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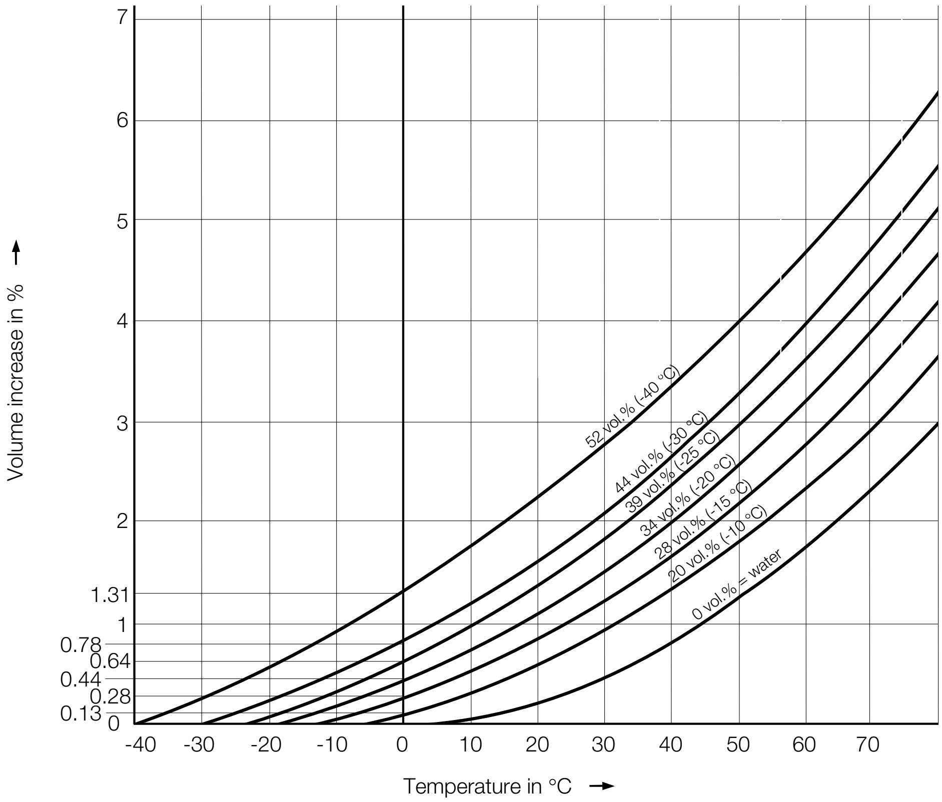
Flexcon vessels in cooling and air conditioning installations

With these applications, the expansion vessel has the following functions:

- When the installation cools, the volume of the cooling water reduces.
  The Flexcon vessel adds water to the installation, so that it remains under pressure.
- When the installation is put out of operation, the water can assume the ambient temperature and therefore expand.
  The Flexcon vessel now absorbs this expansion volume.

Antifreeze has a coefficient of expansion which is much greater than that of water

All Flexcon vessels can be used in installations whereby antifreeze based on ethylene or propylene glycol is added to the water.
The following graph shows the volume increase for various mixtures of water and ethylene glycol.
The figures given here are average values that have been taken from the documentation of Hoechst for Antifrogen N.



Temperature	Volume increase of pure water in %
5 °C	0.00%
10 °C	0.04%
15 °C	0.08%
20 °C	0.18%
25 °C	0.29%
30 °C	0.43%
35 °C	0.60%
40 °C	0.79%

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Calculation of a Flexcon vessel in a cooling installation

The following data is important for the calculation of a Flexcon vessel in a cooling installation:

a. water contents of the installation;

b. percentage of antifreeze added;

c. lowest temperature of the installation;

d. highest temperature of the installation (i.e. highest ambient temperature);

e. percentage expansion of the water and antifreeze mixture;

f. static height of the installation above the vessel;

g. blow-off pressure of the safety valve.

The initial pressure of the Flexcon vessel is chosen according to the static height of the installation (above the vessel).
The lowest working pressure must be 0.5 bar higher than the initial pressure of the vessel, so that the total water contents are not expelled from the vessel when the installation cools and a reserve amount of water remains in the vessel at the lowest temperature.
The following formula can be used to determine how much of the vessel is filled in this state.

$$\text{I} \quad \frac{\text{lowest working pressure - initial pressure}}{\text{lowest working pressure}} = \text{filled content}^{*}$$

With this, the residual factor can be determined.

Residual factor = 1 - filled content.

The final pressure must be remain 0.5 bar below the blow-off pressure of the safety valve.

The efficiency is determined with the following formula:

$$\text{II} \quad \frac{\text{final pressure - lowest working pressure}}{\text{final pressure}} \times \text{residual factor}$$

* pressures in bar absolute

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Calculation example

Data

a. water contents 1,000 litres;

b. no addition of antifreeze, just normal water;

c. lowest temperature + 4 °C;

d. highest ambient temperature + 30 °C;

e. percentage of volume increase at 30 °C: 0.43%;

f. static height 4 m (initial pressure 0.5 bar, lowest working pressure 1 bar);

g. blow-off pressure of the safety valve 3 bar (final pressure 2.5 bar).

Calculation

Residual factor according to **I**:

$$\frac{(1 + 1) - (0.5 + 1)}{(1 + 1)} = 0.25.$$ Therefore, residual factor = 1 - 0.25 = 0.75

The efficiency according to **II**:

$$\frac{(2.5 + 1) - (1 + 1)}{(2.5 + 1)} \times 0.75 = 0.32$$

The expansion volume at 30 °C is 1,000 litres x 0.43% = 4.3 litres

Required gross contents of the Flexcon vessel = $\frac{4.3}{0.32}$ = 13.4 litres.

Vessel to be selected
Flexcon 18/0.5.

Calculation of the filling pressure

The pressure with which the installation must be filled depends on the temperature at which this takes place.

If the percentage volume increase of the mixture at the filling temperature is known, the expansion volume at this temperature can be determined.

Then, the filling pressure can be determined with the following formula:

$$\frac{\text{Gross vessel contents x residual factor x (lowest working pressure + 1)}}{\text{(Gross vessel contents x residual factor) - expansion volume at filling temperature}} - 1$$

Continuation of calculation example

h. filling temperature = 20 °C

i. percentage volume increase at 20 °C = 0.17%

Expansion volume at 20 °C is 1,000 litres x 0.17% = 1.7 litres

Filling pressure $\frac{18 \times 0.75 \times (1 + 1)}{(18 \times 0.75) - 1.7} - 1 = 1.3$ bar.