EXPANSION TANKS

update February 2005

ASME

ASME

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ÚSTAV

Expansion tanks

DET NORSKE VERITAS

QUALITY MANAGEMENT SYSTEM CERTIFICATE

Certificato No. / Certificate No. CERT-01073-96-AQ-VEN-SINCERT

Si attesta che / This certifies that

IL SISTEMA DI GESTIONE PER LA QUALITÀ DI / THE QUALITY MANAGEMENT SYSTEM OF

ELBI S.p.A.

Via Buccia, 9 - 35010 Limena (PD) - Italy

Via delle Magnolie ASI - 70026 Modugno (BA) - Italy

È CONFORME AI REQUISITI DELLA NORMA PER I SISTEMI DI GESTIONE PER LA QUALITÀ
CONFORMS TO THE QUALITY MANAGEMENT SYSTEMS STANDARD

UNI EN ISO 9001:2000 (ISO 9001:2000)

Questa certificazione è valida per il seguente campo applicativo:
This certificate is valid for the following products or services:

Progettazione e produzione di vasi di espansione, serbatoi a pressione, autoclavi, preparatori di acqua calda, contenitori per RSU, vasi da fiori e contenitori in polietilene di capacità massima di 20.000 litri.

Design and manufacture of expansion vessels, pressure tanks, autoclaves, hot water cylinders, containers for SUW, flower pots and polyethylene storage containers with a maximum capacity of 20,000 litres.

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SINCERT

per l'Organismo di Certificazione
for the Accredited Unit
Det Norske Veritas Italia S.r.l.

Leonardo Omodeo Zorini
Management Representative

COMPANY

WITH QUALITY SYSTEM

CERTIFIED BY DNV

ISO 9001/2000

Expansion tanks

Expansion tanks are devices designed to absorb the volume change of water or some other liquids, thus allowing the correct operation of a heating plant during all its operative phases.

Elbi produces closed expansion tanks composed by a tank in sheet steel and a bladder in synthetic material which separates the heating circuit from a chamber previously charged with air.
Expansion tanks with a bladder, which are available from 5 to 5.000 litres, are constructed by using quality sheet steels according to UNI-EN regulations and welded according to some strict qualitative standards; they are produced on automated lines, welded with procedures and approved weld materials, equipped with bladders in special rubber used against heat and ageing which are resistant up to 110° C (all of them are produced by ELBI); they are previously charged at a pressure of 0.5 – 1.0 – 1.5 bars according to the static height of the water column.
Once the construction has been completed, all the models are subjected to a hydraulic test with a pressure of 1.5 times higher than the designed one.
There are also some versions constructed according to the most important European regulations in force.

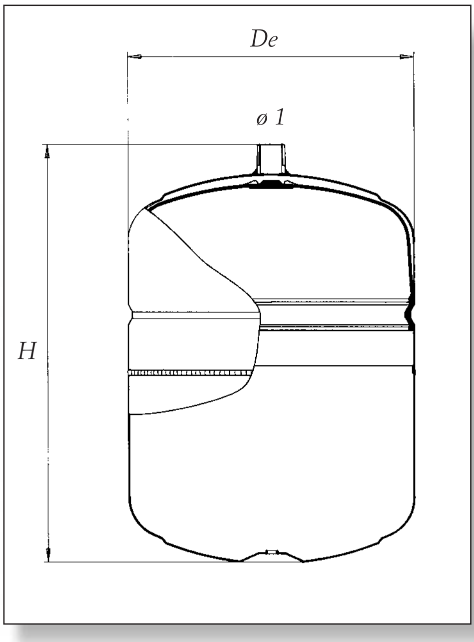
Elbi bladders

Elbi produces all the bladders which mounts on its own equipment, as for the production it makes exclusive use of modern injection presses, the most advanced ones in this sector.
Dies designed by the Elbi technical department ensure the complete compatibility with tanks. All the bladders are tested by the company's quality control service at the end of the production run. Bladders which are used in the ERL series are constructed by applying an exclusive process which allows to obtain the exact dimensions corresponding to the tank's actual volume, thus eliminating every kind of mechanical stress during the operation.
Their mixing is the result of some studies and researches carried out directly by the Elbi technical department.

ER - CE series

2 to 24 litres

The available models from 2 to 24 litres are designed to be installed in different types of plant.
Besides, they are available in special versions, constructed according to the most important international regulations: CE, WRAS, UDT, etc.



Characteristics

- Working temperature: -10°÷ + 99°C
- Sturdy structure in high-quality steel, designed to endure for a long time.
- Painting with long life epoxy powders.
- Bladders in special rubber with those characteristics which ensure better performances and a longer life.
- In compliance with essential safety requirements of directive 97/23/EC.
- CE marking (type ER2 - ER5 without CE marking).

Model	Capacity litres	Maximum working pressure bar	Precharge pressure bar	De mm	H mm	ø1	Packaging mm
ER2	2	8	1,5	146	230	1/2”	150 x 150 x 240
ER5	5	8	1,5	205	225	3/4”	210 x 210 x 250
ER8 CE	8	8	1,5	205	300	3/4”	210 x 210 x 320
ER12 CE	12	8	1,5	270	300	3/4”	280 x 280 x 310
ER18 CE	18	8	1,5	270	410	3/4”	280 x 280 x 450
ER24 CE	24	8	1,5	320	355	3/4”	330 x 330 x 375

1MPa = 10 bar

Selection of the expansion tank

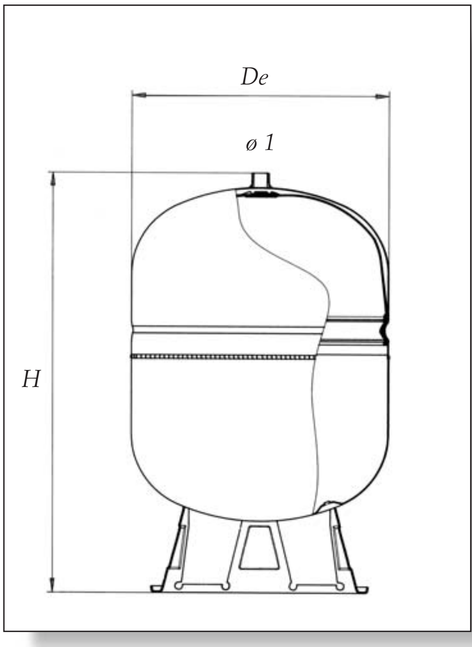
The table simplifies the choice of the ELBI expansion tank to be installed in hot water systems. The selection of the tank can be effectuated starting from the system's total capacity or from the plant's power, taking into consideration an average content of 12 litres per 1000 Kcal/h of power and a plant's maximum working pressure of 3 bars.

Model	Precharge pressure bar	Plant height meters m	Tank's volume acceptable litres	Tank's absorption capacity %	Temperature difference ΔT = (90 - 14)°C Δ coefficient of expansion 0,035		
					Total water content in the plant litres	Heat-generator's power Kcal/h	kW
ER5	0,5	5	3,1	62	89	7.400	8,6
	1	10	2,5	50	71	5.900	6,86
ER8 CE	0,5	5	5	62	143	11.900	13,84
	1	10	4	50	114	9.500	11,4
ER12 CE	0,5	5	7,5	63	214	17.800	20,7
	1	10	6	50	171	14.250	16,57
ER18 CE	0,5	5	11,3	63	323	26.900	31,3
	1	10	9	50	257	24.100	28,2
	1,5	15	6,7	37	191	15.900	18,5
ER24 CE	0,5	5	15,5	65	443	36.900	43
	1	10	12	50	343	28.600	33,26
	1,5	15	9,3	39	266	22.200	25,82

ERCE series

35 to 500 litres

The available models from 35 to 500 litres are designed to be installed in the different types of plant.
Besides, they are available in special versions, constructed according to the most important international regulations: CE, WRAS, UDT, etc.



Characteristics:

- Working temperature: -10°÷ +99°C
- Sturdy structure in high-quality steel, designed to endure for a long time.
- Painting with long life epoxy powders.
- Bladders in special rubber with those characteristics which ensure better performances and a longer life.
- In compliance with essential safety requirements of directive 97/23/EC.
- CE marking.

Model	Capacity litres	Maximum working pressure bar	Precharge pressure bar	De mm	H mm	ø1	Packaging mm
ERCE 35*	35	10	1,5	400	390	3/4"	410 x 410 x 410
ERCE 50*	50	10	1,5	400	500	1"	410 x 410 x 535
ERCE 80	80	10	1,5	400	840	1"	410 x 410 x 860
ERCE 100	100	10	1,5	500	795	1"	510 x 510 x 830
ERCE 150	150	10	1,5	500	1.025	1"	510 x 510 x 1040
ERCE 200	200	10	1,5	600	1.100	1"	610 x 610 x 1100
ERCE 250	250	10	1,5	650	1.190	1"	660 x 660 x 1210
ERCE 300	300	10	1,5	650	1.265	1"	660 x 660 x 1290
ERCE 500	500	10	1,5	775	1.425	1" 1/4	785 x 785 x 1440

*Standard without base, upon request with feet.
1MPa = 10 bar

Selection of the expansion tank

The table simplifies the choice of the ELBI expansion tank to be installed in hot water systems. The selection of the tank can be effectuated starting from the system's total capacity or from the plant's power, taking into consideration an average content of 12 litres per 1000 Kcal/h of power.

Model	Precharge pressure bar	Plant's maximum working pressure bar	Plant height m	Tank's acceptable volume litri	Tank's absorption capacity %	Temperature difference ΔT = (90 - 14)°C Δ coefficient of expansion 0,035		
						Total water content in the plant litres	Heat-generator's power Kcal/h	kW
ER CE 35	1	3	10	17,6	50	503	41.900	48,72093
	1,5		15	13,1	37	374	31.200	36,27907
	2		20	8,8	25	251	20.900	24,30233
ER CE 50	1	3	10	25	50	714	59.500	69,18605
	1,5		15	18,8	38	537	71.400	52,03488
	2		20	12.5	25	357	29.750	34,59302
ER CE 80	1	3	10	40	50	1.143	95.250	110,7558
	1,5		15	30	38	857	71.400	83,02326
	2		20	20	25	571	47.600	55,34884
ER CE 100	1	5	10	50	50	1.428	119.000	138,3721
	1,5		15	38	38	1.086	90.500	105,2326
	2		20	25	25	714	59.500	69,18605
ER CE 150	1	5	10	100	67	2.857	238.000	276,7442
	1,5		15	87	58	2.486	207.000	240,6977
	2		20	75	50	2.143	178.600	207,6744
ER CE 200	1	5	10	133	67	3.800	317.000	368,6047
	1,5		15	116	58	3.314	276.000	320,9302
	2		20	100	50	2.857	238.000	276,7442
	2,5		25	83	42	2.371	197.600	229,7674
	3		30	66	33	1.886	157.200	182,7907
ER CE 250	1	5	10	178	71	5.086	423.800	492,7907
	1,5		15	160	64	4.571	380.900	442,907
	2		20	143	57	4.086	340.500	395,9302
	2,5		25	125	50	3.571	297.600	346,0465
	3		30	107	43	3.057	254.800	296,2791
ER CE 300	1	6	10	214	71	6.114	509.500	592,4419
	1,5		15	193	64	5.514	459.500	534,3023
			20	171	57	4.886	407.000	473,2558
	2,5		25	150	50	4.286	357.200	415,3488
	3		30	128	43	3.657	304.800	354,4186
ER CE 500	1,5	6	15	321	64	9.171	764.300	888,7209
	2		20	285	57	8.143	678.600	789,0698
	2,5		25	250	50	7.143	595.300	692,2093
	3		30	215	43	6.143	512.000	595,3488
	3,5		35	178	36	5.086	427.000	496,5116

ERP series

6 to 24 litres

ERP tanks are available from 6 to 24 litres for a total number of 22 models.
The range of tanks proposed with the ERP series has been designed in order to ensure the greatest reliability. They are available in the TÜV and WRAS approved version.

Characteristics:

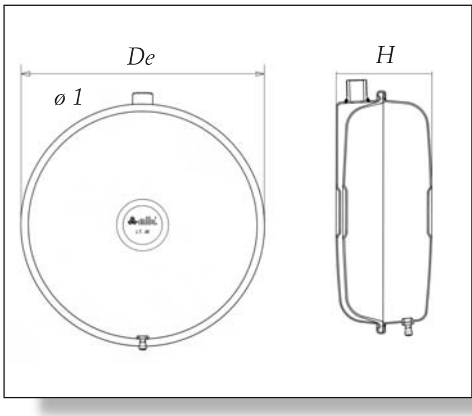
- Sturdy structure in high-quality steel, designed to endure for a long time.
- Painting with long life epoxy powders.
- Bladders in special rubber with those characteristics which ensure better performances and a longer life.
- Working temperature: -10°÷+90°C
- Precharge pressure: 1 bar
- In compliance with directive 97/23/EC (PED)

Model	Capacity litres	Maximum working pressure bar	Dimensions mm	De mm	H mm	ø1
ERP 320/6	6	3	/	320	94	3/4"
ERP 320/8	8	3	/	320	121	3/4"
ERP 320/10	10	3	/	320	131	3/4"
ERP 320/12	12	3	/	320	165	3/4"
ERP 385/7	7	3	/	385	83	3/4"
ERP 385/8	8	3	/	385	98	3/4"
ERP 385/10	10	3	/	385	108	3/4"
ERP 385/12	12	3	/	385	139	3/4"
ERP 385/14	14	3	/	385	146	3/4"
ERP 416/6	6	3	/	416	65	3/8"
ERP 416/8	8	3	/	416	75	3/8"
ERP 416/10	10	3	/	416	90	3/8"
ERP RET 6	6	3	516 x 196	/	95	3/4"
ERP RET 8	8	3	516 x 196	/	110	3/4"
ERP RET 10	10	3	516 x 196	/	124	3/4"
ERP RET 12	12	3	516 x 196	/	152	3/4"
ERP - Q 7	7	3	436 x 344	/	77	3/8"
ERP - Q 10	10	3	436 x 344	/	97	1/2"
ERP - Q 12	12	3	436 x 344	/	117	1/2"
ERP - Q 14	14	3	436 x 344	/	132	1/2"
ERP - Q 16	16	3	436 x 344	/	147	1/2"
ERP - Q 18	18	3	436 x 344	/	155	1/2"
ERP - Q 20	20	3	436 x 344	/	162	1/2"
ERP - Q 24	24	3	436 x 344	/	177	1/2"

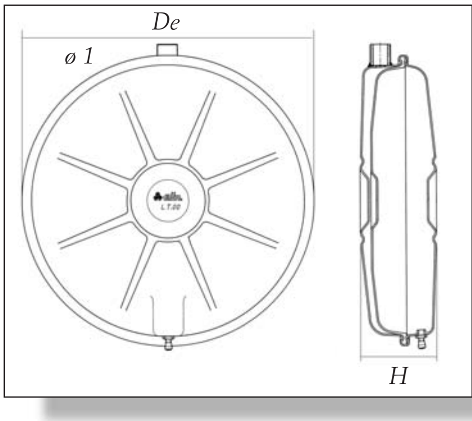
1MPa = 10 bar

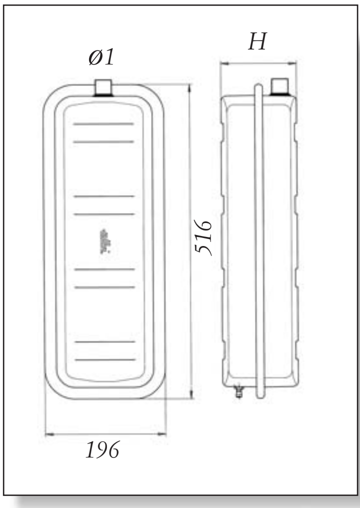
ERP 320

ERP 416

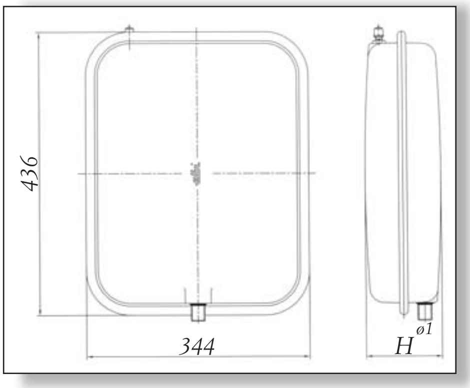


ERP 385





ERP RET



ERP - Q

Selection of the expansion tank ERP series

The table simplifies the choice of the ELBI expansion tank to be installed in hot water systems. The selection of the tank can be effectuated starting from the system's total capacity or from the plant's power, taking into consideration an average content of 8 litres per 1000 Kcal/h of power, a precharge pressure of 1 bar and a plant's maximum working pressure of 3 bars.

Model	Plant height m	Prech. press bar	Tank accept. vol lt	Tank absorb. cap. %	Plant Water content (it)	Plant Power Kcal/h	Plant Power kW
ERP 320/6	10	1,0	3,0	50	86	10.700	12,44
ERP 320/8	10	1,0	4,0	50	114	14.300	16,63
ERP 320/10	10	1,0	5,0	50	143	17.900	20,80
ERP 320/12	10	1,0	6,0	50	172	21.500	25,00
ERP 385/7	10	1,0	3,5	50	100	12.500	14,53
ERP 385/8	10	1,0	4,0	50	114	14.300	16,63
ERP 385/10	10	1,0	5,0	50	143	17.900	20,81
ERP 385/12	10	1,0	6,0	50	172	21.500	25,00
ERP 385/14	10	1,0	7,0	50	200	25.000	29,10
ERP 416/8	10	1,0	4,0	50	114	14.300	16,63
ERP RET 6	10	1,0	3,0	50	86	10.700	12,44
ERP RET 8	10	1,0	4,0	50	114	14.300	16,63
ERP RET 10	10	1,0	5,0	50	143	17.900	20,81
ERP RET 12	10	1,0	6,0	50	172	21.500	25,00
ERP Q 7	10	1,0	3,5	50	100	12.500	14,53
ERP Q 10	10	1,0	5,0	50	143	17.900	20,81
ERP Q 12	10	1,0	6,0	50	172	21.500	25.00
ERP Q 14	10	1,0	7,0	50	200	25.000	29,10
ERP Q 16	10	1,0	8,0	50	228	28.500	33,14
ERP Q 18	10	1,0	9,0	50	258	32.200	37,44
ERP Q 20	10	1,0	10,0	50	286	35.800	41,63
ERP Q 24	10	1,0	12,0	50	343	42.900	49,88

1MPa = 10 bar

Max press.	3 bar
t max	90°C
t min	10°C

Sizing of an expansion tank with a fixed bladder

Technical data

The expansion tank's useful volume must be calculated according to a maximum working pressure (pe), corresponding to the safety valve's adjustment pressure, diminished by a quantity equal to the difference value between the expansion tank and the safety valve, if the latter is situated downwards, otherwise increased if the safety valve is located upwards.
The expansion tank's useful volume must correspond to the expansion volume (Ve), in practice the maximum change of the water volume which can occur in the plant is the following one:

$$V_e = C \times (u_2 - u_1) \quad \text{[litres]}$$

where:
u_2 = water specific volume at the maximum operative temperature litres/kg.
u_1 = water specific volume at the minimum operative temperature litres/kg.
C = plant's total capacity (boiler, pipes, charges, etc.) kg.

The Vt total volume of the closed expansion tank with a bladder is calculated according to the following formula:

$$V_t = \frac{V_e}{1 - \frac{P_p}{P_e}} \quad \text{[litres]}$$

In order to avoid calculating $1 - \frac{P_p}{P_e}$ the table 2 reporting the results of these calculations has Pe been drawn up.

where:
V_e= plant's expansion volume litres
P_p= precharge pressure of the expansion tank bar (absolute pressure)
P_e= plant's maximum working pressure or adjustment pressure of the safety valve bar (absolute pressure)

The precharge pressure must correspond to the hydrostatic pressure in the tank's installation place, whereas the difference between the cut in pressure of the safety valve (pv) and the working pressure (pe) is usually 10% of the cut in pressure.

A tolerance of 10% of the plant's total volume is allowed in the choice of the tank to be installed.

"water specific volume at different temperatures"

Table 1

T °C	υ litres/Kg	T °C	υ litres/Kg	T °C	υ litres/Kg	T °C	υ litres/Kg
- 10	1,00186	16	1,00103	36	1,00632	80	1,0290
- 5	1,00070	18	1,00138	38	1,00706	85	1,0324
0	1,00013	20	1,00177	40	1,0078	90	1,0359
2	1,00003	22	1,00221	45	1,0099	95	1,0396
4	1,00000	24	1,00268	50	1,0121	100	1,0434
6	1,00003	26	1,00320	55	1,0145	10	1,0515
8	1,00012	28	1,00375	60	1,0171	120	1,0600
10	1,00027	30	1,00435	65	1,0198	130	1,0795
12	1,00048	32	1,00497	70	1,0227	140	1,0795
14	1,00073	34	1,00563	75	1,0258	150	1,0903

Table 2 a

Max working pressure	precharge pressure (bar)								
	1	1,5	2	2,5	3	3,5	4	4,5	5
1,5	0,2								
2	0,333	0,167							
2,5	0,429	0,286	0,143						
3	0,5	0,375	0,25	0,125					
3,5	0,556	0,444	0,333	0,222	0,111				
4	0,6	0,5	0,400	0,3	0,2	0,1			
4,5	0,636	0,545	0,455	0,364	0,273	0,182	0,091		
5	0,667	0,583	0,5	0,417	0,333	0,25	0,167	0,083	
5,5	0,692	0,615	0,538	0,462	0,385	0,308	0,231	0,154	0,07
6	0,714	0,643	0,571	0,5	0,429	0,357	0,286	0,21	0,14
6,5	0,733	0,667	0,60	0,533	0,467	0,4	0,333	0,26	0,2
7	0,75	0,688	0,625	0,563	0,5	0,438	0,375	0,31	0,25
7,5	0,765	0,706	0,647	0,588	0,529	0,471	0,412	0,35	0,29
8	0,778	0,722	0,667	0,611	0,556	0,5	0,444	0,38	0,33
8,5	0,789	0,737	0,684	0,632	0,579	0,526	0,474	0,42	0,36
9	0,8	0,75	0,7	0,65	0,6	0,55	0,5	0,45	0,4
9,5	0,81	0,762	0,714	0,667	0,619	0,571	0,524	0,47	0,43
10	0,818	0,773	0,727	0,682	0,636	0,591	0,545	0,5	0,45

Table 2 b

Max working pressure	precharge pressure (bar)								
	5,5	6	6,5	7	7,5	8	8,5	9	9,5
6	0,07								
6,5	0,13	0,06							
7	0,18	0,12	0,06						
7,5	0,23	0,17	0,11	0,06					
8	0,28	0,22	0,16	0,11	0,06				
8,5	0,31	0,26	0,21	0,16	0,1	0,05			
9	0,35	0,3	0,25	0,21	0,15	0,1	0,05		
9,5	0,38	0,33	0,28	0,24	0,19	0,14	0,1	0,05	
10	0,41	0,36	0,32	0,27	0,23	0,18	0,14	0,09	0,045

"MCP" CONTROL UNIT

The MCP unit is equipped with an analogue microprocessor and it is endowed with a compressor, a liquid crystals display, some solenoid valves and some filters for the air outlet and inlet in the tank. The MC unit controls the system operation, by keeping under control the set minimum and maximum pressure data, the compressor and solenoid valves operation. There are four versions in order to satisfy the different types of the compressors' current and power supply.

- **MCP1 – with a compressor of 0.75 kW single-phase**
- **MCP3 – with a compressor of 1.8 kW three-phase**
- **MCP5 – with a compressor of 4 kW three-phase**
- **MCP7 – with a compressor of 7.5 kW three-phase**

The MCP1 unit is available with single-phase supply (110/220V 50/60 Hz); whereas the other models are endowed with a three-phase supply at 380 V.

COMPRESSORS – Technical data

The usually mounted compressors are provided, already inside the unit, with preliminary controls. Four models with powers from 0.75 to 7.5 kW are provided in order to satisfy the most installation requirements. In the event it is necessary to use a compressor with a higher working pressure or with a higher suction index, which is not provided in traditional models, consult the company for getting a suitable model to the plant's requirements.
On request, some versions with tropicalised motor are available.

Description of the system operation

PHASE 1

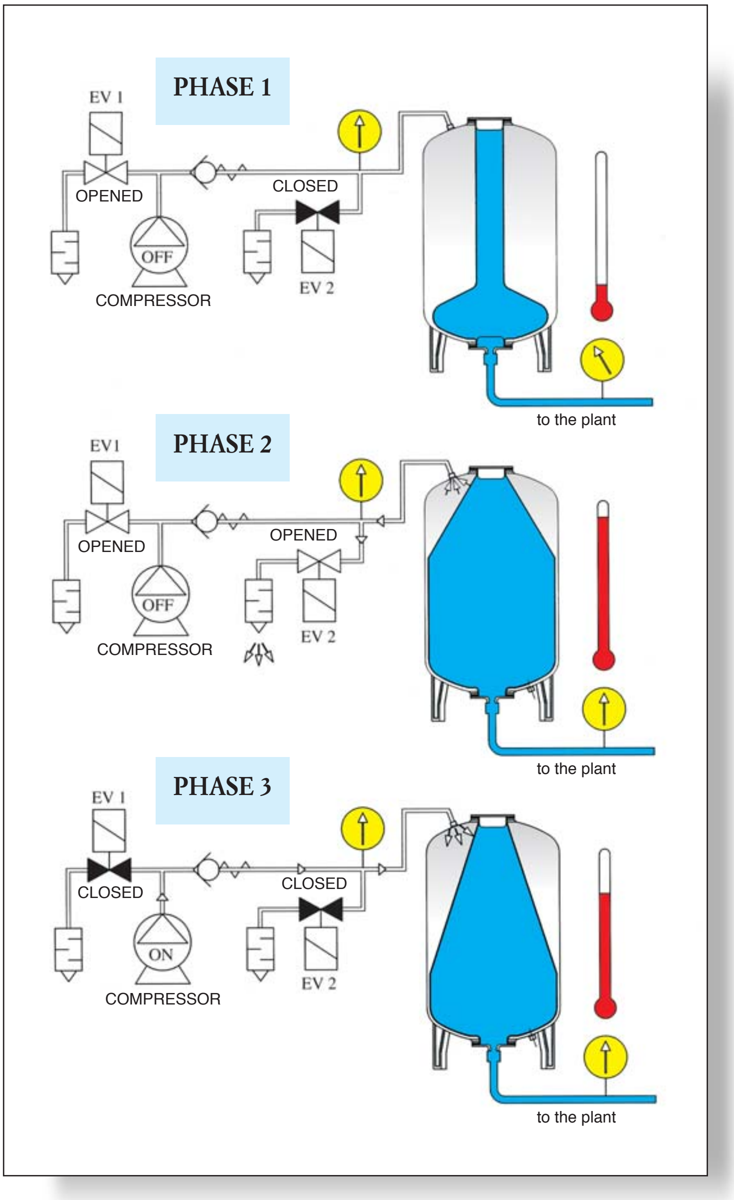
When the system is off, therefore with the water at ambient temperature, the boiler is switched off, the compressor is in the OFF position as well as the solenoid valves and EV-2, the plant is in the static phase as well as the pressure inside the expansion tank.

PHASE 2

The boiler becomes operative, the water volume inside the plant increases with the consequent pressure increase of the air cushion inside the expansion tank. When the maximum pressure reaches the set value, the EV-2 solenoid valve opens with the consequent air outlet through the SIL-1 silencer; the temperature reaches the designed maximum value and the boiler is switched off.

PHASE 3

The boiler is still off for the provided temperature difference, the plant slowly cools and therefore the water volume diminishes with the consequent pressure decrease of the air cushion inside the tank. When the pressure reaches the set minimum value, the compressor becomes operative by letting air in the tank until reaching the set maximum pressure. When the compressor is switched off, the solenoid valve opens by discharging the compressor's head (thus allowing a subsequent soft start without any efforts by the motor).



Sizing of an auto-pressurised expansion tank

Technical data

Tank's sizing

The sizing of the expansion tank is calculated only according to the total expansion volume of the water contained in the plant, increased by 20% in order to leave a margin of working and safety to the air cushion. The air cushion pressure is selected according to the static height (h), which corresponds to the difference expressed in meters between the highest point of the plant and the water inlet coupling in the expansion tank, plus a margin of 3 m for the deaeration.

Example

Plant's data				
Boiler's power	Qk	=	3200	kW
Static height	h	=	18	m
Delivery maximum temperature	TM	=	90	°C
Water inlet temperature	Ti	=	10	°C

If the water contents is 13L/KW, the water volume of the plant will be:
Vi = 3200 x 13 = 41600 L
From the table concerning the coefficients of the water expansion we will get:

Expansion % of the water at 90°C	n	=	3,59	%
Expansion % of the water at 10°C	n2	=	0,04	%

(Tab. 2)
The Ke coefficient of expansion will be:

$$Ke = \frac{3{,}59 - 0{,}04}{100}$$

Therefore, the total water expansion will be:
Ve = 41600 x 0,0355 = 1477 litri

Therefore, the tank's optimum capacity for the involved plant will be:
1,477 + 20% = 1,772 litres.
The model with a higher capacity, that is the ERL 2000 model, must be selected.
As 1 bar corresponds to 10 meters of the water column and the static height is 18 m, the water column's height will be 21 m (taking into consideration 3 meters for the deaeration), to which corresponds a pressure of 2.1 bars. According to the pressure – heat power diagram (fig.1), the CP-1 single-phase compressor corresponds to the 2.1 bar pressure and to the 3200 kW heat power. The suitable supply and control unit is MCP1.
Therefore, the system will be the following one: ERL-2000D coupled with a MCP1 unit.

Choice of the compressor – Calculation of the flow index

Introduction
The total water volume in a heating plant is proportional to the generator's heat power. In a modern heating system, there are on average 13 litres of water per 1000 Kcal/h.

(1) Vs = 13 L/1000 Kcal / h

Calculation of the TS expansion time
(2) Ts = Vs x W x C x Dt
where Vs = 13 L / 1000 Kcal / h
W = water volume at the designed maximum temperature Kg/L
C = specific heat Kcal/Kg x °C
Dt = temperature increase °C

Calculation of the VD water expansion volume relevant to the DT temperature increase
(3) Vd = Vi x K
where Vi = water volume in the plant
K = coefficient of the water expansion according to the DT temperature increase

Calculation of the If flow index
(4) If = Ve / Ts
where If = If – flow index in 1./min.

Calculation of the actual suction index of the compressor (CFM)
(5) CFM = If x Kr
where Kr = Kr = 1.1 is a coefficient under the worst suction conditions, at the suction temperature of 30°C and relative humidity of 100%.

Example for calculating the suction index
(valid for most plants)

plant's water volume	*Vi*	=	*28169 L*
minimum temperature	*Tm*	=	*80 °C*
maximum temperature	*TM*	=	*90 °C*
temperature increase	*Dt*	=	*10 °C*
water inlet temperature	*Ti*	=	*10 °C*
specific heat	*C*	=	*1 Kcal / Kg x °C*
water volume at 90°	*C W*	=	*0,965 Kg/L (tab.)*

$$Ts = \frac{13 \times 0{,}965 \times 1 \times 10 \times 60}{100}$$

Vd = Vi x K
from the table about the coefficients of expansion (table 2) we can get:
expansion % of the water at 90°C n = 3,59%
expansion % of the water at 80°C80°C n1 = 2,90%

$$K = \frac{(n - n1)}{100}$$

$$K = \frac{(3{,}59 - 2{,}90)}{100} = 0{,}0069$$

Vd = 28169 x 0,0069 = 194,36 L

$$If = \frac{194{,}36}{7{,}53} = 25{,}81 \text{ L / min.}$$

CFM = 25,81 x 1,1 = 28,39 = 28,4 L / min.

L'espansione totale dell'acqua nell'impianto è

Ve = 28169 x Ke

total water expansion at 90°C	*n*	=	*3,59%*
total water expansion at 10°C	*n2*	=	*0,04%*

$$Ke = \frac{(n - n2)}{100}$$

$$Ke = \frac{(3{,}59 - 0{,}04)}{100} = 0{,}0355$$

Ve = 28169 x 0,0355 = 1000 L

Therefore, it is possible to affirm that in the most plants it is necessary to use a compressor with a suction index of CFM = 28.4 L/min. per 1,000 L of expanded water at the atmospheric pressure.
In order to size correctly the compressor, it is necessary to compare the suction index with the designed pressure of the expansion tank, taking into consideration that the result "Pressure multiplied by Volume" is a constant value when the pressure is absolute. Therefore, if the pressure in the expansion tank must be kept at 2.5 Bars, remembering that the atmospheric pressure is about 1 Bar, we will get:

$$CFM = \frac{1 + 2{,}5}{1} \times 28{,}4 = 99{,}4 \text{ L / min.}$$

In that case, it is necessary to select a compressor with a CFM suction index which is higher than 99.4 L./min.
As for heating plants with current parameters that vary from 11 to 14 litres per kW, use the diagram reported below for selecting the type of compressor.
For pressures which are higher than 10 bars, consult the company.

TAB. 2

Coefficients of the water expansion expressed in % (with or without addition of anti-freeze glycol)						
Temperature °C	Only water	Anti-freeze 10%	Anti-freeze 20%	Anti-freeze 30%	Anti-freeze 40%	Anti-freeze 50%
10	0,04	0,32	0,64	0,96	1,28	1,60
15	0,11	0,43	0,75	1,07	1,39	1,71
20	0,18	0,50	0,82	1,14	1,46	1,78
25	0,31	0,63	0,95	1,27	1,59	1,91
30	0,44	0,76	1,08	1,40	1,72	2,04
35	0,62	0,94	1,26	1,58	1,90	2,22
40	0,79	1,11	1,43	1,75	2,07	2,39
45	1,00	1,32	1,64	1,96	2,28	2,60
50	1,21	1,53	1,85	2,17	2,49	2,81
55	1,46	1,78	2,10	2,42	2,74	3,06
60	1,71	2,03	2,35	2,67	2,99	3,31
65	2,01	2,33	2,65	2,97	3,29	3,61
70	2,28	2,60	2,92	3,24	3,56	3,88
75	2,59	2,91	3,23	3,55	3,87	4,19
80	2,90	3,22	3,54	3,86	4,18	4,50
85	3,21	3,53	3,85	4,17	4,49	4,81
90	3,59	3,91	4,23	4,55	4,87	5,19
95	3,96	4,29	4,61	4,93	5,25	5,57
100	4,35	4,67	4,99	5,31	5,63	5,95

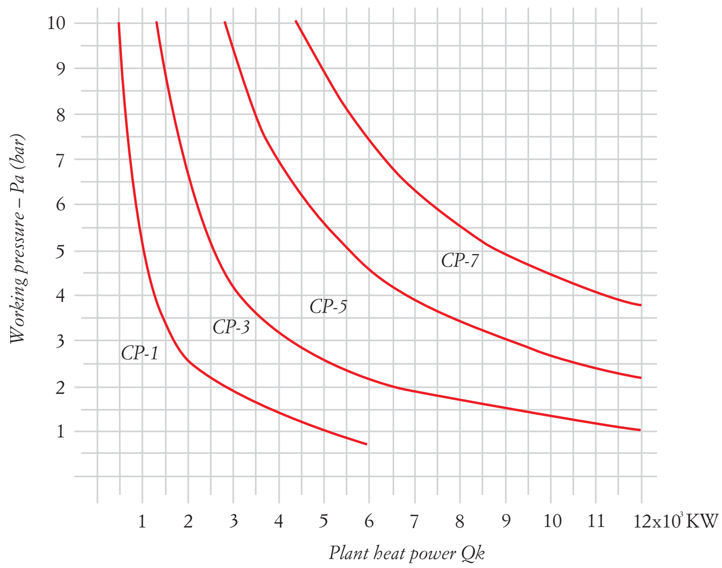
TAB. 3

Water volume	
Temperature °C	Density Kg/l.
10	0,99975
15	0,99915
20	0,99820
25	0,99711
30	0,99576
35	0,99421
40	0,99224
45	0,99025
50	0,98807
55	0,98573
60	0,98324
65	0,98059
70	0,98781
75	0,97849
80	0,97183
85	0,96865
90	0,96534
95	0,96192
100	0,95838

TAB. 4 TYPE OF TANK ACCORDING TO THE PLANT'S WATER VOLUME (m^3) AND THE MAXIMUM WORKING TEMPERATURE (°C)

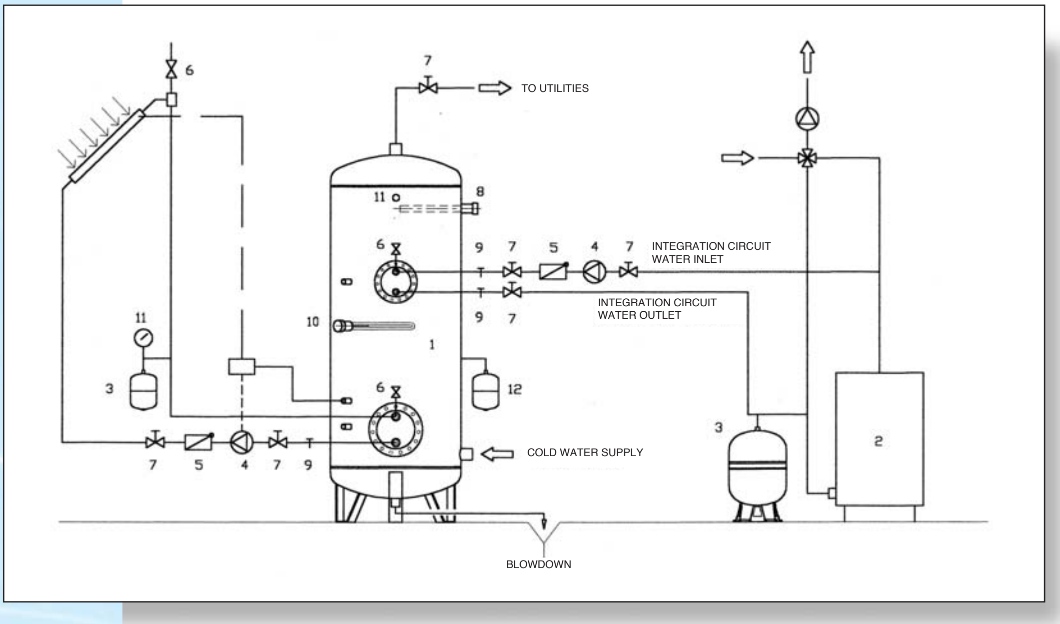
ERL type	Volume m^3 70°C	Volume m^3 80°C	Volume m^3 90°C	Volume m^3 100°C	Expansion (litres)
300	11	9	7	6	250
500	19	15	12	10	430
750	28	22	18	15	640
1000	38	30	24	20	850
2000	76	59	48	39	1.700
3000	114	89	72	59	2.550
5000	190	149	118	99	4.250

Diagram used for selecting the type of compressor



Some examples of installation

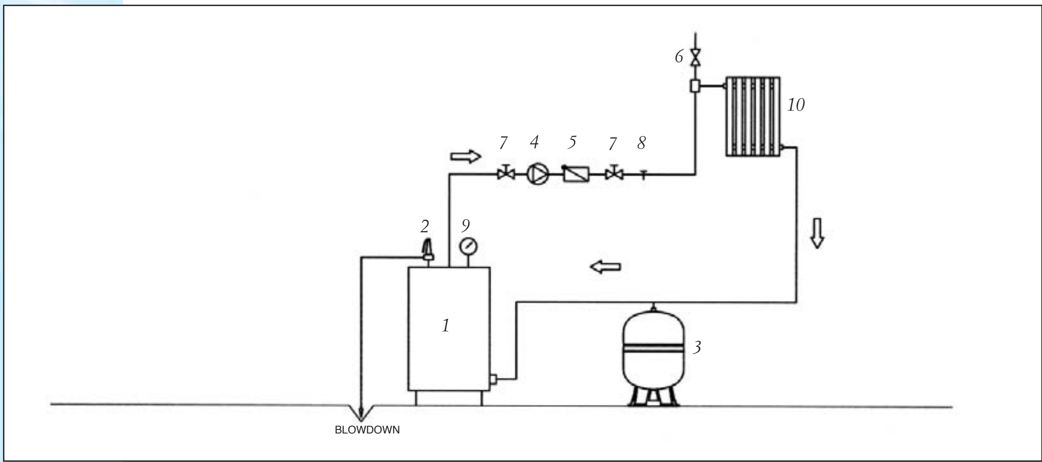
Traditional installation with solar integration



LEGEND

1-ELBI water heater
2-Boiler
3-D expansion tank
4-Circulation pump
5-Clapet check valve
6-Air valve
7-Gate valve
8-Magnesium anode
9-Thermometer
10-Resistor
11-Pressure gauge
12-D expansion tank

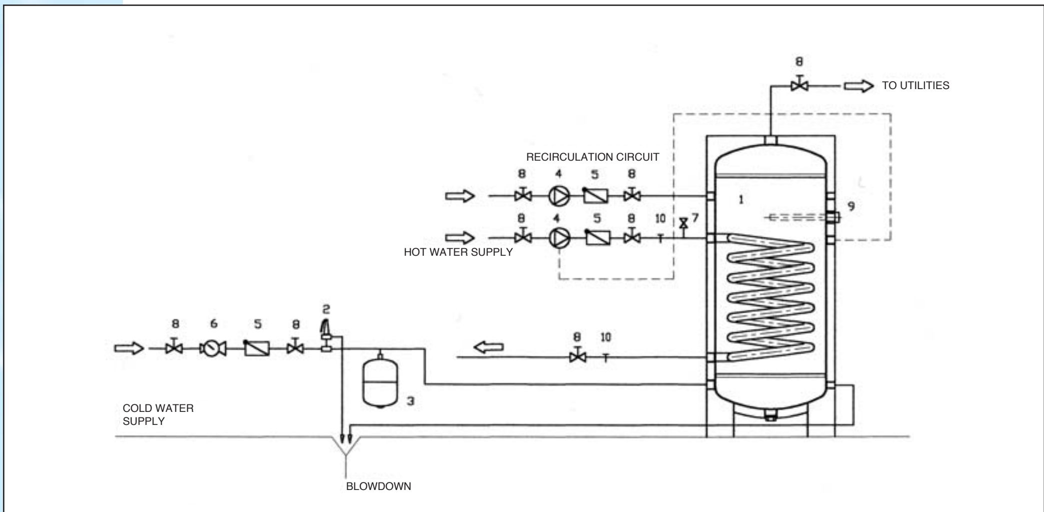
ERE installation



LEGEND

1-Boiler
2-Safety valve
3-ERE expansion tank
4-Circulation pump
5-Clapet check valve
6-Air valve
7-Gate valve
8-Thermometer
9-Pressure gauge
10-Radiator

D installation

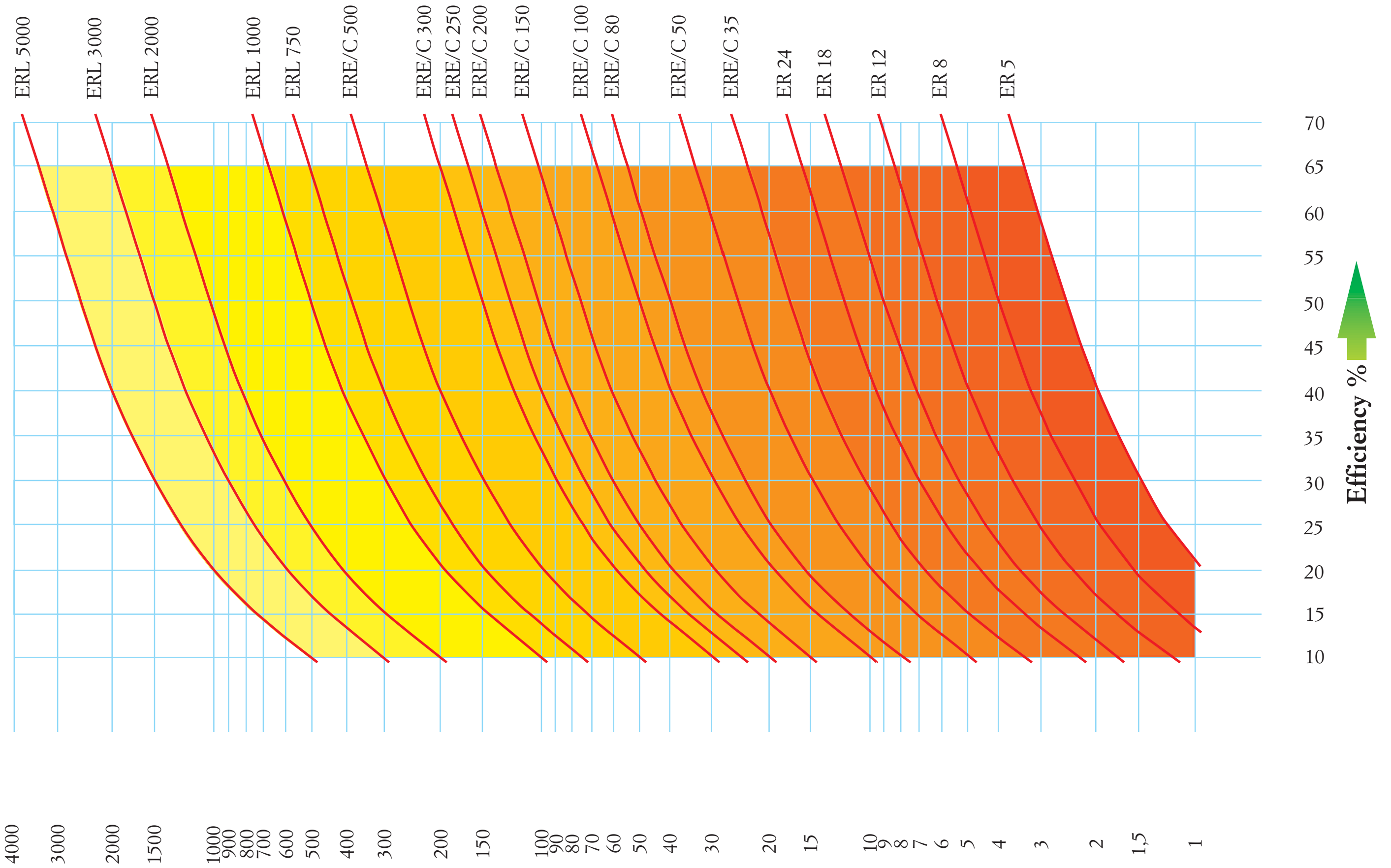


LEGEND

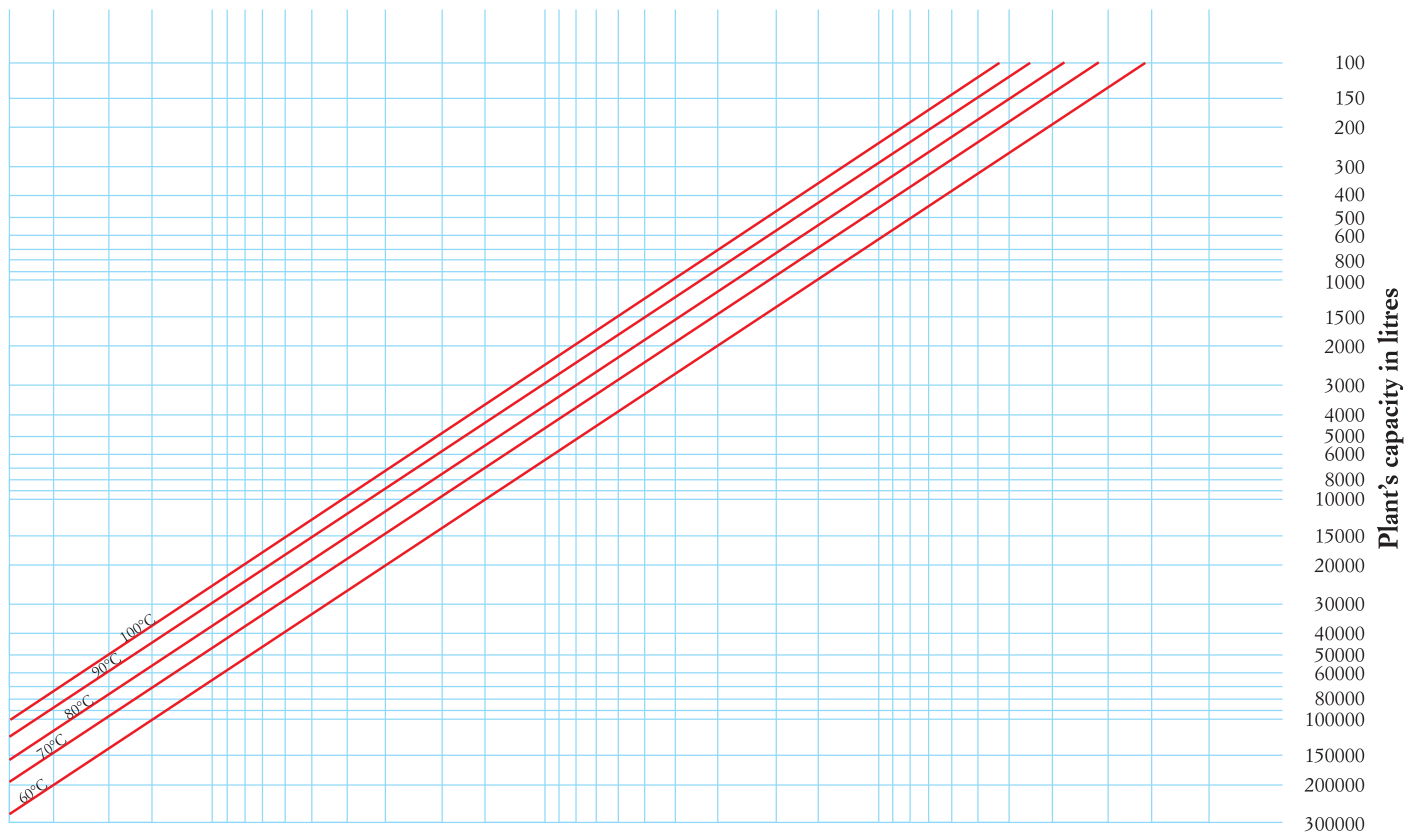
1-ELBI water heater
2-Safety valve
3-D expansion tank
4-Circulation pump
5-Clapet check valve
6-Pressure reducer
7-Air valve
8-Gate valve
9-Magnesium anode
10-Thermometer

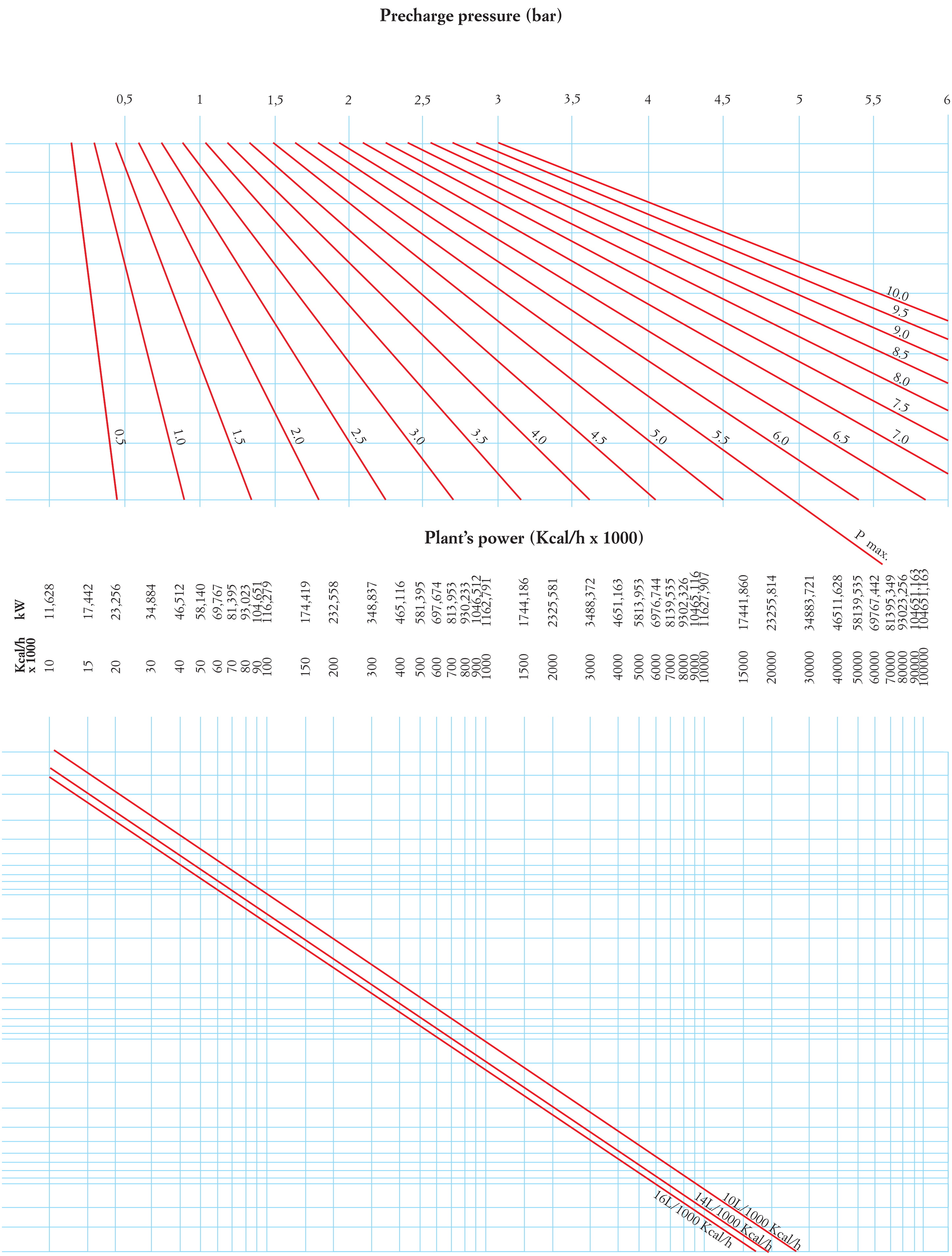
Universal diagram used for selecting the tank

ELBI expansion tanks



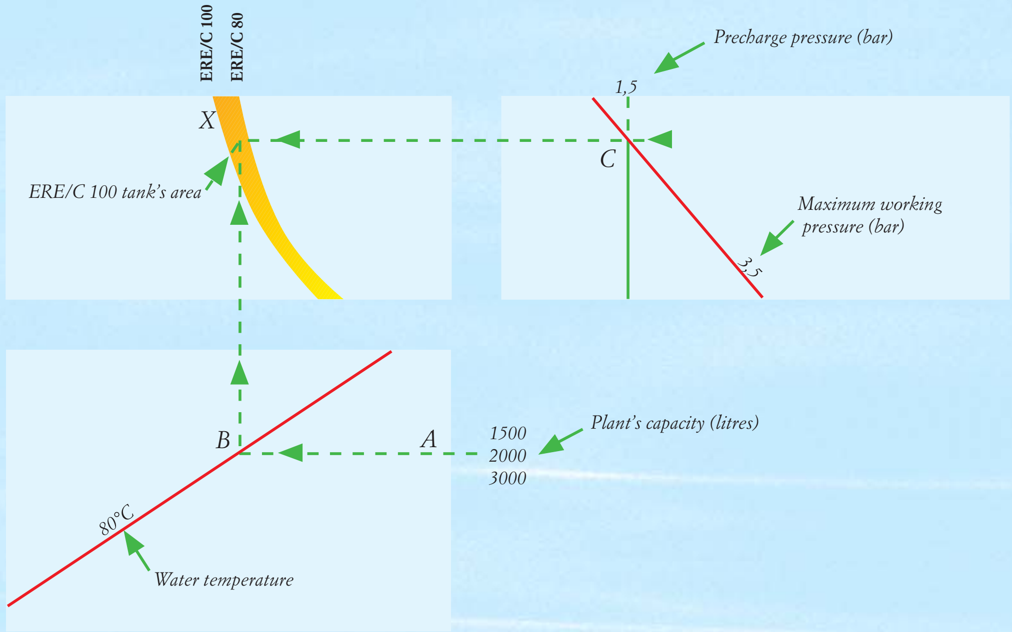
Expansion volume expressed in litres





16L/1000 KCal/h: Plant equipped with radiators
14L/1000 KCal/h: plant equipped with convectors (or radiating panels with steel pipes)
10L/1000 Kcal/h: plant equipped with radiating panels and copper pipes

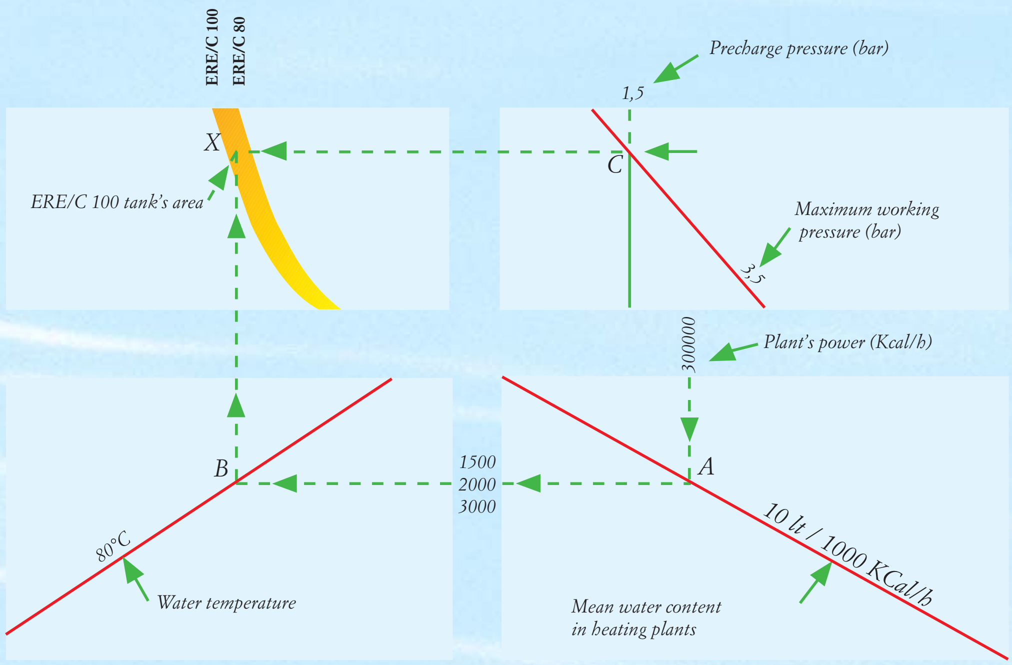
How to use the universal diagram



Determination of the expansion tank according to the plant's water content

The initial data used to determine the expansion tank's capacity are the following ones, namely:
- *plant's static pressure or precharge pressure (absolute pressure);*
- *maximum working pressure of the plant (absolute pressure);*
- *water mean temperature;*
- *plant's capacity.*

As you know already the plant's capacity, draw a horizontal line until intersecting the water mean temperature line "A-B".
From the point "B", draw a vertical line up to the above graph.
Since you know already the precharge pressure and the plant's maximum pressure, it is necessary to find the intersection point of the two right lines "C" and, starting from this one, draw a horizontal line until reaching the graph on the side.
In the intersection point of these two right lines "X" you find the expansion tank necessary for the plant.



Determination of the expansion tank according to the plant's power

The initial data used to determine the expansion tank's capacity are the following ones, namely:
- *plant's static pressure or precharge pressure (absolute pressure);*
- *maximum working pressure of the plant (absolute pressure);*
- *water mean temperature;*
- *plant's power.*

Since you know already the power, draw a vertical line until intersecting the right line relevant to the mean water content of the plant "A". Starting from the point "A", draw a horizontal line until intersecting the water mean temperature line "A-B". From the point "B", draw a vertical line up to the above graph.
Since you know already the precharge pressure and the plant's maximum pressure, it is necessary to find the intersection point of the two right lines "C" and, starting from this one, draw a horizontal line until reaching the graph on the side.
In the intersection point of these two right lines "X" you find the expansion tank necessary for the plant.

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Elbi S.p.A. *via Buccia, 9 - 35010 Limena (Padova) tel. 049 88 40 677 - fax 049 88 41 610*
Internet http:\\www.elbi.it • e-mail: vendite@elbi.it