

Expansion Vessel size and Pre-charge calculation example

System Volume Calculation

Data Values

FES-B20 Solar Collector manifold volume	= 1.2 litres
22mm (0.9mm wall) copper pipe volume / m	= 320cc
15mm (0.7mm wall) copper pipe volume / m	= 145cc
10mm (0.6mm wall) copper pipe volume / m	= 61cc
15mm Solar Coil volume / m	= 85cc
Pressure due to head of Water / Glycol mix approx.	= 10m / Bar

System Spec

	Litres
Number of Collectors = 2	2.4
Length of 22mm = 1.5m	0.48
Length of 15mm = 3m	0.435
Length of 10mm = 28m	1.708
Length of Solar Coil = 6m	0.51
Other fittings allowance	0.17
Total	5.70 Litres

System PRV setting = 3 Bar

Pressure / Sizing Calculations:

Expansion Vessel (EV)

Expansion Vessel volume = Y Litres
 Minimum Fluid Volume assumed in vessel = 2 Litres

Expansion allowance

Expansion of 40% Glycol solution = 8.5% over 130 deg. C

Volume expansion of circuit fluid = 5.7 x 8.5% = 0.48 Litres
 Allowance for expansion of fluid in EV = 0.17

Assuming all the fluid in the collector is heated to a vapour then:

Additional Volume = 2.2 Litres
 Allowance for fluid in pipes being vapour = 0.6 Litres

Max. displacement in EV (2+0.48+0.17+2.4+0.6) = 5.65 Litres

Pressure corrections

Height of Expansion Vessel above PRV / Gauge = 2m
 Decrease in Pressure relative to PRV setting = 2m/10m = 0.2 Bar
 Minimum Pressure valve setting = 3 Bar

Height of Solar collector above PRV / Gauge = 4m
 Loss of Pressure due to height = 0.4Bar

Minimum Pressure case

Desired pressure at Collector = 2.5Bar (1.5 Bar Gauge)
 (to give boiling point of 40% Glycol > 130 deg. C)
 Required Pressure at EV to ensure BP>130 deg.C = 1.5+0.2 = 1.7 Bar
 Minimum fluid assumed in Expansion Vessel = 2 Litres (approx 0.3 of system volume)

Maximum Pressure case

Pressure at expansion Vessel when PRV at 3 Bar = 2.8 Bar
 Volume taken by fluid/vapour = 5.65 Litres

Expansion Volume calculation

Assume volume = Y litres, then using Boyles Law $P_1V_1=P_2V_2$ and Absolute Pressures

$(2.8+1) \times (Y-5.65) = (1.7+1) \times (Y-2)$ which gives

Y = 14.6 Litres therefore use next size 18L expansion vessel.

Now need to calculate the new requirements for this size EV and establish the pre-charge for minimum fluid and maximum system setting pressure

For 18 litre EV (at EV)

Max pressure at volume of 18-5.64= 12.36 litres = 2.8 Bar
 Pressure at max volume of 18-2 = 16 Litres = 1.94 Bar
 EV Pre-charge pressure (at vol = 18 Litres) = 1.61 Bar

Therefore (pressures at Pressure Gauge):

System Pressure = 2.14Bar (2.1-2.2 Bar) Nominal Cold
EV pre-charge = 1.61Bar
EV size = 18 Litres
System Fluid Volume (cold) = 7.5 Litres