure:	1,5 bar	2,5 bar	2,5 bar
System working temperature range:	-10–120°C	-10–70°C	-10–100°C
Membrane working temperature range:	-10–70°C	-10–70°C	-10–100°C
Construction:	conforms to DIN 4807-2 and EN 13831	conforms to DIN 4807-2 and EN 13831	conforms to EN 13831
Application:	heating	domestic water, hydro-pneumatic well conforms to D.M. 6th April 2004, no. 174	domestic water conforms to D.M. 6th April 2004, no. 174
Connections:			
Pipe connection:	8-50 l: 3/4" M (ISO 7-1) 80-600 l: 1" M (ISO 7-1)	8-33 l: 3/4" M (ISO 228-1) 50-100 l: 1" M (ISO 228-1) 200-500 l: 1 1/4" M (ISO 228-1)	2 l: 1/2" M (ISO 228-1) 5 and 8 l: 3/4" M (ISO 228-1)

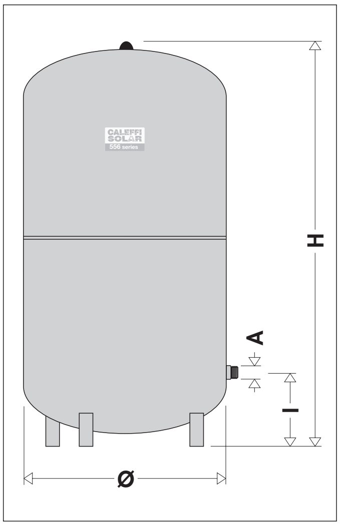
Dimensions



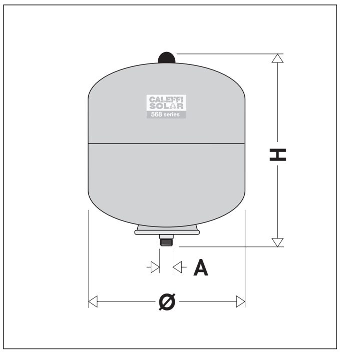
Code	Litres	A	Ø	H	Mass (kg)
556008	8	3/4"	206	285	1,7
556012	12	3/4"	280	275	2,3
556018	18	3/4"	280	345	2,8
556025	25	3/4"	280	465	3,5



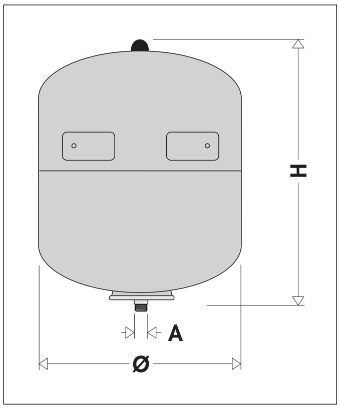
Code	Litres	A	Ø	H	I	Mass (kg)
556035	35	3/4"	354	460	130	5,7
556050	50	3/4"	409	493	175	7,5
556080	80	1"	480	565	175	9,9
556100	100	1"	480	670	175	11,2
556140	140	1"	480	912	175	14,5
556200	200	1"	634	760	205	36,7
556250	250	1"	634	890	205	45,0



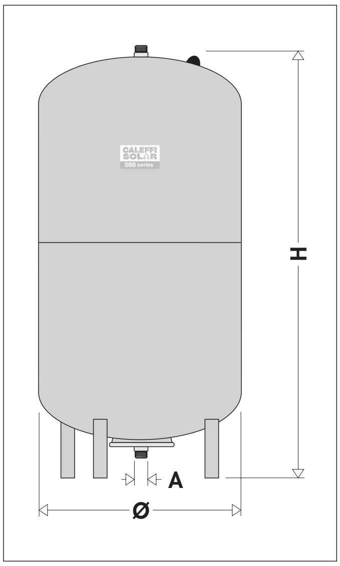
Code	Litres	A	Ø	H	I	Mass (kg)
556300	300	1"	634	1060	235	52,0
556400	400	1"	740	1070	245	65,0
556500	500	1"	740	1290	245	79,0
556600	600	1"	740	1530	245	85,0



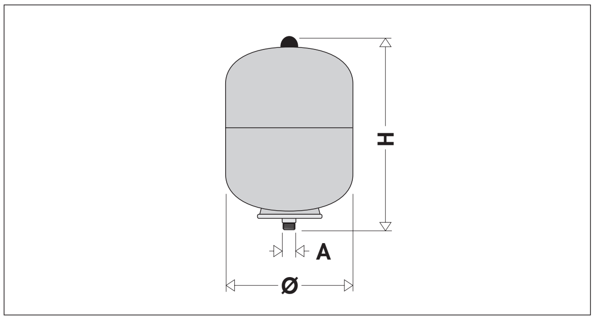
Code	Litres	A	Ø	H	Mass (kg)
568008	8	3/4"	206	320	1,8
568012	12	3/4"	280	310	2,4
568018	18	3/4"	280	380	2,8
568025	25	3/4"	280	500	3,7



Code	Litres	A	Ø	H	Mass (kg)
568033	33	3/4"	354	455	6,6



Code	Litres	A	Ø	H	Mass (kg)
568050	50	1"	409	605	9,5
568060	60	1"	409	740	14,0
568080	80	1"	480	730	16,0
568100	100	1"	480	835	19,0
568200	200	1 1/4"	634	970	47,0
568300	300	1 1/4"	634	1270	53,0
568400	400	1 1/4"	740	1245	70,0
568500	500	1 1/4"	740	1475	79,0



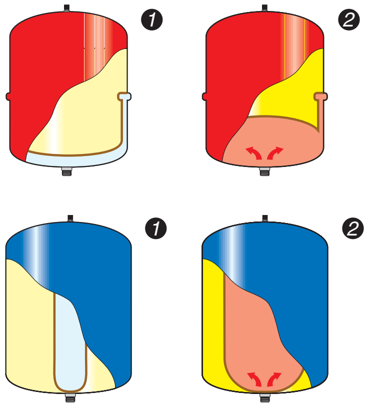
Codice	Litres	A	Ø	H	Mass (kg)
555702	2	1/2"	120	240	1,0
555705	5	3/4"	175	275	1,5
555708	8	3/4"	230	305	2,1

Operating principle

Expansion vessel for heating and domestic water circuits

The closed expansion vessel with membrane consists of a closed container divided into two parts by a membrane which separates the water from the gas (usually nitrogen) and acts as an expansion accommodator.

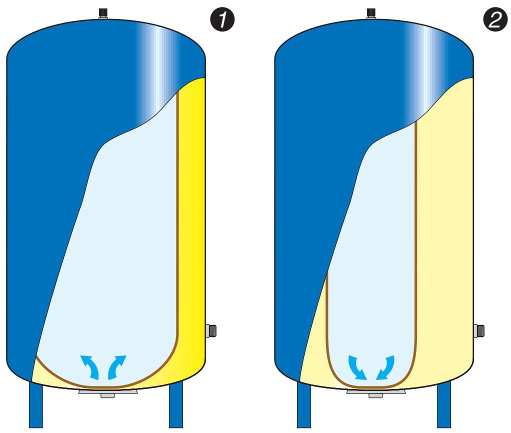
Following an increase in temperature, an increase in pressure takes place in the vessel in relation to the pre-charge pressure when cold (fig. 1) until it reaches the value corresponding to the maximum expansion (fig. 2).



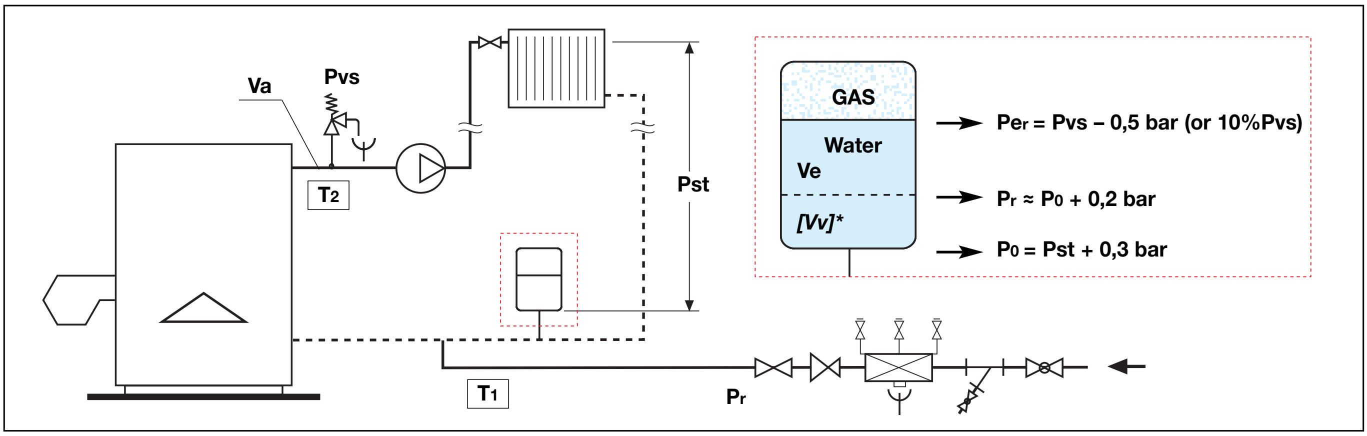
Hydro-pneumatic well

The operating principle of hydro-pneumatic wells is as follows. The pump, activated by the pressure switch, starts up and the vessel starts to fill. When the pressure reaches the setting value, the pump stops: the vessel has reached its maximum capacity (fig. 1).

In case of water request by the user, pressure is used to supply water to the system and gradually decreases in the period between activation and deactivation of the pumps (fig. 2).



Heating systems



Sizing method

e = water expansion coefficient, calculated according to the maximum difference between the temperature of the water when the system is cold (T_1) and the maximum working temperature (T_2)

$$e = n/100$$

t_m = maximum permitted temperature in degrees Celsius with reference to intervention of the safety devices

$$n = 0{,}31 + 3{,}9 \cdot 10^{-4} \cdot t_m^2$$

For temperature values of 110°C, n = 5,029

Definition of volumes

Vn = vessel volume (l), to be calculated
Va = water content in the system (l)
Ve = expansion volume due to the water heating up (l)

Pressure definition - all the pressures listed below are measured at the pressure gauge (relative pressures):

Pst = hydrostatic pressure at the point of installation (bar)
Pvs = safety relief valve setting pressure (bar)
P_0 = pre-charge pressure of the vessel at the gas side (bar) equal to the hydrostatic pressure increased by a cautionary pressure value to ensure no pressure drops occur within the system (bar)

$$P_0 = Pst + 0{,}3 \text{ bar}$$

> ***NOTE:***
>
> **P_r** = system filling pressure at the water side (bar)
>
> *To compensate for any loss in the circuit, it is wise to ensure a minimal volume **[Vv]*** of water is already inside the vessel during the initial stages. To ensure this volume **[Vv]***, with recommended value **0,5% of Va** (with a minimum value of 3 litres), enters the vessel while cold, it is necessary to fill the system with filling P_r of:*
>
> $$P_r \approx P_0 + 0{,}2 \text{ bar}$$
>
> *Minimum recommended charging pressure Pr ≥ 1 bar*

Pe_r = maximum system working pressure at the gas side (bar), i.e. Pvs decreased by a pressure value which prevents the safety relief valve from opening

$$Pe_r = Pvs - 0{,}5 \text{ bar (10\% Pvs if Pvs > 5 bar)}$$

Indicative coefficient "n" as the temperature "T (°C)" varies in relation to the temperature of 10°C, with and without glycol "%"

°C	-20	-10	0	10	20	30	40	50	60	70	80	90	100	110	120	130
% glycol																
0			0	0,1	0,2	0,4	0,8	1,2	1,7	2,3	2,9	3,6	4,3	5,2	6,0	6,9
10			0,1	0,3	0,5	0,7	1,1	1,5	2,0	2,6	3,2	3,9	4,6	5,5	6,3	7,3
20			0,2	0,5	0,8	1,1	1,4	1,8	2,3	2,9	3,5	4,2	4,9	5,8	6,7	7,6
30		0,1	0,4	0,7	1,0	1,3	1,6	2,1	2,6	3,1	3,8	4,4	5,2	6,0	6,9	7,8
40	0,4	0,7	1,0	1,3	1,5	1,7	2,1	2,5	3,0	3,6	4,2	4,9	5,6	6,4	7,3	8,2
50	0,6	0,9	1,2	1,5	1,8	2,0	2,4	2,8	3,3	3,9	4,5	5,2	5,9	6,7	7,6	8,5

The capacity of a closed expansion vessel with membrane (diaphragm) for heating systems is calculated by applying the following formula:

$$Vn = \frac{e \cdot Va\ [+\ Vv]^*}{1 - \frac{Pa}{Pe}} \qquad (1)$$

Absolute pressures

Pa = initial absolute pressure at the gas side (bar), equal to the pressure **P_0** plus the atmospheric pressure (1 bar)

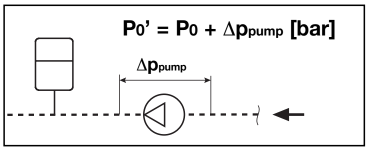
$$Pa = P_0 + [+\ \Delta p]^{**} + 1$$

Pe = final absolute pressure at the gas side (bar), obtained from **Pe_r** plus the atmospheric pressure (1 bar)

$$Pe = Pe_r + 1 = Pvs - 0{,}5 \text{ bar [or -10\% Pvs]} + 1$$

****Vessel installation downstream of the circulation pump**

Vessel installation downstream of the circulation pump requires for the Pa calculation to take into account the pump head **[Δp_{pump}]**:**



$$Pa' = P_0 + \Delta p_{pump} \text{ [bar]} + 1 \text{ bar}$$

Considering that in this formula the pre-charge pressure (at the pressure gauge) at the gas side is obtained from:

$$P_0' = P_0 + \Delta p_{pump} \text{ [bar]}$$

Example:

Sizing an expansion vessel for a heating system with the following technical specifications:

Va = *water content in the system = **1000 l***
Vv = ***5 l** (0,5% of Va)*
t_m = ***110°C***
n = ***5,029***
e = *n/100 = **0,05029***
Pst = *hydrostatic pressure at the point of installation = **2,3 bar***
Pvs = *safety relief valve setting pressure = **4 bar***

Solution:

P_0 = *vessel pre-charge pressure at the gas side = Pst + 0,3 bar = 2,3 + 0,3 = **2,6 bar***
Pe_r = *maximum system working pressure at the gas side = Pvs – 0,5 bar = 4 – 0,5 = 3,5 bar*

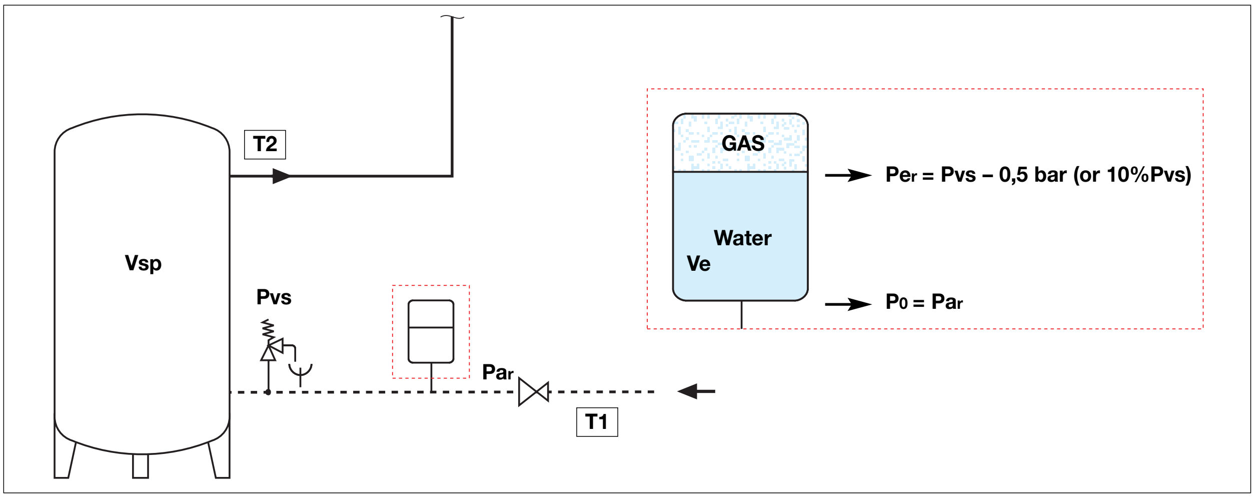
Pa = *initial absolute pressure at the gas side = P_0 + 1 = 2,6 + 1 = **3,6 bar***
Pe = *final absolute pressure at the gas side = Pe_r + 1 = 3,5 + 1 = **4,5 bar***

*Formula (1) is applied to calculate the volume of the vessel **Vn**:*

$$Vn = \frac{0{,}05029 \cdot 1000 + 5}{1 - \frac{3{,}6}{4{,}5}} = 276{,}15 \text{ l}$$

A 300 l vessel should therefore be selected *(this must be pre-charged to 2,6 bar)*

Domestic water systems



Sizing method

T1 = cold water supply temperature
T2 = hot water storage temperature
e = water expansion coefficient, calculated according to the maximum temperature difference between the cold water supply and the hot water storage

$$\mathbf{e} = n_{T2}/100 - n_{T1}/100$$

Definition of volumes

Vn = vessel volume (l), to be calculated
Vsp = volume of the heated water (l) (inside the storage)
Ve = expansion volume due to the water heating up (l)

Pressure definition - all the pressures listed below are measured at the pressure gauge (relative pressures):

P0 = vessel pre-charge pressure at the gas side (bar)
Pvs = safety relief valve setting pressure (bar)
Par = initial relative pressure (bar) at the water side, represented by the maximum inlet pressure (setting value of the pressure reducing valve or the maximum mains supply pressure)

$$P_{ar} = P_0$$

Per = maximum system working pressure (bar) at the gas side (Pvs), decreased by a pressure value which prevents the safety relief valve from opening.

$$P_{er} = P_{vs} - 0{,}5 \text{ bar } (10\% \, P_{vs} \text{ if } P_{vs} > 5 \text{ bar})$$

The capacity of a closed expansion vessel with membrane (diaphragm) for domestic water systems with storage is calculated by applying the following formula:

$$V_n = \frac{e \cdot V_{sp}}{1 - \frac{P_a}{P_e}} \quad (2)$$

Absolute pressures

Pa = initial absolute pressure at the gas side (bar), equal to the maximum inlet pressure Par + atmospheric pressure (1 bar). In practice this is the cold preset pressure of the vessel increased by 1 bar.

$$P_a = P_{ar} + 1 = P_0 + 1$$

Pe = final absolute pressure at the gas side (bar), obtained from the maximum relative system working pressure Per + atmospheric pressure (1 bar).

$$P_e = P_{er} + 1$$

Indicative coefficient "n" as the temperature "T (°C)" varies in relation to the temperature of 10°C, without glycol

°C	0	10	20	30	40	50	60	70	80	90
n	0	0,1	0,2	0,4	0,8	1,2	1,7	2,3	2,9	3,6

Example:

Sizing an expansion vessel for a domestic water system with the following technical specifications:

Vsp = *volume of the heated water (storage) =* ***600 l***
T1 = *cold water supply temperature =* ***10°C***
T2 = *hot water storage temperature =* ***80°C***
Par = *initial pressure at the water side =* ***3,5 bar***
Pvs = *safety relief valve setting pressure =* ***6 bar***

Solution:

From the table of "n" coefficient values we can see:

*for T1 = 10°C -> n_{T1} = 0,1 for T2 = 80°C -> n_{T2} = 2,9 therefore "**e**" for ΔT = 70°C is obtained from:*

$$\mathbf{e} = (2{,}9/100) - (0{,}1/100) = 0{,}028$$

P0 = *vessel pre-charge pressure at the gas side = Par =* ***3,5 bar***
Per = *maximum system working pressure at the gas side = Pvs – 0,5 bar = 6 – 0,5 =* ***5,5 bar***

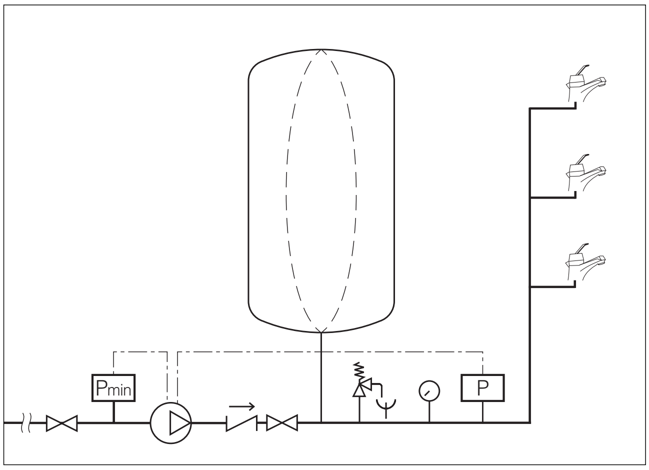
Pa = *initial absolute pressure at the gas side = Par + 1 = 3,5 +1 = 4,5 bar*
Pe = *final absolute pressure at the gas side = Per + 1 = 5,5 +1 = 6,5 bar*

Formula (2) is applied to calculate the volume of the vessel ***Vn***:

$$V_n = \frac{0{,}028 \cdot 600}{1 - \frac{4{,}5}{6{,}5}} = \mathbf{54{,}54\ l}$$

A 60 l vessel should therefore be selected *(this must be pre-charged to 3,5 bar)*

Hydro-pneumatic well with membrane



Sizing method

V_n = volume of the vessel (hydro-pneumatic well) (l)
G_{pr} = design flow rate (l/s)
P_{min} = minimum pressure rise (bar), equal to the **minimum pressure switch trigger value**
P_{max} = maximum pressure rise (bar), equal to the **maximum pressure switch trigger value**
a = maximum number of hourly pump interventions (h^{-1})
a = 30 for pump power < 3 kW
a = 25 for pump power 3–5 kW
a = 20 for pump power 5–7 kW
a = 15 for pump power 7–10 kW
a = 10 for pump power > 10 kW

The capacity of an expansion vessel to be used as hydro-pneumatic well with membrane is calculated with the following formula:

$$V_n = 6 \cdot \frac{G_{pr} \cdot 60}{a} \cdot \frac{P_{max} + 1}{P_{max} - P_{min}} \qquad (3)$$

Example:

Sizing a hydro-pneumatic well with membrane for a network with the following technical specifications:

G_{pr} = 3,4 l/s
P_{min} = 5 bar
P_{max} = 6 bar
Pump power P = 1,5 kW

Solution:
Formula (3) is applied to calculate the volume of the vessel ***V_n****:*

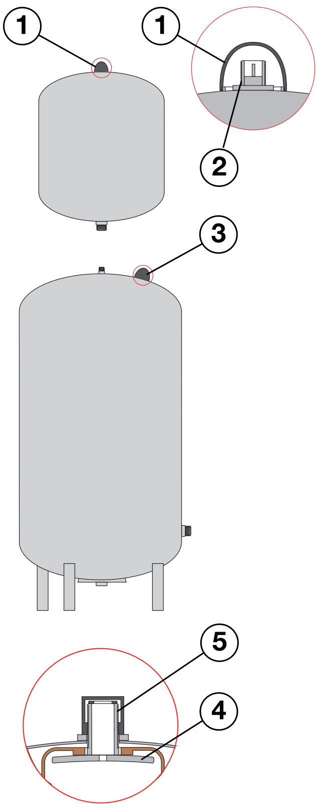
$$V_n = 6 \cdot \frac{3{,}4 \cdot 60}{30} \cdot \frac{6 + 1}{6 - 5} = \mathbf{285{,}6\ l}$$

A 300 l vessel should therefore be selected.

Construction details

The expansion vessels are supplied preset with nitrogen. The pre-charge pressure can be modified with compressed air.

Vessel specifications for domestic water systems



Gas valve position

For 8 to 50 l vessels, the top cap (1) can be removed manually and protects the gas pre-charging valve (2) used to change or restore the pre-charge pressure.

For 80 to 500 l vessels, the gas presetting valve with protection cover is positioned at the side (3).

Replaceable membrane

The internal membrane can be replaced in 60 to 500 litre models.

Bladder membrane in 80 to 500 l vessels

In this range of vessels, the internal membrane is drilled on top and rests on the internal support (4). A 1/2" male connection (5) with cap offers contact with the water contained inside.

Reference standards

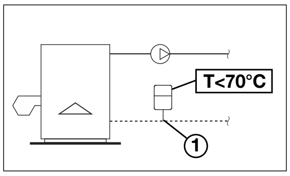
The reference European standard is Directive 97/23/EC, also known as P.E.D. (Pressure Equipment Directive) which until 29.05.2002 coexisted with the Italian standard.
Caleffi 556 - 568 series expansion vessels are CE marked and a declaration of conformity is available.

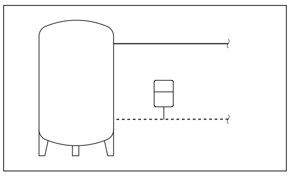
Installation

It is advisable to install expansion vessels on the pipe containing the lowest temperature water. For heating systems, the correct installation should be on the return pipe.

If the temperature at the point of installation (1) causes the vessel to reach a temperature over 70°C, it is advisable to adopt suitable system devices, such as an intermediate through-vessel.

For domestic water systems, the correct installation should be on the incoming cold water supply pipe.





Accessories

5580

Shut-off ball valve for expansion vessels, with drain cock for domestic water circuit.
Max. working pressure: 6 bar.
Max. working temperature: 85°C.

Code	
558050	3/4”
558060	1”
558070	1 1/4”

Vessel preset check

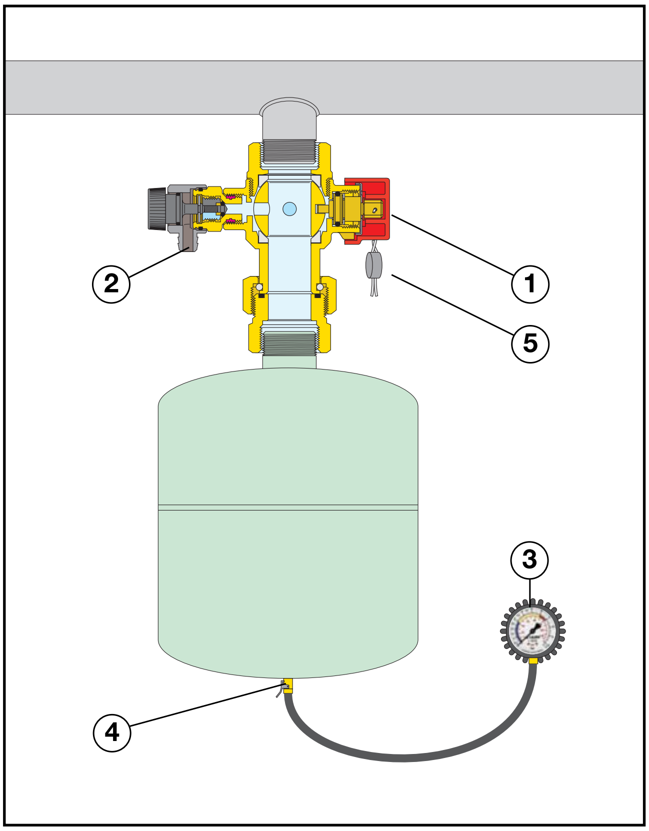
For the system to work properly, the vessel pre-charge value (at the gas side) must be checked regularly. The 5580 series valve* allows checking without having to drain the entire system, using the following method:

A) Close the shut-off valve (1) after removing the seal
B) Drain the vessel (2)
C) Check the pre-charge value using the 5560 series pressure gauge (3)

Once the vessel has been checked (procedures in steps A, B and C), the pre-charging pressure may be restored as necessary using the gas pre-charging valve (4).

**** The 5580 series valve is sealed (5) to prevent tampering or unauthorised operations.***

Application diagram for 5580 series shut-off valve on domestic water vessel



SPECIFICATION SUMMARY

556 series
Welded expansion vessel for heating systems, CE certified. Connection 3/4” (3/4” from 8 to 50 l and 1” from 80 to 600 l) M (ISO 7-1). Steel body. SBR diaphragm membrane. Galvanised steel connection to pipe. Red colour. Medium water and glycol solutions; maximum percentage of glycol 50%. Maximum working pressure 6 bar. Pre-charge pressure 1,5 bar. System working temperature range -10–120°C; membrane working temperature range -10–70°C.

568 series
Welded expansion vessel for domestic water systems and hydro-pneumatic well applications, CE certified. Connection 3/4” (3/4” from 8 to 33 l, 1” from 50 to 100 l and 1 1/4” from 200 to 500 l) M (ISO 228-1). Steel body. Bladder membrane; in butyl (from 8 to 33 l) or in EPDM (from 50 to 500 l; replaceable for volumes from 60 to 500 l). Galvanised steel connection to pipe. Protection for connection to pipe: plastic insert (8 to 33 l) or epoxy coating (50 to 500 l). Blue colour. Medium water. Maximum working pressure 10 bar. Pre-charge pressure 2,5 bar. System working temperature range -10–70°C; membrane working temperature range -10–70°C.

5557 series
Welded expansion vessel for domestic water systems, CE certified. Connection 1/2” (1/2” 2 l; 3/4” 5 and 8 l) M (ISO 228-1). Steel body. Bladder membrane in butyl. Galvanised steel connection to pipe. Protection for connection to pipe, plastic insert. White colour. Medium water. Maximum working pressure 10 bar. Pre-charge pressure 2,5 bar. System working temperature range -10–100°C; membrane working temperature range -10–100°C.

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