Hydronic Tank Sizing (Closed Loop Heating System)

Example

- Maximum Temperature (T_{max}): 90 °C
- Radiators: 10 x 10 liter, 8 x 15 liter
- Piping: 20 liter
- Safety valve relief pressure: 3 bar
- Static height[1]: 5 m
- Fluid: Water

Water Expansion Factor	
Max Temp [°C]	Expansion Factor
25	0.0036
30	0.0056
35	0.0074
40	0.0094
45	0.0108
50	0.0126
55	0.0146
60	0.0172
65	0.0198
70	0.0226
75	0.0260
80	0.0293
85	0.0338
90	0.0386
95	0.0430

1. Calculate the Total System Volume (TSV)

Add up all the volume of piping, radiators, buffer tank, etc.

$$TSV = Radiator\ Volume + Piping\ Volume$$

$$TSV = 10\ x\ 10\ liter + 8\ x\ 15\ liter + 20\ liter = 240\ liter$$

2. Calculate the Water Reserve (WR)[2]

The recommended amount of Water Reserve is based on the Total System Volume as per table below:

TSV [liter]	0 ≤ 150	150 ≤ 600	> 600
WR [liter]	TSV x 0,2	3	TSV x 0,005

The recommended Water Reserve (WR) for a Total System Volume (TSV) of 240 liter is 3 liter as per table above.

3. Calculate the Expanded Volume

Look up the Expansion Factor (EF) in the expansion factor table above (or in case additives are used, refer to additive specification sheet) and calculate the expanded volume ($V_{expanded}$).

The Expansion Factor for a maximum temperature of 90 °C is 0.0386.

$$V_{expanded} = (Total\ System\ Volume + Water\ Reserve)\ x\ Expansion\ Factor$$

$$V_{expanded} = (240\ liter + 3\ liter)\ x\ 0{,}0386 = 9{,}38\ liter$$

4. Calculate the Maximum Allowed System Pressure (p_{high})[3]

$$p_{High} = Relief\ Pressure\ x\ 0{,}85$$

Recommendation for safety relief valve pressure, >1,5 bar and ≤ 3 bar:
p_{High} = Relief Pressure - 0.5 bar

Due to this recommendation:

$$p_{High} = Relief\ Pressure - 0{,}5\ bar$$

$$p_{High} = 3\ bar - 0{,}5\ bar = 2{,}5\ bar$$

5. Calculate the tank precharge (p_{Low})

$$Tank\ Precharge = Low\ Pressure\ (p_{Low})$$

Precharge should be set to the Static Pressure + 0,2 bar[4]

$$Static\ Pressure = Static\ Height\ [m]\ x\ 0.1\ \ bar/m$$

$$Static\ Pressure = 5m\ x\ 0.1\ bar/m = 0.5\ bar$$

$$Precharge = Low\ Pressure\ (p_{Low}) = Static\ Pressure + 0{,}2\ bar$$

$$Precharge = 0{,}5\ bar + 0{,}2\ bar = 0{,}7\ bar$$

Precharge is recommended to always be ≥ 1 bar[5]

Due to this recommendation, we will actually use a precharge (=p_{Low}) of 1 bar instead of 0,7 bar.

6. Calculate the Acceptance Factor (AF)

$$AF = \frac{p_{High} - p_{Low}}{p_{High} + 1\ bar}$$

$$AF = \frac{2{,}5\ bar - 1\ bar}{2{,}5\ bar + 1\ bar} = \frac{1{,}5\ bar}{3{,}5\ bar} = 0{,}429\ (42{,}9\%)$$

If the calculated Acceptance Factor exceeds 0,5 (50%), go on with 0,5 as acceptance factor instead of the calculated or looked up one.

7. Calculate the Minimum Total Tank Volume

$$Minimum\ Total\ Tank\ Volume = \frac{Expanded\ Volume + Water\ Reserve}{AF}$$

$$Minimum\ Total\ Tank\ Volume = \frac{9{,}38\ liter + 3\ liter}{0{,}429} = 28{,}858\ liter$$

A 28,858 liter expansion tank installed in the above system will maintain the system pressure between 1,0 bar (p_{Low}) and 2,5 bar (p_{High}) and accept 9,38 liter of expanded water and additionally provide a Water Reserve of 3 liter.

Always choose a tank size at least equivalent or bigger than the calculated value.
In this case we choose a HWB-35LX.

Chosen Tank Value (CTV) = 35 liter

8. Acceptance Factor Water Reserve (AF_w)

$$AF_w = \frac{Water\ Reserve}{Chosen\ Tank\ Volume} = \frac{3\ liter}{35\ liter} = 0{,}086\ (8{,}6\%)$$

9. System Fill Pressure (p_{fill})

$$p_{fill} = \frac{p_{Low} + \ (1\ bar\ x\ AF_w)}{1\ bar - (1\ bar\ x\ AF_w)} = \frac{1\ bar + (1 bar\ x\ 0{,}086)}{1\ bar - (1\ bar\ x\ 0{,}086)} = 1{,}188\ bar$$

Notes

1. Height from expansion tank to highest point in the system
2. To compensate for initial de-gassing and water loss due to de-gassing in the system
3. To create a safety pressure differential to the response pressure of the safety relief valve.
4. To avoid vacuum in the system
5. To avoid cavitation in the system

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