Expansion vessels

**556 - 568 - 5557 series**

**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.

**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**

<table>
<thead>
<tr>
<th>series</th>
<th>556</th>
<th>568</th>
<th>5557</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Materials:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body:</td>
<td>steel</td>
<td>steel</td>
<td>steel</td>
</tr>
<tr>
<td>Membrane:</td>
<td>SBR</td>
<td>8-33 l, butyl</td>
<td>2-8 l, butyl</td>
</tr>
<tr>
<td>Type of membrane:</td>
<td>diaphragm</td>
<td>bladder (can be replaced for volumes from 60 to 500 l)</td>
<td>bladder</td>
</tr>
<tr>
<td>Pipe connection:</td>
<td>galvanised steel</td>
<td>galvanised steel</td>
<td>galvanised steel</td>
</tr>
<tr>
<td>Protection for pipe connection:</td>
<td>-</td>
<td>plastic insert</td>
<td>plastic insert</td>
</tr>
<tr>
<td>Colour:</td>
<td>red</td>
<td>blue</td>
<td>white</td>
</tr>
<tr>
<td><strong>Performance:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium:</td>
<td>water, glycol solutions</td>
<td>water</td>
<td>water</td>
</tr>
<tr>
<td>Max. percentage of glycol:</td>
<td>50%</td>
<td>not applicable</td>
<td>not applicable</td>
</tr>
<tr>
<td>Max. working pressure:</td>
<td>6 bar</td>
<td>10 bar</td>
<td>10 bar</td>
</tr>
<tr>
<td>Pre-charge pressure:</td>
<td>1.5 bar</td>
<td>2.5 bar</td>
<td>2.5 bar</td>
</tr>
<tr>
<td>System working temperature range:</td>
<td>-10–120°C</td>
<td>-10–70°C</td>
<td>-10–100°C</td>
</tr>
<tr>
<td>Membrane working temperature range:</td>
<td>-10–70°C</td>
<td>-10–70°C</td>
<td>-10–70°C</td>
</tr>
<tr>
<td>Construction:</td>
<td>conforms to DIN 4807-2 and EN 13831</td>
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<td>conforms to EN 13831</td>
</tr>
<tr>
<td><strong>Application:</strong></td>
<td>heating</td>
<td>domestic water, hydro-pneumatic well</td>
<td>domestic water</td>
</tr>
<tr>
<td><strong>Connections:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pipe connection:</td>
<td>8-50 l: 3/4&quot; M (ISO 7-1) 80-600 l: 1&quot; M (ISO 7-1)</td>
<td>8-33 l: 3/4&quot; M (ISO 228-1) 50-100 l: 1&quot; M (ISO 228-1) 200-500 l: 1 1/4&quot; M (ISO 228-1)</td>
<td>2 l: 1/2&quot; M (ISO 228-1) 5 and 8 l: 3/4&quot; M (ISO 228-1)</td>
</tr>
</tbody>
</table>
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).
Sizing method

\[ e = \text{water expansion coefficient, calculated according to the maximum difference between the temperature of the water when the system is cold (T1) and the maximum working temperature (T2)} \]

\[ e = \frac{n}{100} \]

\[ T_m = \text{maximum permitted temperature in degrees Celsius with reference to intervention of the safety devices} \]

\[ n = 0.31 + 3.9 \times 10^{-4} \times T_m^2 \]

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

Definition of volumes

\[ V_n = \text{vessel volume (l), to be calculated}\]

\[ V_a = \text{water content in the system (l)} \]

\[ V_e = \text{expansion volume due to the water heating up (l)} \]

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

\[ P_{st} = \text{hydrostatic pressure at the point of installation (bar)} \]

\[ P_{vs} = \text{safety relief valve setting pressure (bar)} \]

\[ P_0 = \text{pre-charge pressure of the vessel at the gas side (bar) equal to the hydrostatic pressure increased by a cautionary pressure value to ensure no pressure drops occur within the system (bar)} \]

\[ P_0 = P_{st} + 0.3 \text{ bar} \]

**NOTE:**

\[ P_r = \text{system filling pressure at the water side (bar)} \]

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 \( V_a \) (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 \( P_r \geq 1 \text{ bar} \)

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

\[
\begin{array}{|c|c|c|c|c|c|c|c|c|c|c|c|c|c|c|c|}
\hline
\text{°C} & -20 & -10 & 0 & 10 & 20 & 30 & 40 & 50 & 60 & 70 & 80 & 90 & 100 & 110 & 120 & 130 \\
\hline
\text{% glycol} & 0 & 0.1 & 0.2 & 0.4 & 0.8 & 1.2 & 1.7 & 2.3 & 2.9 & 3.6 & 4.3 & 5.2 & 6.0 & 6.9 & 8.0 & 9.0 \%
\hline
\end{array}
\]

Example:

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

\[ V_a = \text{water content in the system} = 1000 \text{ l} \]

\[ T_m = 110^\circ \text{C} \]

\[ n = 5,029 \]

\[ e = \frac{n}{100} = 0.05029 \]

\[ P_{st} = \text{hydrostatic pressure at the point of installation} = 2.3 \text{ bar} \]

\[ P_{vs} = \text{safety relief valve setting pressure} = 4 \text{ bar} \]

Solution:

\[ P_r = \text{vessel pre-charge pressure at the gas side} = P_0 + 0.3 \text{ bar} = 2.3 + 0.3 = 2.6 \text{ bar} \]

\[ Pe_r = \text{maximum system working pressure at the gas side} = P_{vs} - 0.5 \text{ bar} = 4 - 0.5 = 3.5 \text{ bar} \]

\[ P_a = \text{initial absolute pressure at the gas side} = P_r + 1 = 2.6 + 1 = 3.6 \text{ bar} \]

\[ P_e = \text{final absolute pressure at the gas side} = Pe_r + 1 = 3.5 + 1 = 4.5 \text{ bar} \]

Formula (1) is applied to calculate the volume of the vessel \( V_n \):

\[
V_n = \frac{e \cdot V_a + [Vv]^*}{1 - \frac{P_a}{P_r}} (1)
\]

A 300 l vessel should therefore be selected (this must be pre-charged to 2.6 bar)
**Sizing method**

- **T<sub>1</sub>** = cold water supply temperature
- **T<sub>2</sub>** = 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
  
  \[ e = \frac{nT_2}{100} - \frac{nT_1}{100} \]

**Definition of volumes**

- **V<sub>n</sub>** = vessel volume (l), to be calculated
- **V<sub>sp</sub>** = volume of the heated water (l) (inside the storage)
- **V<sub>e</sub>** = expansion volume due to the water heating up (l)

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

- **P<sub>0</sub>** = vessel pre-charge pressure at the gas side (bar)
- **P<sub>vs</sub>** = safety relief valve setting pressure (bar)
- **P<sub>ar</sub>** = 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)
  \[ P_{ar} = P_0 \]
- **P<sub>e</sub>** = maximum system working pressure (bar) at the gas side (P<sub>vs</sub>), decreased by a pressure value which prevents the safety relief valve from opening.
  \[ P_e = P_{vs} - 0.5 \text{ bar (or } 10\% \text{ } P_{vs}) \]

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

\[ V_n = \frac{e \cdot V_{sp}}{1 - \frac{P_a - P_e}{P_0}} \quad (2) \]

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

<table>
<thead>
<tr>
<th>°C</th>
<th>0</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
<th>90</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>0</td>
<td>0.1</td>
<td>0.2</td>
<td>0.4</td>
<td>0.8</td>
<td>1.2</td>
<td>1.7</td>
<td>2.3</td>
<td>2.9</td>
<td>3.6</td>
</tr>
</tbody>
</table>

**Example:**

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

- **V<sub>sp</sub>** = volume of the heated water (storage) = 600 l
- **T<sub>1</sub>** = cold water supply temperature = 10°C
- **T<sub>2</sub>** = hot water storage temperature = 80°C
- **P<sub>ar</sub>** = initial pressure at the water side = 3,5 bar
- **P<sub>vs</sub>** = safety relief valve setting pressure = 6 bar

**Solution:**

From the table of “n” coefficient values we can see:

- For **T<sub>1</sub>** = 10°C -> **n<sub>T1</sub>** = 0,1
- For **T<sub>2</sub>** = 80°C -> **n<sub>T2</sub>** = 2,9

Therefore

\[ e = (2.9/100) - (0.1/100) = 0.028 \]

**P<sub>0</sub>** = vessel pre-charge pressure at the gas side = **P<sub>ar</sub>** = 3,5 bar

\[ P_e = P_{vs} - 0.5 \text{ bar (or } 10\% \text{ } P_{vs}) \]

\[ P_a = \text{initial absolute pressure at the gas side } = P_{vs} - 0.5 \text{ bar } = 6 - 0.5 = 5.5 \text{ bar} \]

\[ P_f = \text{final absolute pressure at the gas side } = P_{ar} + 1 = 3.5 + 1 = 4.5 \text{ bar} \]

**Formula (2)** is applied to calculate the volume of the vessel **V<sub>n</sub>**:

\[ V_n = \frac{0.028 \cdot 600}{1 - \frac{4.5}{6.5}} = 54.54 \text{ l} \]

A 60 l vessel should therefore be selected (this must be pre-charged to 3.5 bar)
**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.

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**Example**

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

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

**Solution**

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

\[
V_n = 6 \cdot \frac{G_{pr} \cdot 60}{a} \cdot \frac{P_{max} + 1}{P_{max} - P_{min}}
\]

\( a \) = 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

A 300 l vessel should therefore be selected.
5580 series

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) or in EPDM (from 50 to 500 l; replaceable for volumes from 60 to 500 l). Steel body. Bladder membrane; in butyl (from 8 to 33 l) or in EPDM (from 50 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.

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.