Expansion vessels

series 555 - 5558 - 556 - 568

CALEFFI

01079/01

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 pressure restorers in potable water distribution systems.

CE

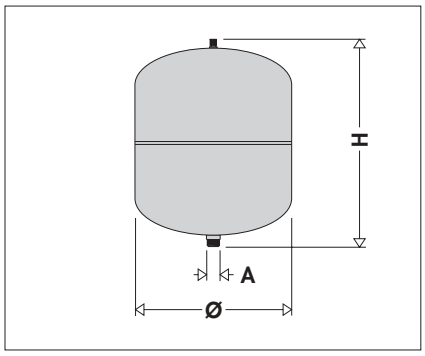
Product range

Series 555	Standardised crimped expansion vessel for heating and potable water systems	Capacities l: 2, 5, 8, 12, 18, 24
Series 5558	Flat circular crimped expansion vessel for heating systems	Capacities l: 5, 8, 10, 12, 14, 18
Series 556	Welded expansion vessel for heating systems, CE certified	Capacities l: 35, 50, 80, 105, 150, 200, 250, 300, 400, 500, 600
Series 568	Welded expansion vessel for potable water systems, CE certified	Capacities l: 60, 80, 100, 200, 300, 500

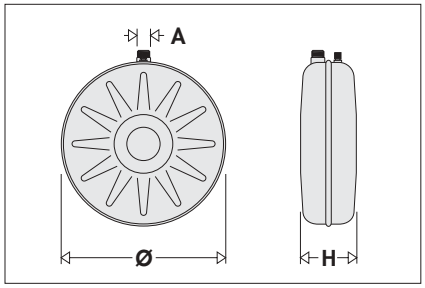
Technical specification

Series ⇨	555	5558	556	568
Materials:				
- Body:	Steel	Steel	Steel	Steel
- Membrane:	Non-toxic butyl	SBR synthetic rubber	SBR synthetic rubber	Non-toxic butyl
Performance:				
- Max working pressure:	10 bar	3 bar	35 and 50 l; 4 bar 80÷600 l; 6 bar	10 bar
- Pre-charge pressure:	1,5 bar	1 bar	35 and 50 l; 1,5 bar 80÷150 l; 2 bar 200÷600 l; 2,5 bar	1,5 bar
- Max working temperature:	99°C	90°C	99°C	99°C
Connection to pipework:	2 l; 1/2" M 5÷24 l; 3/4" M	3/4" M	35÷400 l; 3/4" M 500 e 600 l; 1" M	60÷100 l; 1" M 200÷500 l; 1 1/2" M

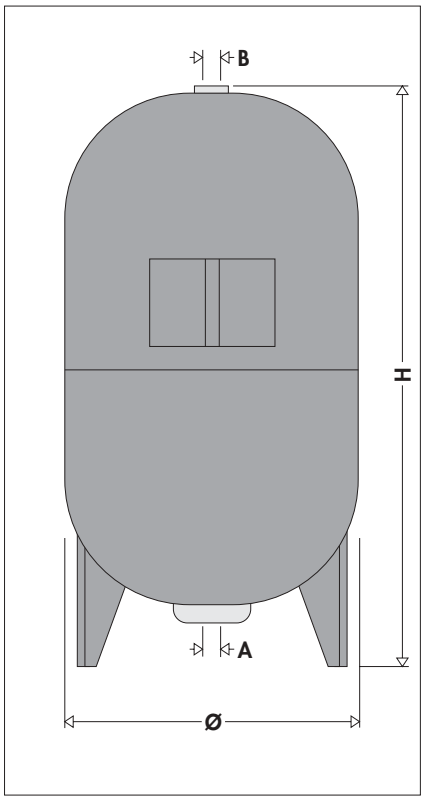
Dimensions



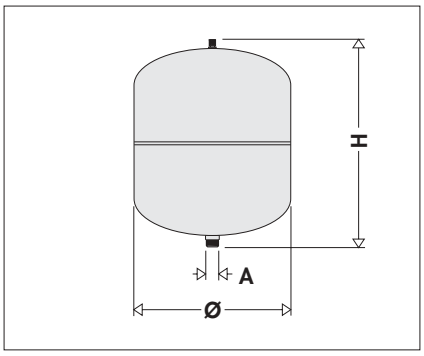
Code	Litres	A	Ø	H
555002	2	1/2″	140	220
555005	5	3/4″	160	288
555008	8	3/4″	200	308
555012	12	3/4″	270	292
555018	18	3/4″	270	377
555024	24	3/4″	300	420



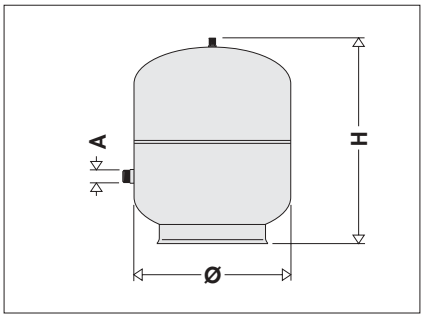
Code	Litres	A	Ø	H
555805	5	3/4″	387	85
555808	8	3/4″	387	104
555810	10	3/4″	387	110
555812	12	3/4″	387	140
555814	14	3/4″	387	150
555818	18	3/4″	387	200



Code	Litres	A	B	Ø	H
568060	60	1″	1/2″	380	860
568080	80	1″	1/2″	450	830
568100	100	1″	1/2″	450	910
568200	200	1 1/2″	1/2″	550	1235
568300	300	1 1/2″	1/2″	630	1365
568500	500	1 1/2″	1/2″	750	1560



Code	Litres	A	Ø	H
556035	35	3/4″	404	408
556050	50	3/4″	407	530



Code	Litres	A	Ø	H
556080	80	3/4″	450	608
556105	105	3/4″	500	665
556150	150	3/4″	500	897
556200	200	3/4″	600	812
556250	250	3/4″	630	957
556300	300	3/4″	630	1105
556400	400	3/4″	630	1450
556500	500	1″	750	1340
556600	600	1″	750	1555

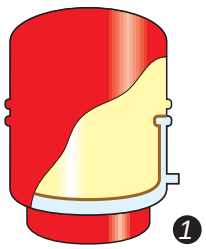
Operating principle

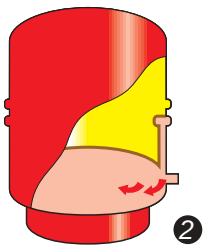
Expansion vessel

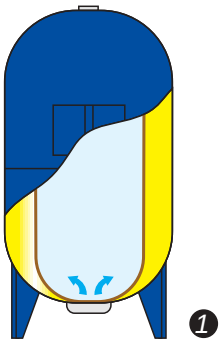
The closed expansion vessel with membrane (diaphragm) consists of a closed container divided into two parts by a membrane which separates the water from the gas (usually nitrogen) and acts as an expansion accommodator.
Following an increase in temperature, an increase in pressure takes place in the vessel in relation to the pre-charge pressure when cold (Fig. 1) until it reaches the value corresponding to the maximum expansion (Fig. 2).

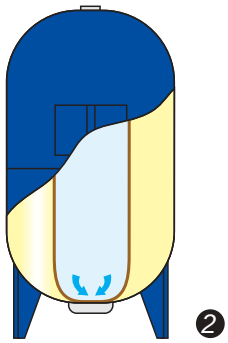
Pressure restorer

The operating principle of a pressure restorer is as follows:
The pump, activated by the pressure switch, starts up and the vessel starts to fill. When the pressure reaches the set value, the pump stops; the tank is at its maximum capacity (Fig. 1). If the user draws off water, the pressure is gradually restored to the system, in the period between the de-activation and the activation of the pump (Fig. 2).









Sizing Method

Heating systems

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

$$V = \frac{e \cdot C}{1 - \frac{P_i}{P_f}}$$

Where:

V = Volume of vessel (l)

e = Water expansion coefficient. Calculated on the basis of the maximum difference between the temperature of the water when the system is cold and the maximum working temperature. **In practice, for heating, a conventional value of 0,035 is assumed.**

C = Water content of system (l).

P_i = Initial absolute pressure (bar) at the point where the vessel is installed, given by hydrostatic pressure + 0,3 bar + atmospheric pressure (1 bar). In practice this is the initial charge pressure of the vessel plus 1 bar.

P_f = Final absolute pressure (bar), given by the maximum working pressure of the system + atmospheric pressure (1 bar). In practice, this is the calibrated pressure of the safety valve plus 1 bar.

Table of coefficient "e", on variation of temperature, relative to a temperature of 4°C. (ρ = 1000 kg/m³)

T (°C)	Coeff. "e"	T (°C)	Coeff. "e"	T (°C)	Coeff. "e"
0	0,00013	40	0,00782	75	0,02575
10	0,00025	45	0,00984	80	0,02898
15	0,00085	50	0,01207	85	0,03236
20	0,00180	55	0,01447	90	0,03590
25	0,00289	60	0,01704	95	0,03958
30	0,00425	65	0,01979	100	0,04342
35	0,00582	70	0,02269		

Example

Size an expansion vessel for a heating system with the following characteristics:

C = water content = 3000 l
P_{id} = hydrostatic pressure at installation point = 2 bar
P_{sic} = calibrated pressure of safety valve = 3,5 bar

Solution

The above formula is applied, where:

e = 0,035 conventional absolute value
$P_i = P_{id} + 0,3 + P_{atm} = 2 + 0,3 + 1 = 3,3$ bar
$P_f = P_{sic} + P_{atm} = 3,5 + 1 = 4,5$ bar

Thus: $V = (0,035 \cdot 3000) \div \left[1 - (3,3 \div 4,5)\right] = 393$ l

A vessel is therefore selected with a capacity of 400 l.

Quick method

To obtain the vessel capacity, multiply the system water content, expressed in litres, by the value shown in the table below.

Capacity of diaphragm expansion vessels per litre of system capacity (expansion coefficient = 0,035)

Calibrated pressure of safety valve (bar)*	Initial charge pressure (bar)*										
	1,0	1,2	1,4	1,6	1,8	2,0	2,2	2,4	2,6	2,8	3,0
2,25	0,091	0,106	0,134	0,175	0,253	-	-	-	-	-	-
2,50	0,082	0,094	0,111	0,136	0,175	0,245	-	-	-	-	-
2,70	0,076	0,086	0,100	0,118	0,144	0,185	0,259	-	-	-	-
3,00	0,070	0,078	0,088	0,100	0,117	0,140	0,175	0,233	-	-	-
3,50	0,063	0,068	0,075	0,083	0,093	0,105	0,121	0,143	0,175	0,225	-
4,00	0,058	0,063	0,067	0,073	0,080	0,088	0,097	0,109	0,125	0,146	0,175
4,50	0,055	0,058	0,062	0,066	0,071	0,077	0,084	0,092	0,101	0,113	0,128
5,00	0,052	0,055	0,058	0,062	0,066	0,070	0,075	0,081	0,088	0,095	0,105
5,40	0,051	0,053	0,056	0,059	0,062	0,066	0,070	0,075	0,080	0,086	0,093
6,00	0,049	0,051	0,053	0,056	0,058	0,061	0,064	0,068	0,072	0,077	0,082

Potable water system with storage

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

$$V = \frac{e \cdot C_a}{1 - \frac{P_{in}}{P_{fin}}}$$

Where:

V = Volume of vessel (l)

e = Water expansion coefficient. Calculated on the basis of the maximum difference between the temperature of the cold water feed and the stored hot water.

C_a = Volume of heated water (l).

P_{in} = Initial absolute pressure (bar), given by the maximum incoming pressure + atmospheric pressure (1 bar). In practice, this is the initial charge pressure of the vessel plus 1 bar.

P_{fin} = Final absolute pressure (bar) given by the maximum working pressure of the system + atmospheric pressure (1 bar). In practice, this is the calibrated pressure of the safety valve plus 1 bar.

Example

Size an expansion vessel for a potable water system with the following characteristics:

C_a = Volume of hot water = 500 l
T_1 = Temperature of cold feed water = 10°C
T_2 = Hot water storage temperature = 55°C
P_{es} = Max incoming pressure = 3,5 bar
P_{sic} = Calibrated pressure of safety valve = 6 bar

Solution

The following is taken from the table of coefficient "e":

for $T_1 = 10°C \Rightarrow e_1 = 0,00025$ for $T_2 = 55°C \Rightarrow e_2 = 0,01447$

Thus: $e_{(\Delta T=45°C)} = (e_2 - e_1) = (0,01447 - 0,00025) = 0,014$

In addition: $P_{in} = P_{es} + P_{atm} = 3,5 + 1 = 4,5$ bar
$P_{fin} = P_{sic} + P_{atm} = 6 + 1 = 7$ bar

The formula is applied:

$$V = (0,014 \cdot 500) \div \left[1 - (4,5 \div 7)\right] = 19,6 \text{ l}$$

A vessel is therefore selected with a capacity of 24 l.

Quick method

For quicker calculation, the following formula can be applied:

$$V = f \cdot C_a$$

Where "f" is a coefficient which, for temperature differences between 40 and 50°C, can be taken from the table below, according to the working pressure and the calibrated pressure of the safety valve.

Table coefficient "f"

Calibrated pressure of safety valve (bar)*	Working pressure (bar)*								
	2	2,5	3	3,5	4	4,5	5	5,5	6
4	0,035	0,047	0,070	0,140	-	-	-	-	-
5	0,028	0,034	0,042	0,056	0,084	0,168	-	-	-
6	0,025	0,028	0,033	0,039	0,049	0,065	0,098	0,196	-
7	0,022	0,025	0,028	0,032	0,037	0,045	0,056	0,075	0,112
8	0,021	0,023	0,025	0,028	0,032	0,036	0,042	0,050	0,063
9	0,020	0,022	0,023	0,025	0,028	0,031	0,035	0,040	0,047
10	0,019	0,021	0,022	0,024	0,026	0,028	0,031	0,034	0,039

** Relative pressures*

Membrane pressure restorers

The capacity of a membrane pressure restorer is calculated by means of the following formula:

$$V = 6 \cdot \frac{G_{pr} \cdot 60}{a} \cdot \frac{P_{max} + 1}{P_{max} - P_{min}}$$

Where:

V = Volume of vessel (l)
G_{pr} = Design flow rate (l/s)
P_{min} = Minimum boost in pressure (bar), equal to the **minimum pressure switch operating pressure**
P_{max} = Maximum boost in pressure (bar), equal to the **maximum pressure switch operating pressure**
a = Maximum number of pump start-ups per hour (h^{-1})
a = 30 for pump rating < 3kW
a = 25 for pump rating 3÷5 kW
a = 20 for pump rating 5÷7 kW
a = 15 for pump rating 7÷10 kW
a = 10 for pump rating > 7 kW

Example

Size a membrane pressure restorer for a system with the following characteristics:

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

Solution

Application of the formula gives:

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

A vessel is therefore selected with a capacity of 300 l.

Installation

It is advisable to install expansion vessels in pipework containing water at the lowest system temperature.

Constructional details

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

Series 555
Vessels in the series 555 up to 24 litres are standardised. This means that they can be installed in either heating systems or potable water systems, as they are supplied with membranes made of a non-toxic material (butyl) and can withstand temperatures of up to 99°C.

Series 568
The membrane of vessels for potable water systems are replaceable.

Standard references

The standards relating to the construction of expansion vessels are at present undergoing modification:
I.S.P.E.S.L. approval, which relates to certain types of vessel, has been supplemented by CE Marking. This means that, when the system is being checked, both devices tested to I.S.P.E.S.L. and those with the CE Mark must be accepted. The European reference standard is Directive 97/23/CE, also known as the P.E.D. (Pressure Equipment Directive).
Caleffi series 556 expansion tanks for heating systems and 568 for potable water systems already bear the CE mark instead of I.S.P.E.S.L. approval.

SPECIFICATION SUMMARIES

Series 555

Crimped expansion vessel, standardised for heating and potable water systems. Connection 3/4"M (2 l 1/2"). Crimped membrane - non-toxic butyl (food standard). Maximum working pressure 10 bar. Pre-charge pressure 1,5 bar. Maximum working temperature 99°C. Capacity 2 l (from 2 to 24 l).

Series 5558

Crimped circular flat expansion vessel for heating systems. Connection 3/4"M radial. Steel body. Crimped membrane - SBR synthetic rubber. Maximum working pressure 4 bar. Pre-charge pressure 1 bar. Maximum working temperature 90°C. Capacity 8 l (from 8 to 18 l).

Series 556

Welded expansion vessel for heating systems. CE Mark. Connection 3/4"M (3/4" from 35 to 400 l and 1" 500 and 600 l). Steel body. Membrane sack - SBR synthetic rubber. Maximum working pressure 4 bar (4 bar 35 and 50 l; 6 bar 80÷600 l). Pre-charge pressure 1,5 bar (from 1,5 to 2,5 bar - see technical specification table). Maximum working temperature 99°C. Capacity 35 l (from 35 to 600 l).).

Series 568

Welded expansion vessel for potable water systems. CE Mark. Connection 1"M (1" from 60 to 100 l; 1 1/2" from 200 to 500 l). Steel body. Replaceable butyl membrane sack. Maximum working pressure 10 bar. Pre-charge pressure 1,5 bar. Maximum working temperature 99°C. Capacity 60 l (from 60 to 500 l).

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CALEFFI S.P.A. · I · 28010 FONTANETO D'AGOGNA (NO) · S.R. 229, N.25 · TEL.INT. +39 0322 8491 R.A. · FAX +39 0322 863723
· Http://www.caleffi.com · E-mail: info@caleffi.it ·