

HANDBOOK
REGULATOR VALVES

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 **Castel**[®]
Italian technology

CHAPTER 4

EVAPORATING PRESSURE REGULATORS

FOR REFRIGERATION PLANTS THAT USE THE R744 REFRIGERANT



APPLICATIONS

Evaporating pressure regulators are an accessory designed to maintain a constant evaporating pressure and thereby a constant surface temperature on the evaporator under varying evaporator loads. This valve prevents too low evaporating pressure and therefore protects against freezing in water chiller or against coil icing in air evaporators. These regulators allow multiple evaporators to operate at different temperatures in a system with only one compressor.

The evaporating pressure regulators illustrated in this chapter have been developed by Castel for all applications that use subcritical R744 refrigeration fluid belonging to Group 2, defined in Article 13, Chapter 1, Point (b) of Directive 2014/68/EU, with reference to EC Regulation No. 1272/2008.

CAUTION!: the evaporating pressure regulators in this chapter cannot be used with other refrigerant fluids.

OPERATION

Evaporating pressure regulators adjust the flow of hot gas according to changes of suction pressure, upstream the regulator. When the evaporating pressure is less than the regulator calibration pressure, the shutter remains closed. As the suction pressure rises above the regulator's calibration setting, the shutter begins to open and modulates in proportion to the variation in evaporating pressure. As the evaporating pressure continues to rise, the shutter continues to open, until the stroke limit is reached and the

regulator is open completely. When the shutter is fully open, a further increase in the valve capacity can be obtained only by increasing the load loss across the valve.

Evaporating pressure regulators only modulate based on the inlet pressure change, pressure changes on the outlet side do not affect their opening as the valve is equipped with an equalizer bellow with an area equal to that of the valve seat

The factory pressure settings for regulators in series 3335EL is 12 bar. This means that until the condensation (discharge) pressure is below 12 bar, the regulator remains closed. When it rises above 12 bar, the regulator begins to open. According to the characteristics of the refrigerating system it may be necessary to change the factory setting by adjusting the adjustment ring on the top of the regulator body. Turn this ring clockwise to increase the regulator's calibration pressure; turn it counter-clockwise to decrease the calibration pressure. Each turn of the ring corresponds to an increase/decrease of 2.5 bar in calibration pressure. The calibration range varies from 12 to 36 bar.

CONSTRUCTION

The main parts of the evaporating pressure regulators are made with the following materials:

- Hot forged brass EN 12420 – CW 617N for the body
- Copper pipe EN 12735-1 – Cu--DHP for solder connections
- Austenitic stainless steel AISI 321 for the bellows
- Austenitic stainless steel AISI 303 for the shutter
- Brass bar EN 12164 – CW 614N for regulator ring
- Spring steel DIN 17223/84 Class C/D for setting spring
- Ethylene propylene rubber (EPDM) for outlet seal gaskets

INSTALLATION

Evaporating pressure regulators in series 3335EL are installed in the suction line between the evaporator and the compressor.

Refrigerating system with one compressor serving two or more evaporators in parallel, where the same evaporating temperature is required. In this case the evaporating pressure regulator is installed on the common suction line. Refrigerating system with one compressor serving two or more evaporators in parallel, where different evaporating temperature are required. In this case the evaporating pressure regulator is installed downstream the evaporator with the highest temperature. Downstream of the evaporators with lower temperatures, it is necessary to install a check valve to avoid refrigerant condensing during compressor stops.

SELECTION

To correctly select evaporating pressure regulators, all information on the system where it will be installed must be available. Selection is based on the following data:

1. Type of refrigerant = R744

2. Designed evaporator capacity.

3. Designed evaporating temperature.

4. Minimum evaporating temperature. This data identifies the valve calibration pressure.

5. Allowable pressure drop across the valves at design load condition.

6. Liquid temperature

The refrigerating capacities indicated in Table 23A are based on:

- A liquid reference temperature of -6.7 °C.
 - An allowable variation in evaporating pressure of 1.12 bar.
- With liquid temperatures other than -6.7 °C and for variations in evaporating pressure other than 1.12 bar, the required cooling capacity of regulator is:

$$\frac{Q_{\text{evap}}}{K_{T \text{ liquid}} \times K_{\Delta P \text{ evap}}} = Q_{\text{valve}}$$

where:

Q_{evap} = Evaporator capacity [kW]

$K_{T \text{ liquid}}$ = Correction factor for $T_{\text{liquid}} \neq -6.7 \text{ °C}$.

$K_{\Delta P \text{ evap}}$ = Correction factor for $\Delta P_{\text{valve}} \neq 1.12 \text{ bar}$.

Q_{valve} = Refrigerating capacity requested at regulator. [kW]

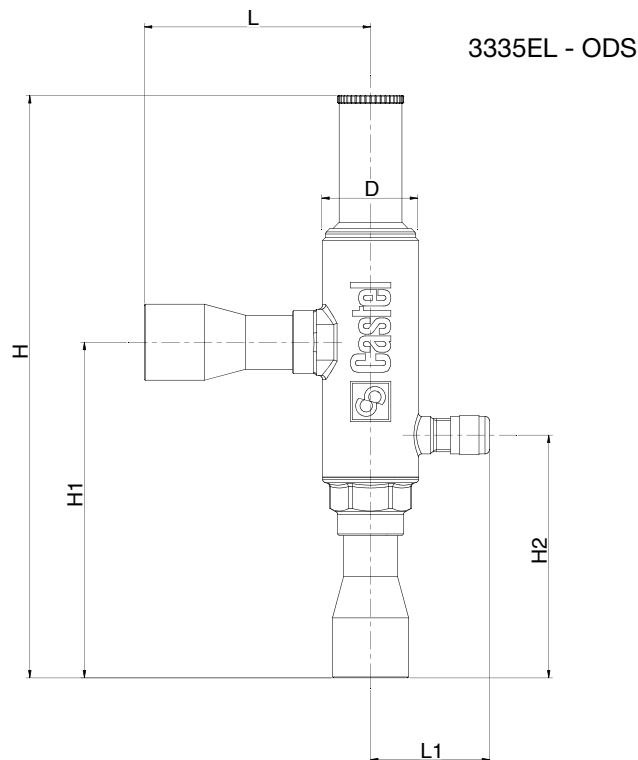


TABLE 21: General characteristics of evaporator pressure regulators for R744

Catalogue Number	Connections			Kv Factor [m³/h]	Regulating range [bar]		Factory setting [bar]	PS [bar]	TS [°C]		TA [°C]		Risk Category according to PED Recast
	SAE Flare	ODS			min.	max.			min.	max.	min.	max.	
		Ø [in.]	Ø [mm]										
3335EL/M12S	–	–	12	2,7	12	36	12	45	-40	+120	-40	+50	Art. 4.3
3335EL/4S	–	1/2"	–										
3335EL/5S	–	5/8"	16										
3335EL/7S	–	7/8"	22										

TABLE 22. Dimensions and weights of evaporator pressure regulators for R744

Catalogue Number	Dimensions [mm]								Weight [g]
	H	H ₁	H ₂	L	L ₁	D	Ch1	Ch2	
3335EL/M12S	183	100,5	69,5	64	37	32	-	-	510
3335EL/4S	183	100,5	69,5	64					480
3335EL/5S	183	100,5	69,5	64					500
3335EL/7S	194	112	81	75,5					560

TABLE 23A : Refrigerant Flow Capacity of evaporator pressure regulators 3335EL [kW]

Catalogue Number	Pressure drop across regulator [bar]	Design evaporator temperature [°C]									
		5	0	-5	-10	-15	-20	-25	-30	-35	-40
3335/4S 3335/M12S	0,07	3,85	3,50	3,14	2,79	2,46	2,12	1,94	1,76	1,58	1,40
	0,14	7,81	7,06	6,30	5,55	4,89	4,22	3,86	3,50	3,14	2,77
	0,21	12,80	11,52	10,24	8,97	7,81	6,65	6,00	5,36	4,72	4,08
	0,35	19,39	17,41	15,43	13,45	11,62	9,79	8,77	7,75	6,73	5,70
	0,42	26,64	23,70	20,75	17,80	15,12	12,43	10,97	9,51	8,05	6,59
	0,56	39,96	35,28	30,61	25,93	21,71	17,49	15,24	12,99	10,74	8,49
	0,81	49,24	43,34	37,44	31,53	26,23	20,93	18,13	15,32	12,52	9,71
	1,12	59,53	52,28	45,02	37,77	31,28	24,78	21,36	17,94	14,53	11,11
3335/5S	0,07	4,84	4,40	3,96	3,51	3,07	2,63	2,45	2,27	2,09	1,91
	0,14	9,90	8,98	8,06	7,14	6,25	5,36	4,99	4,61	4,24	3,86
	0,21	14,93	13,54	12,15	10,76	9,39	8,03	7,46	6,90	6,33	5,76
	0,35	20,80	18,86	16,92	14,98	13,06	11,14	10,35	9,55	8,76	7,97
	0,42	27,64	25,03	22,42	19,81	17,22	14,63	13,56	12,49	11,42	10,35
	0,56	37,34	33,78	30,22	26,66	23,13	19,59	18,13	16,67	15,20	13,74
	0,81	43,70	39,53	35,35	31,18	27,04	22,89	21,18	19,46	17,75	16,03
	1,12	51,10	46,22	41,33	36,44	31,57	26,71	24,70	22,69	20,67	18,66
3335/7S	0,07	5,37	4,87	4,38	3,89	3,42	2,96	2,71	2,46	2,20	1,95
	0,14	11,12	10,05	8,97	7,90	6,96	6,01	5,50	4,98	4,47	3,95
	0,21	18,17	16,35	14,54	12,73	11,08	9,43	8,52	7,61	6,70	5,79
	0,35	27,29	24,50	21,72	18,93	16,36	13,78	12,34	10,91	9,47	8,03
	0,42	36,74	32,67	28,61	24,55	20,84	17,14	15,13	13,12	11,11	9,09
	0,56	55,11	48,66	42,20	35,75	29,93	24,12	21,01	17,91	14,81	11,71
	0,81	64,39	56,82	49,24	41,66	34,82	27,97	24,32	20,67	17,01	13,36
	1,12	76,42	67,32	58,23	49,13	40,92	32,71	28,34	23,98	19,61	15,24

Standard rating conditions according to AHRI Standard 770-2014

Condensing temperature	30°F	-1,2°C	Suction temperature	-5°F	-15°C
Liquid temperature	20°F	-6,7°C	Superheating	15°R	8,4°K
Subcooling	10° R	5,5°K	Discharge temperature	80°F	26,6°C
Evaporating temperature	-20°F	-28,9°C			

Nominal evaporator pressure change ($T_{\text{design evap}} - T_{\text{min evap}}$) : 16 psi (1,12 bar)

TABLE 23B : Correction factor for liquid temperature different from nominal value

Liquid temperature [°C]								
-25	-20	-15	-10	-5	0	5	10	15
1,21	1,15	1,1	1,04	0,98	0,92	0,86	0,8	0,73

TABLE 23C : Correction factor for evaporator pressure change different from nominal value

Evaporator pressure change [bar]								
0,35	0,42	0,56	0,81	1,12	1,39	1,67	1,84	2,05
0,35	0,48	0,72	0,84	1	1,2	1,3	1,4	1,5

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