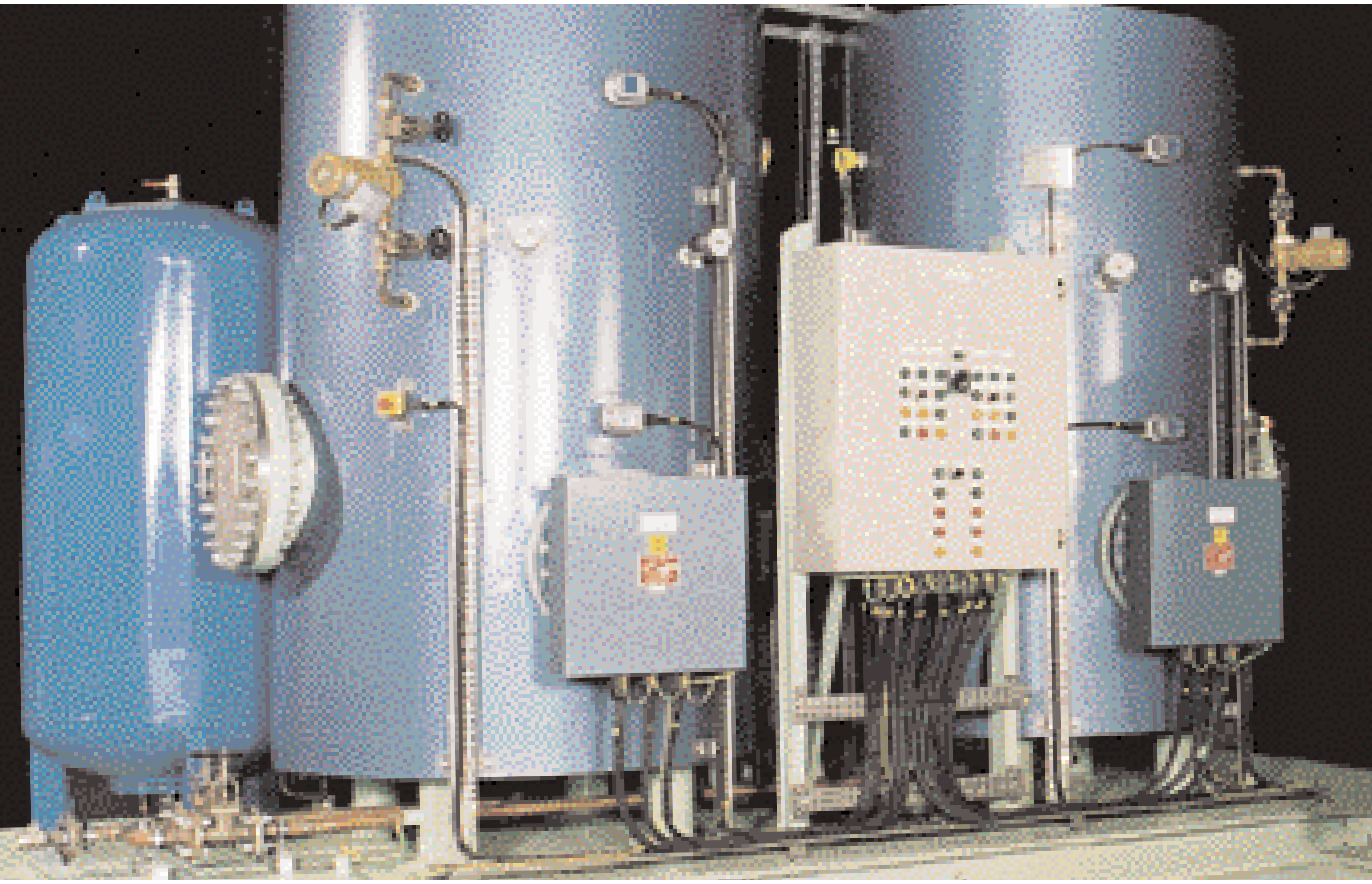
Unvented Packages



Rycroft
HEATING THE WORLD'S WATER

Contents

Unvented Hot Water Systems

UNVENTED HOT WATER SYSTEMS HAVE BECOME EXTREMELY POPULAR FOR BUILDING APPLICATIONS. WITH ALL THE MANDATORY REQUIREMENTS ADDRESSED, UNVENTED SYSTEMS PROVIDE A HIGHLY EFFICIENT MEANS OF STORING AND DISTRIBUTING WATER.

THE MANDATORY REQUIREMENTS FOR UNVENTED SYSTEMS CAN BE FOUND IN THE BUILDING REGULATIONS SECTION 3 AND 4 OF G3 (1991 – SECOND IMPRESSION 1992).

Unvented systems have been divided into two categories labelled as sections 3 and 4 of the G3 building regulations.

- Section 3 – Systems up to 500 litres and 45 kW.
- Section 4 – Systems over 500 litres or over 45 kW.

Section 4 Systems should comply with the requirements of BS 6700:1987 (Specification for the design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages). BS 6700:1997 Section 2.3.9.3.1. calls for calorifiers to conform with BS 853.

It is vitally important that the safety requirements of BS 6700 are met. Calorifiers must be fitted with the appropriate number of temperature pressure relief valves. G3 regulations require the safety devices to comply with BS 6283:1991 Part 2 or Part 3. The discharge ratings must be measured in accordance with BS 6281:1991 Part 2 App. F or Part 3 App. G.

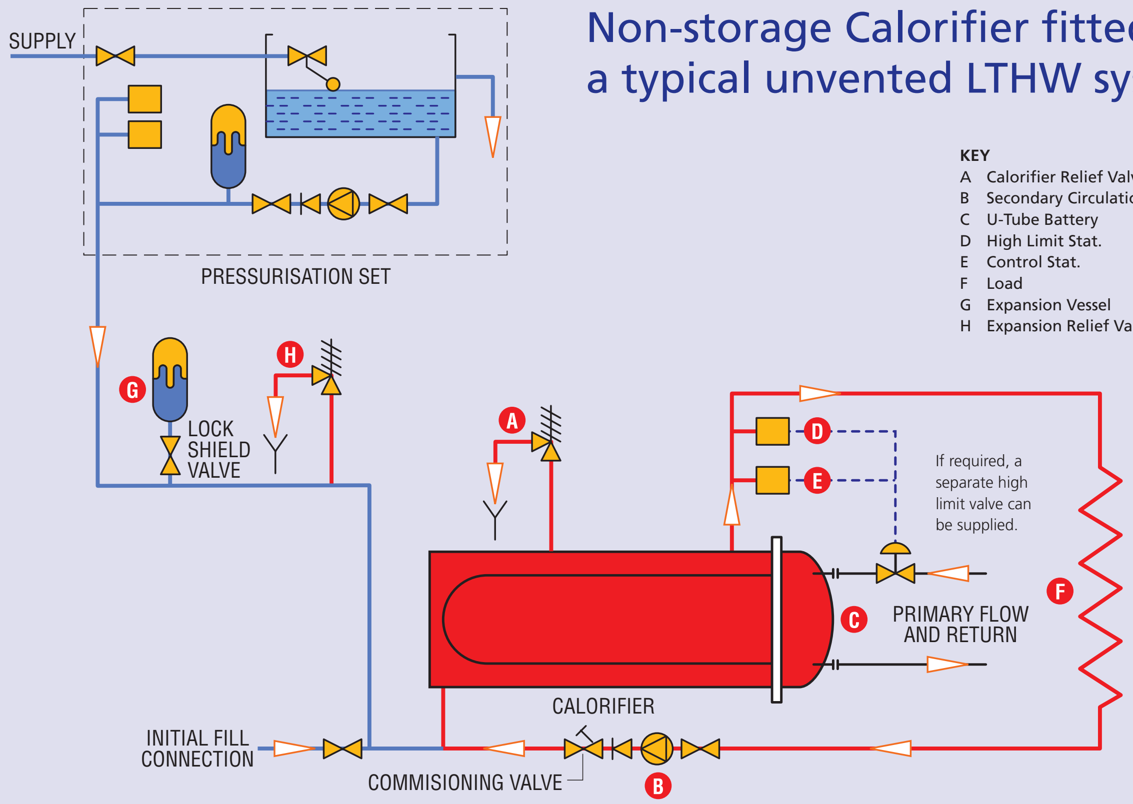
Rycroft have vast experience in the design and manufacture of unvented systems. The sizing tables from pages 9 and 10 can be used to select the 'best fit' expansion vessel. The highlighted figures in the table indicate the recommended size, however, alternative sizes have been shown with the corresponding change in the final working pressure. It should be remembered that it is frequently more economical to increase the size of the expansion vessel rather than the design pressure of the calorifier. The figures in the tables have been calculated using the formulae illustrated in the worked examples.

Note

MOST RELIEF VALVE CAPACITY CHARTS REFER TO BS 6759. REFERENCE TO THE VALVE MANUFACTURER MUST BE MADE TO ENSURE RATINGS TO BS 6283 ARE USED.

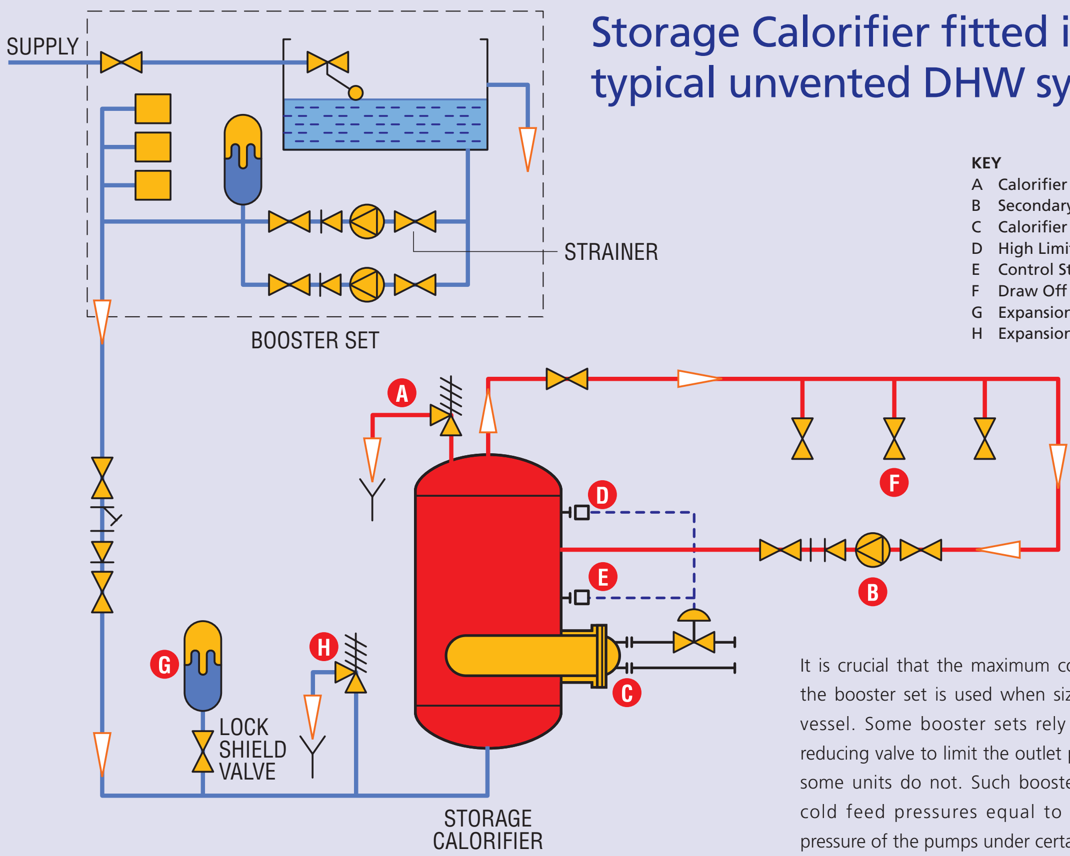
System Schematics

Non-storage Calorifier fitted in a typical unvented LTHW system



KEY
A Calorifier Relief Valve
B Secondary Circulation Pump
C U-Tube Battery
D High Limit Stat.
E Control Stat.
F Load
G Expansion Vessel
H Expansion Relief Valve

Storage Calorifier fitted in a typical unvented DHW system



KEY
A Calorifier P/T Relief Valve
B Secondary Circulation Pump
C Calorifier U-Tube Battery
D High Limit Stat.
E Control Stat.
F Draw Off Points
G Expansion Vessel
H Expansion Relief Valve

It is crucial that the maximum cold fill pressure of the booster set is used when sizing an expansion vessel. Some booster sets rely upon a pressure reducing valve to limit the outlet pressure, however, some units do not. Such booster sets can create cold feed pressures equal to the closed head pressure of the pumps under certain conditions.

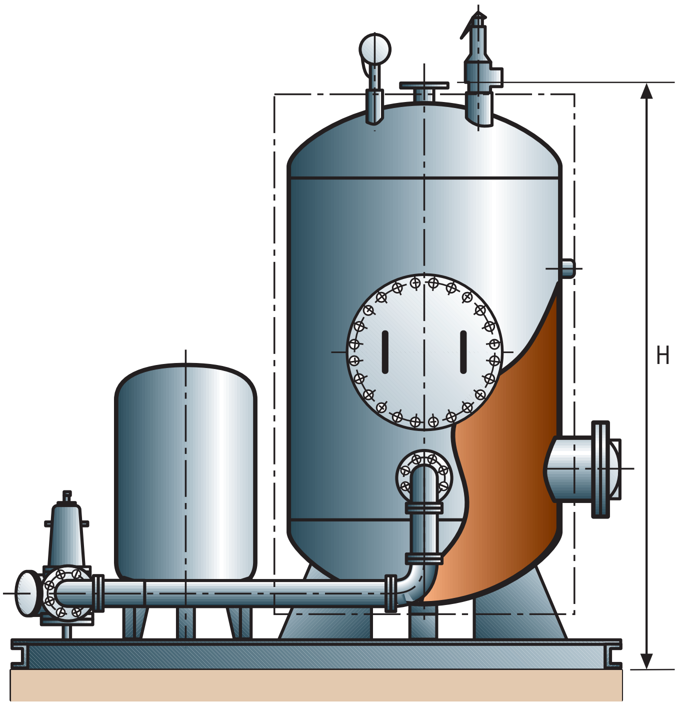
Packaged Equipment

RYCROFT CAN OFFER A COMPLETE UNVENTED PACKAGED SYSTEM. THESE MODULES ENSURE ALL THE RELEVANT DESIGN PARAMETERS HAVE BEEN MET AND THAT THE EXPANSION VESSEL SELECTION IS APPROPRIATE. PROCURING AN UNVENTED PACKAGE OFFERS THE FOLLOWING ADVANTAGES:

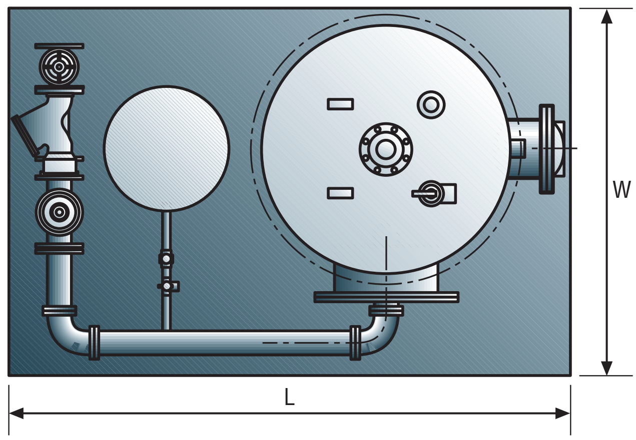
- Complete system design, fabrication and testing
- Reduced site labour
- Greatly simplified installation
- Factory commissioned reliability
- Minimum maintenance requirements
- Maximum economy of operation
- Minimum plantroom space requirements

Rycroft have a multi-disciplined design team with extensive experience in the field of unvented packages. Mechanical, thermal and electrical design issues are all addressed in our engineering department based in Bradford. All the main items including the electric control panels are manufactured by Rycroft ensuring compatibility of all components. With full accreditation to BS EN ISO 9001 clients can be assured of a quality package.

Unvented Packages
Sizes and Dimensions



Front Elevation



Plan View

Diagram illustrates a vertical module. For horizontal type calorifiers please refer to the appropriate table. Connections and vessel orientation can be changed to suit specific plant room layouts.

		Vertical Calorifiers				Horizontal Calorifiers			
Calorifier Volume	Max. Expansion Vessel Size	Module	Dim. L	Dim. W	Dim. H	Module	Dim. L	Dim. W	Dim. H
440	200	UNVM 440	1700	950	2150	UNHM 440	3200	950	1300
550	300	UNVM 550	1900	1050	2050	UNHM 550	3150	1050	1400
700	300	UNVM 700	2000	1150	2100	UNHM 700	3250	1150	1400
800	500	UNVM 800	2100	1250	2300	UNHM 800	3550	1250	1750
900	500	UNVM 900	2150	1300	2350	UNHM 900	3600	1300	1750
1000	500	UNVM 1000	2200	1350	2300	UNHM 1000	3550	1300	1750
1200	500	UNVM 1200	2250	1400	2450	UNHM 1200	3700	1350	1750
1350	750	UNVM 1350	2400	1450	2700	UNHM 1350	4000	1400	1950
1500	750	UNVM 1500	2550	1600	2300	UNHM 1500	3700	1550	1950
1800	750	UNVM 1800	2550	1600	2650	UNHM 1800	3950	1550	1950
2000	750	UNVM 2000	2550	1600	2850	UNHM 2000	4150	1550	1950
2300	750	UNVM 2300	2650	1700	2750	UNHM 2300	4050	1650	1950
2500	1000	UNVM 2500	2700	1800	2800	UNHM 2500	4200	1800	2250
3000	1000	UNVM 3000	2700	1800	3150	UNHM 3000	4550	1800	2250
3500	1000	UNVM 3500	2850	1950	2950	UNHM 3500	4350	1950	2250
4000	1000	UNVM 4000	2850	1950	3400	UNHM 4000	4800	1950	2250
4500	1500	UNVM 4500	3100	2150	3750	UNHM 4500	5400	2200	2250
5000	1500	UNVM 5000	3200	2250	3550	UNHM 5000	5200	2300	2250
6000	1500	UNVM 6000	3200	2250	4150	UNHM 6000	5800	2300	2250
7000	2000	UNVM 7000	3600	2650	3650	UNHM 7000	5400	2800	2700
8000	2000	UNVM 8000	3600	2650	4050	UNHM 8000	5800	2800	2700
9000	2000	UNVM 9000	3600	2650	4550	UNHM 9000	6300	2800	2700
10000	3000	UNVM 10000	3700	2750	4950	UNHM 10000	6750	2900	3100

Designing Unvented Systems

THE FOLLOWING WORKED EXAMPLE OUTLINES THE BASIC STEPS IN UNVENTED SYSTEM DESIGN. THE SIZING TABLES FROM PAGES 9 AND 10 CAN BE USED FOR DOMESTIC HOT WATER SYSTEMS HEATING WATER TO 60-65°C ONLY. FOR OTHER CONDITIONS AND CAPACITIES THE EXAMPLES CAN BE FOLLOWED.

Example – Unvented Domestic Hot Water

We are required to size the expansion vessel for an unvented hot water with a contents of 1200 litres.

The minimum inlet temperature is 10°C with a required temperature of 65°C (1000 litre calorifier + 200 litre system volume). The booster pump set supplies water at a maximum pressure of 3 Bar g. The maximum working pressure must not exceed 3.55 Bar g.

STEP 1: Calculate the compression ratio R

$$R = \frac{(\text{Final working pressure Bar g} + 1)}{(\text{Max. cold feed pressure Bar g} + 1)}$$

$$R = \frac{(3.55 + 1)}{(3.0 + 1)}$$

R = 1.138 *The compression ratio must not exceed a value of 2.*

STEP 2: Calculate the expansion volume Evol

Evol = System volume in litres x the expansion factor.

The expansion factor can be taken from Table 1. From the table it can be seen that the expansion factor for 65°C is = .02

Evol = 1200 x .02

Evol = 24 litre

STEP 3: Calculate the required expansion vessel size Expvel

$$\text{Expvel} = \frac{\text{Evol}}{(1 - 1/R)}$$

$$\text{Expvel} = \frac{24}{(1 - 1/1.138)}$$

Expvel = 197.9 litre

Therefore a 200 litre expansion vessel is required.

STEP 4: Calculate the required storage calorifier design pressure.

The design pressure must be the greater of:

i. The maximum working pressure + .5 Bar (BS 6700 2.4.3 and 2.4.2.4)

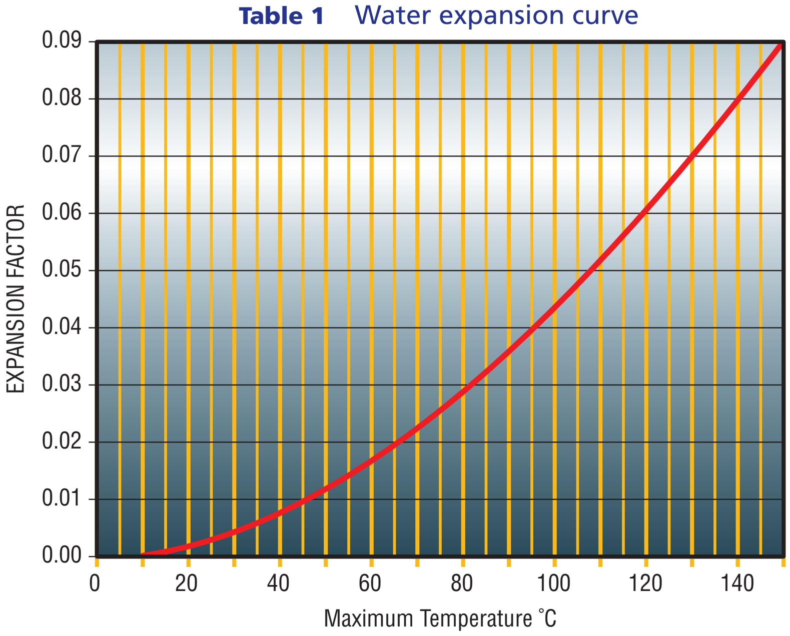
ii. The maximum working pressure Bar g x 1.1 (BS 853 10.2.1.4)

Therefore the design pressure = 3.55 + .5 = **4.05 Bar g**

alternatively = 3.55 x 1.1 = 3.91 Bar g

The domestic hot water design pressure = the safety valve set pressure (BS 853 10.2.1.4). (Storage calorifiers only.)

Table 1 Water expansion curve



Designing Unvented Systems

THE FOLLOWING WORKED EXAMPLE OUTLINES THE BASIC STEPS IN DESIGNING A LTHW UNVENTED SYSTEM. SYSTEMS OPERATING BELOW 85°C POSE NO RISK FROM FLASH OVER.

Example – LTHW Primary Hot Water Service

We are required to size the expansion vessel for a primary hot water system running at 82°C. The system volume is 5000 litre. The system has an allowable maximum working pressure of 5 Bar g and the pressurisation unit is set at 4 Bar g. At 82°C the system offers no threat of achieving flash over conditions.

STEP 1: Calculate the compression ratio R

$$R = \frac{\text{(Final working pressure Bar g + 1)}}{\text{(Max. cold feed pressure Bar g + 1)}}$$

$$R = \frac{(5 + 1)}{(4 + 1)}$$

R = 1.2 *The compression ratio must not exceed a value of 2.*

STEP 2: Calculate the expansion volume Evol

Evol = System volume in litres x the expansion factor.

Evol = 5000 x .03

From Table 1 it can be seen that the expansion factor for 82°C is = 0.03

Evol = 150 litre

STEP 3: Calculate the required expansion vessel size Expvel

$$\text{Expvel} = \frac{\text{Evol}}{(1 - 1/R)}$$

$$\text{Expvel} = \frac{150}{(1 - 1/1.2)}$$

Expvel = 900 litres

Therefore a 1000 litre expansion vessel is required.

A smaller expansion vessel could be used by decreasing the pressurisation set pressure from 4 to 3 Bar g. Under these conditions R = 1.5 and the expansion vessel volume = 500 litre. Care must be taken when reducing the operating pressure to ensure that the pump NPSH requirements are met.

Designing Unvented Systems

THE FOLLOWING WORKED EXAMPLE OUTLINES THE BASIC STEPS FOR DESIGNING AN UNVENTED SYSTEM OPERATING AT TEMPERATURES IN EXCESS OF 100°C. CARE MUST BE TAKEN TO ENSURE CORRECT APPLICATION OF THE VAPOUR PRESSURE FACTOR.

Rycroft expansion vessels fitted with EPDM replaceable bags are limited to a maximum working temperature of 100°C. Frequently primary systems run at temperatures greater than this value. In order to prevent premature failure intermediate buffer vessels are connected between the system and expansion vessel. In this manner the incoming water supplied to the expansion vessel can be kept below 100°C.

Example – MTHW Primary Hot Water Service

We are required to size the expansion vessel for a primary hot water system running at 145°C. The system volume is 1600 litre. The system has an allowable maximum working pressure of 10.8 Bar g.

STEP 1: Calculate the minimum working pressure Pmin

The minimum working pressure must be calculated from the section of the system which experiences the lowest pressure. For this example we will assume a static head of 20m. In order to prevent flash over the following procedure must be followed.

1.1 Add 15°C to the maximum working temperature.
ie 145 + 15 = 160°C.

1.2 Select the appropriate vapour pressure from Table 2.
ie 5.17 Bar g.

1.3 Add the static pressure of the system to the vapour pressure selected in 1.2.

$$= 5.17 + \frac{20}{10.2}$$

= 7.13 Bar g.

STEP 2: Calculate the compression ratio R

$$R = \frac{(\text{Final working pressure Bar g} + 1)}{(\text{Max. cold feed pressure Bar g} + 1)}$$

$$R = \frac{(10.8 + 1)}{(7.13 + 1)}$$

R = 1.45 *The compression ratio must not exceed a value of 2.*

STEP 3: Calculate the expansion volume Evol

Evol = System volume in litres x the expansion factor.

The expansion factor can be taken from Table 1.
From the table it can be seen that the expansion factor for 145°C is = 0.085.

Evol = 1600 x .085

Evol = 136 litre

STEP 4: Calculate the required expansion vessel size Expvel

$$\text{Expvel} = \frac{\text{Evol}}{(1 - 1/R)}$$

$$\text{Expvel} = \frac{136}{(1 - 1/1.45)}$$

Expvel = 438.2 litres

Therefore a 500 litre expansion vessel is required.

Due to the high water temperature an intermediate buffer vessel is required between the system and expansion vessel. The volume of this intermediate vessel must be greater than the expansion volume of 136 litre.

Table 2 Vapour pressure – vp

Temp °C	vp – bar
100	0
105	0.20
100	0.43
115	0.68
120	0.98
125	1.31
130	1.69
135	2.12
140	2.60
145	3.15
150	3.75
155	4.43
160	5.17
165	6.00
170	6.91
175	7.92
180	9.01

Conversion Factors

Area

1mm^2	=	0.01 cm^2
1 cm^2	=	0.155 in^2
1 m^2	=	10000 cm^2
	=	10.76 ft^2
	=	1.196 yd^2
1 in^2	=	6.452 cm^2
		645.2 mm^2
1 ft^2	=	144 in^2
	=	929 cm^2
	=	0.0929 m^2
1 yd^2	=	9 ft^2
	=	0.8361 m^2

Pressure

1 Bar	=	100 kPa
	=	100 kN/m^2
	=	14.5 psi
1 kPa	=	0.01 Bar
	=	0.145 psi
1 psi	=	0.06895 Bar
	=	6.895 kPa
	=	6.895 kN/m^2

Length

1 m	=	1000 mm
	=	3.28 ft
	=	1.0936 yd
1 inch	=	0.08333 ft
	=	25.4 mm
1 yd	=	3 ft
	=	0.9144 m

Weight

1 kg	=	1000 g
	=	2.204 lb
1 tonne	=	1000 kg
	=	0.984 ton
	=	2204 lb
1 lb	=	16 oz
	=	0.454 kg
1 ton	=	2240 lb

Energy

1 kW	=	1000 J/s
1 kWh	=	1 kW for 1 hour (3600 seconds)
	=	860 kcal
	=	3412 BTU
1 kJ	=	0.2388 kcal
	=	0.952 BTU
1 kcal	=	energy required to raise 1 kg of water through 1 deg. C.
	=	4187 J
	=	3.97 BTU

Volume

1 litre	=	1000 ml
	=	0.22 gal (UK)
	=	1 kg water
1 m^3	=	1000 litres
	=	220 gal (UK)
1 gal (UK)	=	4.546 litres

Duty Equation

Power equation for water = litres per second x temp rise °C x 4.187 = kW

Alternatively

$$\left(\frac{\text{Capacity litres}}{\text{Recovery time in seconds}}\right) \times \text{temp rise °C} \times 4.187 = \text{kW}$$

Expansion Vessel Selection Tables

440 l Calorifier +20% System Allowance — 528 litre System

Volume Inlet Pressure Bar g	Expansion Vessel Size 24	35	50	60	80	100	150	200	300	500
0.5	1.68	1.15	.9	.82	.73					
0.75		1.51	1.22	1.12	1.02	.96				
1		1.86	1.54	1.43	1.3	1.24				
1.25		2.22	1.85	1.73	1.59	1.52				
1.5		2.58	2.17	2.03	1.88	1.8				
1.75			2.49	2.34	2.17	2.07	1.96			
2			2.80	2.64	2.46	2.35	2.23			
2.25			3.12	2.94	2.74	2.63	2.5			
2.5			3.44	3.25	3.03	2.91	2.77			
2.75				3.55	3.32	3.19	3.03	2.96		
3				3.85	3.61	3.47	3.3	3.22		
3.25				4.16	3.9	3.75	3.57	3.49		
3.5				4.46	4.18	4.03	3.84	3.75		
3.75				4.76	4.47	4.31	4.11	4.01		
4				5.07	4.76	4.59	4.38	4.28		
4.25				5.37	5.05	4.87	4.65	4.54		
4.5				5.67	5.34	5.15	4.92	4.81		
4.75				5.98	5.62	5.43	5.19	5.07		
5				6.28	5.91	5.71	5.45	5.33		
5.25					6.2	5.99	5.72	5.6	5.48	
5.5					6.49	6.27	5.99	5.86	5.74	
5.75					6.78	6.55	6.26	6.13	6.0	
6					7.06	6.83	6.53	6.39	6.26	
6.25					7.35	7.11	6.8	6.65	6.51	
6.5					7.64	7.39	7.07	6.92	6.77	
6.75					7.93	7.67	7.34	7.18	7.03	
7					8.22	7.94	7.61	7.45	7.29	
7.5						8.5	8.14	7.97	7.81	7.68
8						9.06	8.68	8.5	8.33	8.19
8.5						9.96	9.54	9.35	9.16	9.01
9						10.18	9.76	9.56	9.36	9.22
9.5						10.74	10.3	10.09	9.88	9.73
10						11.3	10.83	10.61	10.4	10.24

550 l Calorifier +20% System Allowance — 660 litre System

Volume Inlet Pressure Bar g	Expansion Vessel Size 35	50	60	80	100	150	200	300	500	750
0.5	1.41	1.04	.92	.8						
0.75	1.81	1.38	1.24	1.1	1.02					
1	2.21	1.72	1.56	1.4	1.3					
1.25	2.61	2.06	1.88	1.69	1.59					
1.5		2.4	2.21	1.99	1.88	1.74				
1.75		2.74	2.53	2.29	2.17	2.02				
2		3.08	2.85	2.59	2.46	2.29				
2.25		3.42	3.17	2.89	2.74	2.56				
2.5		3.76	3.49	3.19	3.03	2.84				
2.75			3.81	3.49	3.32	3.11	3.01			
3			4.13	3.79	3.61	3.39	3.28			
3.25			4.45	4.09	3.9	3.66	3.55			
3.5			4.77	4.39	4.18	3.93	3.82			
3.75			5.09	4.69	4.47	4.21	4.09			
4				4.99	4.76	4.48	4.35	4.23		
4.25				5.29	5.05	4.76	4.62	4.49		
4.5				5.59	5.34	5.03	4.89	4.75		
4.75				5.89	5.62	5.3	5.16	5.01		
5				6.19	5.91	5.58	5.42	5.28		
5.25				6.49	6.2	5.85	5.69	5.54		
5.5				6.78	6.49	6.13	5.96	5.8		
5.75				7.05	6.78	6.4	6.23	6.06		
6				7.38	7.06	6.68	6.49	6.32		
6.25				7.68	7.35	6.95	6.76	6.58		
6.5					7.64	7.22	7.03	6.85	6.7	
6.75					7.93	7.5	7.3	7.11	6.96	
7					8.22	7.77	7.57	7.37	7.22	
7.5					8.79	8.32	8.1	7.89	7.73	
8					9.37	8.87	8.64	8.41	8.24	
8.5						9.75	9.49	9.25	8.76	8.6
9						9.96	9.71	9.46	9.27	9.13
9.5						10.51	10.24	9.98	9.78	9.64
10						11.06	10.78	10.51	10.3	10.15

700 l Calorifier +20% System Allowance — 840 litre System

Volume Inlet Pressure Bar g	Expansion Vessel Size 35	50	60	80	100	150	200	300	500	750
0.5	1.88	1.26	1.08	.9	.8					
0.75		1.64	1.43	1.22	1.1	.97				
1		2.01	1.78	1.53	1.4	1.25				
1.25		2.39	2.13	1.85	1.7	1.53				
1.5		2.77	2.47	2.16	2	1.82				
1.75			2.82	2.48	2.31	2.1	2			
2			3.17	2.8	2.61	2.38	2.28			
2.25			3.51	3.11	2.91	2.66	2.55			
2.5			3.86	3.43	3.21	2.94	2.82			
2.75			4.21	3.75	3.51	3.22	3.09			
3				4.06	3.81	3.5	3.37	3.24		
3.25				4.38	4.11	3.79	3.64	3.5		
3.5				4.7	4.41	4.07	3.91	3.77		
3.75				5.01	4.71	4.35	4.19	4.03		
4				5.33	5.01	4.63	4.46	4.3		
4.25				5.65	5.31	4.91	4.73	4.56		
4.5				5.96	5.61	5.19	5	4.83		
4.75					5.91	5.48	5.28	5.09	4.95	
5					6.21	5.76	5.55	5.36	5.21	
5.25					6.51	6.04	5.82	5.62	5.47	
5.5					6.81	6.32	6.1	5.89	5.73	
5.75					7.11	6.6	6.37	6.15	5.98	
6					7.41	6.88	6.64	6.42	6.24	
6.25					7.71	7.16	6.91	6.68	6.5	
6.5						7.45	7.19	6.94	6.76	6.67
6.75						7.73	7.46	7.21	7.02	6.93
7						8.01	7.73	7.47	7.28	7.18
7.5						8.57	8.28	8	7.8	7.69
8						9.14	8.83	8.53	8.31	8.21
8.5						9.7	9.37	9.06	8.83	8.72
9						10.26	9.92	9.59	9.35	9.23
9.5						10.8	10.46	10.12	9.87	9.74
10						11.39	11.01	10.65	10.38	10.25

These expansion vessel selection tables provide a visual representation of the effect that the expansion vessel volume has on the final working pressure of the system.

The selection tables can be used as follows.

A 700 litre calorifier is required to have an initial cold fill pressure of 5 Bar g.

From the 700 litre calorifier table a horizontal line should be drawn across the page from the 5 Bar g inlet pressure. The intercepted columns are actual final working pressures achieved utilising the expansion vessel sizes listed at the top of each column.

For the example given it can be seen that the use of a 200 litre expansion vessel would result in a final working pressure of 5.55 Bar g.

The highlighted column represents the recommended expansion vessel size.

A 100 litre expansion vessel however, would result in a final working pressure of 6.21 bar g. The higher pressure would require a 12% increase in the thickness of the copper shell.

It is frequently more economic to increase the size of the expansion vessel rather than increasing the final working pressure. This is especially true for high pressure systems where a greater final working pressure can result in a considerably thicker copper shell.

Note

These tables allow for a 20% system volume. It is essential to check the actual system volume to ensure the assumptions made are appropriate. The tables on page 10 can be referred to for calculating the system pipe volume.

800 l Calorifier +20% System Allowance — 960 litre System

Volume Inlet Pressure Bar g	Expansion Vessel Size 50	60	80	100	150	200	300	500	750	1000
0.5	1.44	1.21	.97	.86	.72					
0.75		1.57	1.3	1.17	1.01	.94				
1		1.94	1.63	1.48	1.29	1.21				
1.25		2.31	1.96	1.78	1.58	1.49				
1.5		2.68	2.29	2.09	1.87	1.77				
1.75		3.04	2.62	2.4	2.15	2.04				
2			2.95	2.71	2.44	2.32	2.21			
2.25			3.28	3.02	2.73	2.6	2.47			
2.5			3.61	3.33	3.01	2.87	2.74			
2.75			3.93	3.64	3.3	3.15	3.01			
3			4.26	3.95	3.59	3.42	3.27			
3.25			4.59	4.26	3.87	3.7	3.54			
3.5			4.92	4.57	4.16	3.98	3.81			
3.75			5.25	4.88	4.45	4.25	4.07			
4				5.19	4.73	4.53	4.34	4.2		
4.25				5.5	5.02	4.81	4.61	4.46		
4.5				5.81	5.31	5.08	4.88	4.72		
4.75				6.12	5.59	5.36	5.14	4.98		
5				6.43	5.88	5.64	5.41	5.24		
5.25				6.74	6.17	5.91	5.68	5.5		
5.5				7.04	6.45	6.19	5.94	5.76		
5.75					6.74	6.47	6.21	6.02	5.93	
6					7.03	6.74	6.48	6.28	6.18	
6.25					7.31	7.02	6.75	6.54	6.44	
6.5					7.6	7.3	7.01	6.8	6.70	
6.75					7.89	7.57	7.28	7.06	6.95	
7					8.17	7.85	7.55	7.32	7.21	
7.5					8.75	8.4	8.08	7.84	7.72	
8					9.32	8.96	8.62	8.36	8.24	
8.5					9.89	9.51	9.15	8.88	8.75	
9					10.47	10.06	9.68	9.4	9.26	
9.5						10.62	10.22	9.92	9.78	9.64
10						11.17	10.75	10.44	10.29	10.14

900 l Calorifier +20% System Allowance — 1080 litre System

Volume Inlet Pressure Bar g	Expansion Vessel Size 60	80	100	150	200	300	500	750	1000	1500
0.5	1.34	1.05	.91	.75	.68					
0.75	1.73	1.4	1.23	1.04	.96					
1	2.13	1.74	1.55	1.34	1.24					
1.25	2.52	2.08	1.87	1.63	1.52					
1.5	2.91	2.42	2.19	1.92	1.8					
1.75		2.77	2.51	2.21	2.08	1.96				
2		3.11	2.83	2.5	2.36	2.23				
2.25		3.45	3.15	2.8	2.64	2.5				
2.5		3.79	3.46	3.09	2.92	2.77				
2.75		4.14	3.78	3.38	3.2	3.04				
3		4.48	4.1	3.67	3.48	3.31				
3.25			4.42	3.96	3.76	3.58	3.44			
3.5			4.74	4.26	4.04	3.85	3.7			
3.75			5.06	4.55	4.33	4.12	3.96			
4			5.38	4.84	4.61	4.39	4.23			
4.25			5.7	5.13	4.89	4.66	4.49			
4.5			6.02	5.43	5.17	4.93	4.75			
4.75			6.33	5.72	5.45	5.2	5.01			
5				6.01	5.73	5.47	5.27	5.18		
5.25				6.3	6.01	5.73	5.53	5.44		
5.5				6.59	6.29	6	5.79	5.69		
5.75				6.89	6.57	6.27	6.05	5.95		
6				7.18	6.85	6.54	6.32	6.21		
6.25				7.47	7.13	6.81	6.58	6.46		
6.5				7.76	7.41	7.08	6.84	6.72		
6.75				8.05	7.69	7.35	7.1	6.98		
7				8.35	7.97	7.62	7.36	7.24		
7.5				8.93	8.53	8.16	7.88	7.75		
8				9.51	9.09	8.7	8.41	8.27		
8.5					9.65	9.24	8.93	8.78	8.71	
9					10.21	9.78	9.45	9.3	9.22	
9.5					10.77	10.31	9.97	9.81	9.73	
10					11.33	10.85	10.5	10.33	10.24	

1000 l Calorifier +20% System Allowance — 1200 litre System

Volume Inlet Pressure Bar g	Expansion Vessel Size 60	80	100	150	200	300	500	750	1000	1500
0.5	1.5	1.14	.97	.79	.7					
0.75	1.92	1.5	1.3	1.08	.99					
1	2.33	1.86	1.63	1.38	1.27					
1.25	2.75	2.21	1.96	1.68	1.56					
1.5		2.57	2.29	1.98	1.84	1.72				
1.75		2.93	2.62	2.27	2.13	1.99				
2		3.29	2.95	2.57	2.41	2.26				
2.25		3.64	3.28	2.87	2.69	2.53				
2.5		4	3.61	3.17	2.98	2.8				
2.75		4.36	3.93	3.46	3.26	3.08				
3			4.26	3.76	3.55	3.35	3.2			
3.25			4.59	4.06	3.83	3.62	3.46			
3.5			4.92	4.36	4.11	3.89	3.73			
3.75			5.25	4.65	4.4	4.16	3.99			
4			5.58	4.95	4.68	4.43	4.25			
4.25				5.25	4.97	4.71	4.51	4.42		
4.5				5.55	5.25	4.98	4.78	4.68		
4.75				5.85	5.53	5.25	5.04	4.94		
5				6.14	5.82	5.52	5.3	5.2		
5.25				6.44	6.1	5.79	5.57	5.46		
5.5				6.74	6.39	6.07	5.83	5.71		
5.75				7.04	6.67	6.34	6.09	5.97		
6				7.33	6.95	6.61	6.35	6.23		
6.25				7.63	7.24	6.88	6.62	6.49		
6.5				7.93	7.52	7.15	6.88	6.75		
6.75				8.23	7.81	7.42	7.14	7.01		
7				8.52	8.09	7.7	7.4	7.26		
7.5					8.66	8.24	7.93	7.78	7.71	
8					9.23	8.78	8.45	8.3	8.22	
8.5					9.8	9.33	8.98	8.81	8.73	
9					10.36	9.87	9.5	9.33	9.25	
9.5					10.93	10.41	10.03	9.85	9.76	
10					11.5	10.96	10.55	10.36	10.27	

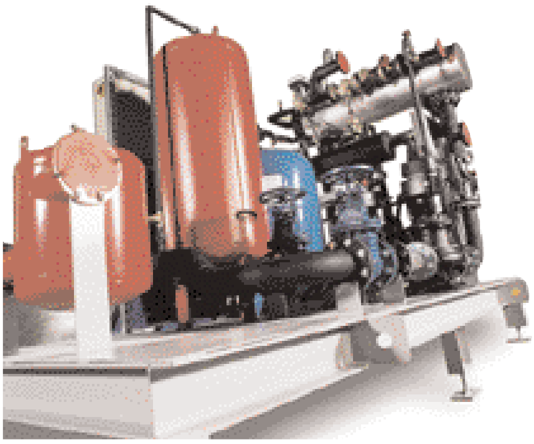
Pipe Volumes

Pipe volumes in litres per metre for Table X copper tube

Nom dia. mm	Volume litres per metre
22	0.322
28	0.542
35	0.839
42	1.236
54	2.098
67	3.289
76.1	4.221
108	8.704
133	13.381
159	18.998

Pipe volumes in litres per metre for steel tube to BS1387 medium

Nom dia. mm	Volume litres per metre
15	0.196
20	0.356
25	0.569
32	0.996
40	1.353
50	2.166
65	3.644
80	5.028
100	8.547
125	13.075
150	18.731



Expansion Vessels

Application

When water is heated it expands. For example the change in volume from 5°C to 65°C is 2%. This may appear small but since water is almost incompressible it is essential that provision is made for expansion to avoid extremely high pressures. Correctly installed hot water systems are fitted with a relief valve to limit the maximum pressure. However, this is a safety device which is not intended to operate frequently as a pressure controller. Apart from the loss of water which would appear with each expansion cycle the valve may wear and begin to leak continuously.

Hot water circuits which have an open vent normally discharge the expansion volume back into the make up tank. When the pressure is too high for an open vent or the water is above 85°C the circuit is sealed and an enclosed space is necessary to accommodate the expansion.

Sometimes an air pocket is provided in the top of a vessel for this purpose but unless the air is replenished regularly it can be absorbed by the water and the buffer volume will disappear.

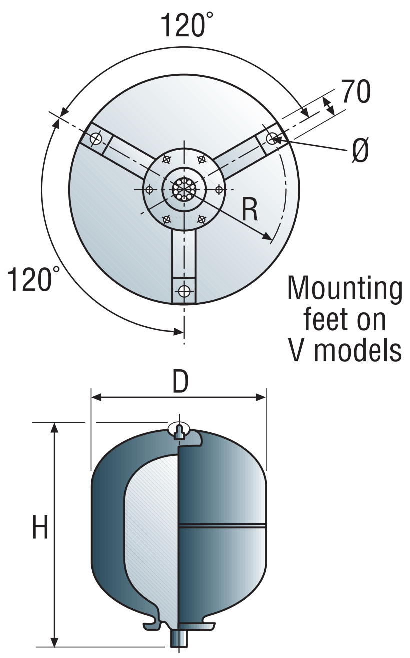
The Rycroft expansion vessel uses an air pocket but there is a rubber bag which separates the air from the water and so avoids absorption. The rubber bag also acts as a barrier between the water and the interior surface of the expansion vessel. This prevents corrosion and contamination of the water.

Designation

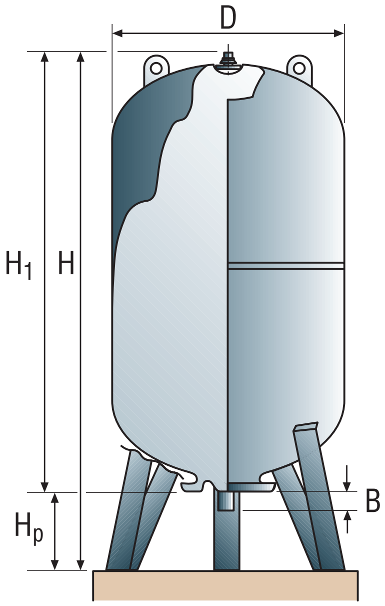
EXP	150	V
Model	Capacity	H = Horizontal V = Vertical P = Pipeline mounted

Technical Specification

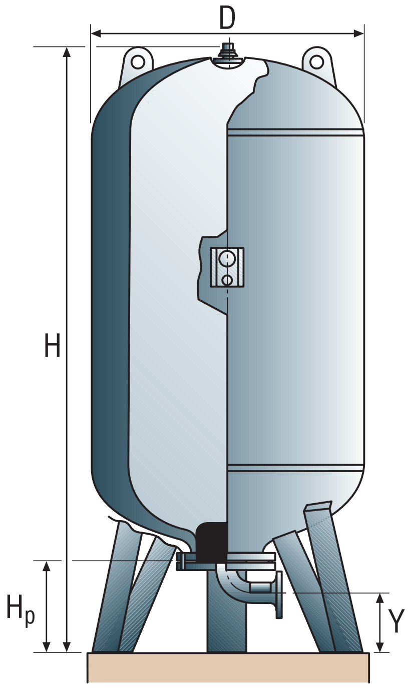
- Temperature range to 100°C
- Interchangeable EPDM membrane
- Maximum of 8 or 10 bar system pressure
- Suitable for hot and cold water, glycol mixtures, de-mineralised and de-ionised water
- Vertical, horizontal and pipeline mounted models
- WRC approved
- Water totally isolated from tank avoiding dangerous corrosion.



EXP 3P to EXP 35P



EXP 50V to EXP 1500V



EXP 2000V to EXP 3000V

Dimensions for Vertical and Pipeline Mounted Models

Model	Capacity (litres)	Diameter D (mm)	Height H (mm)	H1 (mm)	Y (mm)	HP (mm)	R (mm)	Dia (mm)	Connection (BSPM)	Maximum Working Pressure	Weight (kg)
EXP 3 P	3	170	240						3/4"	8 BAR	1.3
EXP 5 P	5	170	280						3/4"	8 BAR	1.4
EXP 8 P	8	220	310						3/4"	8 BAR	1.8
EXP 12 P	12	265	315						3/4"	8 BAR	2.4
EXP 16 P	16	265	340						3/4"	8 BAR	3.0
EXP 18 P	18	265	375						3/4"	8 BAR	3.2
EXP 24 P	24	265	490						1"	10 BAR	3.6
EXP 35 P	35	380	590						1"	10 BAR	7.0
EXP 50 V	50	380	740	555		140	153	12.5	1"	10 BAR	10.3
EXP 60 V	60	380	830	635		140	153	12.5	1"	10 BAR	11.3
EXP 80 V	80	460	760	600		140	195	12.5	1"	10 BAR	14.0
EXP 100 V	100	460	880	720		140	195	12.5	1"	10 BAR	17.6
EXP 150 V	150	510	1030	870		140	220	12.5	1.1/4"	10 BAR	24.7
EXP 200 V	200	590	1070	885		140	220	12.5	1.1/4"	10 BAR	27.4
EXP 300 V	300	650	1250	1085		140	220	12.5	1.1/4"	10 BAR	43.8
EXP 500 V	500	750	1600	1360		240	325	14	1.1/4"	10 BAR	81.1
EXP 750 V	750	800	1785	1520		265	350	14	2"	10 BAR	157.0
EXP 1000 V	1000	800	2100	1820		280	350	14	2.1/2"	10 BAR	187.0
EXP 1500 V	1500	1000	2100	1850		250	450	14	2.1/2"	10 BAR	241.0
EXP 2000 V	2000	1100	1550	2170	200	335	940	14	DN65 PN16	10 BAR	301.0
EXP 3000 V	3000	1200	2950	2615	200	335	500	14	DN65 PN16	10 BAR	400.0

Checklist

Rycroft will be pleased to select the correct size and pressure rating for all applications of their expansion vessels. The following information is required for an accurate assessment to be made.

- Cold feed pressure of a domestic hot water service or the static head of a primary hot water system.
- Maximum working temperature – design pressure of the system.
- Circulating pump head – volume of the system.
- Any additive to the water such as glycol and the percentage mixture.

Much of this information will already be available if Rycroft are supplying the calorifiers or water heaters.

Accessories

Pressure Temperature Relief Valve
Unvented calorifiers must be fitted with a Temperature Pressure Relief Valve to protect the system from excess temperature. The valve is tested to comply with BS 6283. The pressure and temperature elements of the valve operate independently providing dual safety protection in one valve. Temperature protection is provided by wax capsule thermostat set at 95°C. All the valve wetted parts are manufactured from de-zincification resistant materials, approved by Water Research Centre for use in potable water systems.
The valve discharge must be unrestricted and piped to safe area.

Anti-vacuum Valve
Copper lined vessels must be protected against partial vacuum so all Rycroft copper lined calorifiers are fitted with a disc type anti vacuum valves as standard.

Bursting Discs
On indirect systems where a fluid primary working pressure exceeds the secondary design pressure a bursting disc must be fitted to the calorifier. It is extremely important that the discharge from the bursting disc is unrestricted and piped to a safe area.
When using BS 853 as code of design, bursting discs are not required when the primary is steam.

Anodes
Sacrificial anodes can be supplied to counteract certain adverse water properties. Magnesium anodes help to protect galvanised cylinders whilst the initial deposit of scale forms on the shell. The combination of copper pipework and galvanised cylinders should be avoided. The life of the magnesium anode depends on the quality of the water and regular checks should be made to establish a service period.
Aluminium anodes can be fitted to copper cylinders to give lasting protection. This is only necessary for fresh water supplies which are known to prevent the formation of the natural protective oxide film.
Aluminium anodes do not require replacement and are maintenance free.

Expansion Relief Valve
A 20mm expansion relief valve must be fitted to the incoming cold water supply. Isolation valves must not be fitted between this valve and the calorifier.
This valve protects the system from overpressure due to failure of the expansion vessel, ie loss of vessel air charge, damaged bladder.

Expansion Vessel
All unvented systems must be fitted with devices to accommodate the expansion of water during the heating cycle. Rycroft offer an extensive range of expansion vessels fitted with replaceable EPDM bags. All Rycroft expansion vessels are WRc approved.

Control Devices
Direct electric systems are fitted with control thermostats wired to control panel. All other systems can be fitted with direct acting, electric or pneumatic control valves depending on the installation or clients specified choice.

Insulation
Adequate thermal insulation is essential to prevent unnecessary heat losses from storage calorifiers which may be standing for many hours at working temperature.
Rycroft standard factory fitted type 'M' insulation consists of 80mm thick fibreglass mattress compressed to 50mm thick, closely fitted to the shell and encased in rigid galvanised mild steel sheets 1.6mm thick.
Nominal density: 95kg/m cu.
Thermal conductivity: 0.04 W/mk
Fire protection: BS 476:Part 4:1970 class I.
Alternative insulation materials and aluminium or stainless steel cladding are also available.

High Limit Cut Out

Direct electrically heated calorifiers must be fitted with an independent high limit cut out device.
All other systems require an independent high limit thermostat directly connected to the control device or to an independent shut off device.

Manhole

Calorifier access conforms to the minimum requirements of BS 853 unless specifically requested.

Booster Sets

Rycroft can offer a wide selection of cold water booster sets suitable for Marine, Offshore, Commercial, Industrial and Process application. The pump control method available are conventional pressure switches or frequency converter control (inverter) of the motor speed. Pump arrangements include single, dual or triple operating in duty standby mode or duty assist.
Pump materials: Stainless Steel, Cast Iron, Bronze.
Pipework choices: Plastic ABS, Glavanised Steel, Copper, Stainless Steel.
Build Standards: Commercial, Lloyds, American Bureau of Shipping.
All sets are mounted on a purpose mild skid.
Please contact our sales department for further information.

Low Water Level Switch

We strongly recommend the fitting of a low water cut out device on all electrically heated calorifiers. This prevents the risk of switching the immersion heater on whilst the calorifier is empty.

General Fittings

Temperature gauges complete with pockets.
Pressure gauges complete with gauge cocks.
Pressure gauge syphons.
Strainers, isolating, check, drain and pressure reducing valves.

Pressure Reducing Valves

Pressure reducing valves maintain a constant cold fill supply pressure to the calorifier protecting it from the cyclic operation of booster set and any overpressure as booster pumps charge accumulator vessels.
Pressure reducing valves are supplied with Water Research Centre approval in bronze and cast iron. Pressure gauges can be supplied on the inlet and outlet flanges for visual verification of pressure drop.

General

All Unvented Packages are supplied on a purpose-made skid, manufactured from BS 4630-43A carbon steel RSC and totally decked. Standard skids are spray painted with protective black gloss. If required the skids can be painted to customers' specification.

Pressurisation Units

Rycroft pressurisation units are designed for pressurisation of unvented hot water system, eg LTHW, MTHW system, to make up minor water losses and accommodate the water thermal expension. Units are available with single and dual pumps mounted in a fully-packaged housing. The systems water thermal expansion is accommodated by the expansion vessel. Alternative units are available where the water expands into a spill tank.

Unvented Package Specification

Calorifiers built in accordance with BS 853 and G3 Building Regulations and in line with the following specification.

1. No. of Calorifiers ☐ (Each Unit 100%, 50% etc)
2. Volume of Calorifier ☐ Litres or Fixture Count
3. Recovery Time ☐ Hours/kW
4. Cold Feed Temperature ☐ °C/ °F
5. Operating Temperature ☐ °C/ °F
6. Primary Heat Medium ☐ Steam/LTHW/MTHW/HTHW
   Electric

Others, specify____

____

____

7. How is system fed? ☐ Mains, Tank, Boosted
8. Cold Feed Pressure ☐ Bar g
   Max. Operating Pressure Hot ☐ Bar g
9. Volume of System ☐ Litres (Calculated or Assumed)
10. Is a standard package required? Yes ☐ No ☐
    Are there space restrictions? Yes ☐ No ☐

    If yes, details____

    ____

    ____

    ____

11. If a standard package is not required any of the following fittings can be supplied:
    - Combined pressure/temperature relief valve. ☐
    - Expansion relief valve. ☐
    - Suitably sized expansion vessel (based on Q8 and 9). ☐
    - Cold Feed Isolating Valve ☐
    - Cold Feed Strainer ☐
    - Cold Feed Non Return Valve ☐
    - Secondary Pressure Gauge ☐
    - Secondary Temperature Gauge ☐
    - Secondary Drain Cock ☐
12. Other Options
    Type of control required
    A) Self Acting ☐
    B) Electrically Actuated ☐
    C) Pneumatic ☐
    Is there a separate high limit valve? Yes ☐ No ☐
13. Secondary recirculation pump required? Yes ☐ No ☐
14. Legionella shunt pump required? Yes ☐ No ☐
15. Package control panel? Yes ☐ No ☐
    Pre-wired? Yes ☐ No ☐

SUPAPAC Plate Heat Exchangers

Shell and Tube Heat Exchangers

COMPAC Plate Heat Exchanger Packages

MAXIMISER Semi-Storage Calorifiers

Calorifiers/Cylinders

Unvented Packages

Pressurisation

Electric Water Heaters

Rycroft Process Solutions

HEATING THE WORLD'S WATER

BS EN ISO 9001

FM No 28819

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