HANDBOOK

OIL CONTROL SYSTEMS

Castel®
Italian technology

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INDEX

THE NATURAL DEVELOPMENT OF QUALITY

Having achieved the goal of fifty-five years working in the Refrigeration and Air Conditioning Industry, Castel's range of quality products is well known and highly appreciated around the world. Quality is the product of our Company philosophy and marks every step of the production cycle. It is certified by the company's Quality Management System (certified by TUV SUD in accordance with the UNI EN ISO 9001:2008 standard), as well as by the various product certifications of compliance with European Directives and European and extra-European Quality Marks.

Product quality is connected with the quality of manufacturing. We produce on high-tech machinery and updated automatic production lines, operating in compliance with the current safety and environmental protection standards.

Castel offers the Refrigeration and Air Conditioning Market and Manufacturers tested certified products suitable for use with the HCF and HFO refrigerants currently used in the Refrigeration & Air Conditioning Industry.

Based on the experience gained in the refrigeration field using fluorinated fluids, Castel is proud to present the Refrigeration and Air Conditioning Market and Manufacturers two complete lines of products developed and proven for use in systems using natural refrigerants: hydrocarbons (HC fluids) and carbon dioxide (R744).

DIRECTIVE 2014/68/EU ISSUED OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL OF 15 MAY 2014 ON PRESSURE EQUIPMENT

Directive 2014/68/EU (PED Recast) applies to the design, manufacture and evaluation of compliance of pressure equipment and assemblies with a maximum allowable pressure, PS, greater than 0.5 bar excluding the cases listed in Article 1, Paragraph 2 of the Directive.
Directive 2014/68/EU was transposed into the Italian legal system by Legislative Decree No. 26 dated 15 February 2016, published in the Official Journal of the Republic of Italy No. 53 of 4 March 2016.
The revised PED Recast Directive repeals previous Directive 97/23/EC. More specifically:
• Article 13 of the PED Recast Directive, regarding the classification of pressure equipment, came into force as of 1 June 2015, and repeals Article 9 of the previous PED Directive.
• All other articles of the PED Recast Directive are in force as of 19 July 2016, repealing all articles of the previous PED directive.
All indicators and inspectionable mesh filters in series 4727E and 4728E illustrated in this technical handbook are considered "Pressure Accessories" according to the definition provided in Article 2, Point 5 of said Directive and are subject to the classification indicated in Article 4, Points 1.c) and 3 of the same Directive. The saddle indicators in series 3680, 3780, and 3781 are excluded from the scope of said Directive, as specified in the Guidelines 1/8 and 1/9, because they are piping components.
All other filters illustrated in this technical handbook are considered "Pressure Vessels" according to the definition provided in Article 2, Point 2 of said Directive and are subject to the classification indicated in Article 4, Points 1.a) and 3 of the same Directive.

EXTERNAL LEAKAGE

All the products illustrated in this Handbook individually undergo tightness tests as well as specific functional tests. The allowable external leakage, measurable during the test, complies with the requirements of standards:
• EN 12178:2003 – Refrigerating systems and heat pumps Liquid-level indicators - Requirements, testing and marking
• EN 12284:2003 – Refrigerating systems and heat pumps Valves - Requirements, testing and marking
• EN 14276-1:2011 – Pressure equipment for refrigerating systems and heat pumps.
Part 1: Vessels - General requirements
• EN 16084:2011 – Refrigerating systems and heat pumps Qualification of tightness of components and joints

PRESSURE CONTAINMENT

All the products illustrated in this Handbook, if submitted to hydrostatic testing, guarantee a pressure strength at least equal to 1.43 x PS in compliance with Directive 2014/68/EU.
All the products illustrated in this Handbook, if submitted to burst test, guarantee a pressure strength at least equal to 3 x PS according to EN 378-2:2016 Standard.

WEIGHT

The weights of the items listed in this Handbook include packaging and are not binding.

WARRANTY

All Castel products are covered by a 12-month warranty. This warranty covers all products or parts thereof that turn out to be defective within the warranty period. In this case, at his own expenses, the customer shall return the defective item with a detailed description of the claimed defects. The warranty does not apply if the defect of the Castel product is due to mistakes by the customer or by third parties, such as incorrect installation, use contrary to Castel instructions, or tampering. In the event of defects found in its products, Castel will only replace the defective goods and will not refund damages of any kind. Castel reserves the right to make changes or modifications to its products at any time without prior notice.
The products listed in this handbook are protected according to law.

OIL CONTROL SYSTEMS

A proper oil control system is essential to ensuring compressor lubrication and energy efficient cooling. If selected and installed correctly, an oil control system protects the compressors from both low and high oil levels and avoids expensive replacements of compressors due to poor lubrication. Excessive oil in a refrigerating system can lead to oil slugging to the compressor. This can damage a compressor in the same manner as liquid refrigerant slugging.
Removing or reducing the amount of oil that enters the discharge line increases the yield of the refrigeration plant. Large quantities of oil in a refrigeration or air conditioning system reduce the efficiency of the system due as:

- Oil coating on the condenser and evaporator walls reduces the heat transfer
- The slugged oil volume displaces refrigerant fluid volume in the system mass flow but oil has no refrigerating power and does not contribute to the system yield.

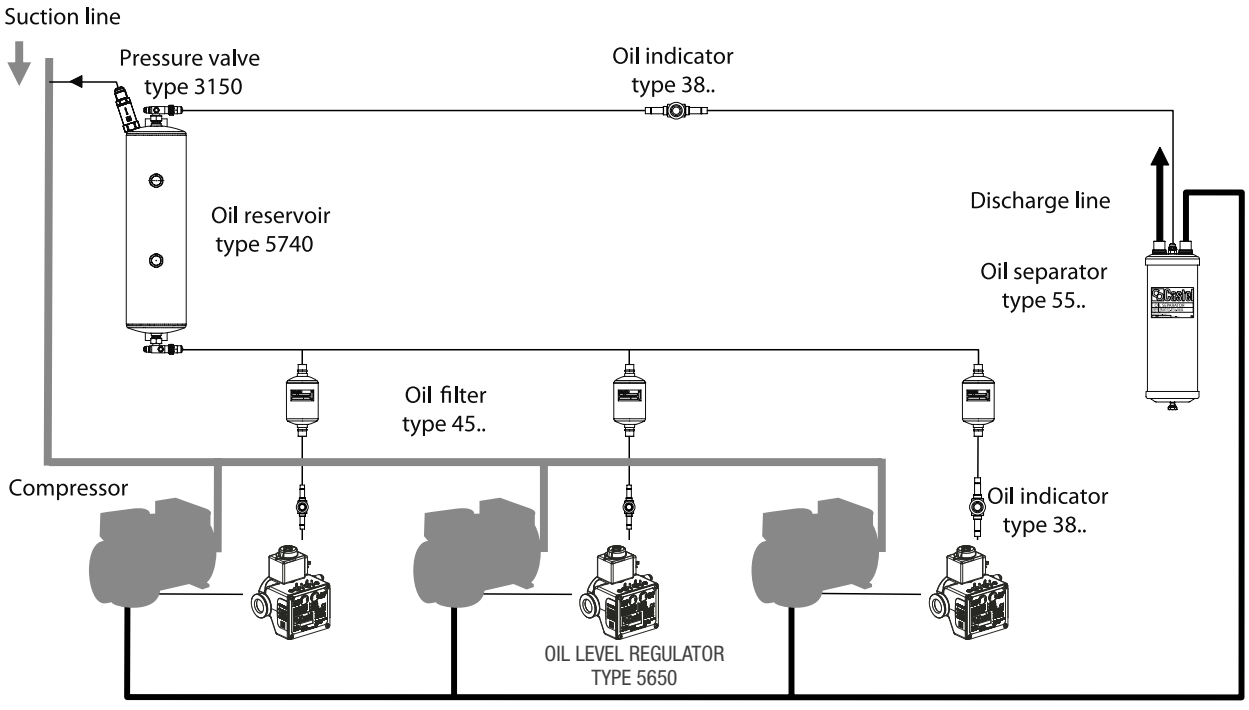
The products shown in this handbook can be used in two control systems:

- Single compressor system
- Low pressure oil control system

The single compressor system has a simple oil control system. The compressor discharge is piped to the inlet of the oil separator and the outlet of the oil separator is piped to the condenser. Normally, a check valve is fitted between the oil separator and condenser. An oil return line is connected from the oil separator to the compressor crankcase, through an oil strainer. When the oil level in the separator increases, a float valve opens and feeds to the crankcase a small amount of oil at the discharge pressure. When the oil level in the separator falls, the float valve closes and prevents hot gas from by-passing to the crankcase.
It is recognized best practice to fit a liquid indicator between the separator and crankcase to check the correct operation of the separator and the oil feed to the crankcase.

The low-pressure oil control system is normally used for multi- compressor parallel systems. The common discharge header is piped to the inlet of the oil separator and the outlet of the oil separator is piped to the condenser. Normally, a check valve is fitted between the oil separator and condenser. An oil return line is connected from the oil separator to the top valve of the oil reservoir. A vent line connects the suction line to the oil reservoir, using a calibrated pressure relief valve to reduce the pressure in the reservoir. This calibrated pressure relief valve, mounted on the top header of the reservoir, keeps the reservoir at a set pressure above the suction line. The bottom valve of oil reservoir is piped to the electronic oil level regulators individually mounted on the compressor crankcases. Each oil level regulator is equipped with a strainer, assembled upstream from it, to remove any impurities from the oil.
These regulators open to feed oil as the oil level drops, and close as the oil level rises to the set level, controlling the oil level in the compressor crankcases.
It is recognized best practice to fit:

- A liquid indicator between separator and reservoir to check the correct operation of the separator
- a liquid indicator before each level regulator to check the oil feed to the regulator



CHAPTER 1
OIL SEPARATORS
FOR REFRIGERATION PLANTS THAT USE HCFC, HFC OR HFO REFRIGERANTS

APPLICATIONS

The oil separators illustrated in this chapter are designed for installation on commercial refrigeration systems and on civil and industrial air conditioning plants that use the following refrigerant fluids:

- HCFC (R22)
- HFC (R134a, R404A, R407C, R410A, or R507)

belonging to Group 2, as defined in Article 13, Chapter 1, Point (b) of Directive 2014/68/EU, with reference to EC Regulation No. 1272/2008.

For specific applications with refrigerant fluids not listed above, please contact Castel Technical Department.

The advantages of the oil separator on the discharge line of a compressor in a refrigeration system are confirmed by many years of experience. The oil separator intercepts the oil mixed with compressed gas and returns it to the oil reservoir or to the compressor crankcase, ensuring efficient lubrication of its moving parts. Furthermore, by eliminating or reducing the oil film on the condenser and evaporator heat exchange surfaces, it maintains a high heat exchange coefficient in this equipment. When a very high temperature at the end of the compression stage leads to the formation of oil vapours, a separator with a capacity exceeding the values shown in the table should be used. Moreover, the oil separator, damping the pulsing from the valves, reduces the system noise in open or semi-hermetic compressors.

Finally, the use of an oil separator leads to:

- Longer compressor life;
- Better performance of the whole system with consequent energy savings;
- Quieter operation by reducing pulsing.

Tables 1 and 3 show the data relating to the operating conditions of oil separators.

CONSTRUCTION

Castel manufactures two types of oil separators:

- Separators in series 5520 can be inspected for maintenance and can be removed from the system. They are equipped with threaded connections, which can mate to the connections type 5590 (to be ordered separately)
- Separators in series 5540 are hermetically closed and cannot be disassembled from the system, except by cutting the piping.

The separator body is composed by a steel pipe of adequate thickness. The flanges and cover are also made of steel. Both the threaded connections of separators in series 5520 or the solder connections of separators in series 5540 are machined from steel bar EN 10277-3 11S Mn Pb 37 + C. The internal device is simple to ensure a trouble-free long-term operation.

Appropriate metal screens, placed on the inlet and outlet, along with the rapid reduction in gas speed create ideal conditions for separating the oil from the refrigerant.

A float mechanism, located on the bottom of the vessel, returns the oil to the compressor.

The bottom of the separator also includes a chamber for collecting any iron debris. A permanent magnet holds these impurities to avoid they clog or damage the operation of the float-controlled needle.

HOW TO CHOOSE AN OIL SEPARATOR

An oil separator must be sized based on the characteristics of the compressor installed, once the following have been defined:

- Inlet connection corresponding to the discharge diameter of the compressor
- Refrigerant fluid power for the established operating conditions (discharge saturation temperature, suction saturation temperature, any liquid subcooling, overheating of suction vapour).

This is necessary to define, for an end compression temperature assigned, the gas speed in reference to the gross section of the oil separator. It is advisable that the above-mentioned speed does not exceed 0.4 m/s, to avoid excessive turbulence.

Generally, once the refrigerating potential of the compressor has been assigned, based on the type of refrigerant and operating conditions, the volumetric flow rate, Q, of the compressed gas, is given by:

$$Q = \frac{P}{\Delta H} \times v_g \quad [m^3/s]$$

where:
- P = refrigerant potential [kW]
- ΔH = enthalpy of superheated vapour, taken from the cycle diagram (fig. 1). [kJ/kg]
- v_g = specific volume of the compressed gas at the separator inlet (Fig. 1). [m^3/kg]

Checking the gas speed, with reference to the cross section of oil separator, the following is obtained:

$$v = Q/S \quad [m/s]$$

with:
- S = gross section of separator body [m^2]

INSTALLATION

The oil separators 5520 and 5540 should be installed on the discharge line between the compressor and the condenser, mounted exclusively in a vertical position and as close to the compressor as possible.
To prevent the return of the refrigerant liquid from condenser to the oil separator, it's advisable to install a check valve between the condenser and oil separator during a shut-down period.
The oil separator performs best when operating at or near the compressor discharge temperature. If possible, avoid installation in locations that could cause the body of the separator to be cooled, causing condensation of the refrigerant. If this is not possible, it is advisable to equip the separator with appropriate solutions (insulation, strap heater, or other) to prevent the refrigerant in the system from condensing.
Before the oil separator is installed, be it a 5520 or a 5540, add the amount of lubricant specified in the table as an initial oil charge. It is very important to carry out this oil pre-charge correctly for a good operation of the separator and to avoid damaging the float mechanism. Always use the same type of lubricant that is in the compressor crankcase.
Based on the layout of refrigerating system, connect the oil return line to one of the following positions:
- Directly to the compressor crankcase
- To the suction line upstream of the compressor or upstream of the receiver, if present
- To the oil reservoir if the system has a centralised oil control system and an oil distribution system to compressors

It is recommended that a liquid indicator be installed in the oil return line, in order to check the correct working of the oil separator.

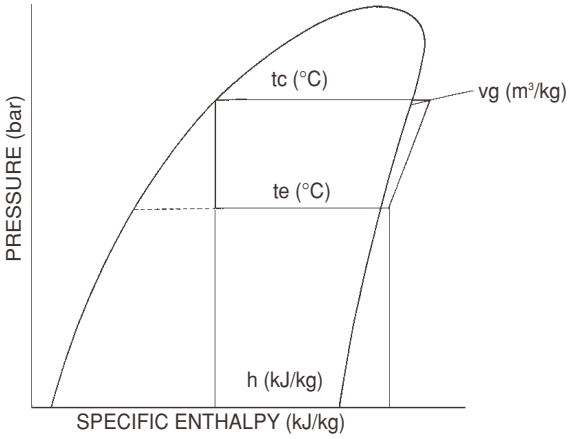


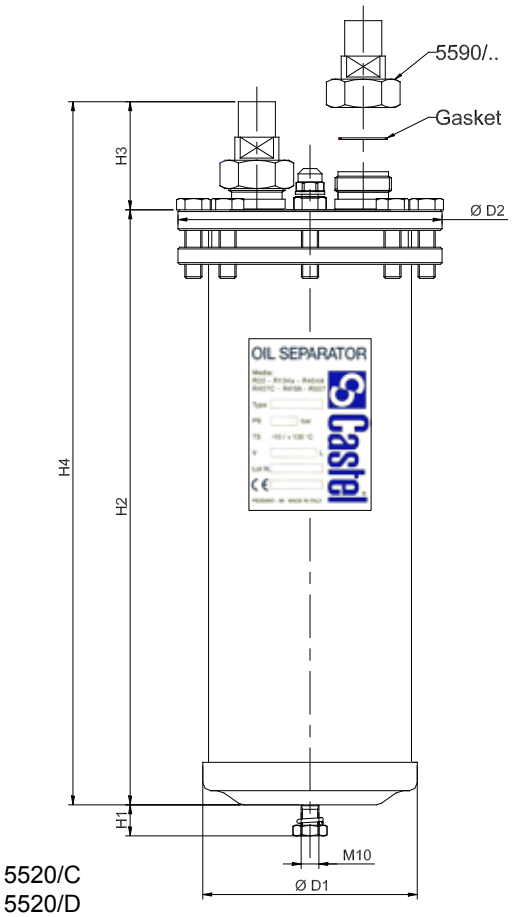
Fig. 1

TABLE 1: General characteristics of oil separators

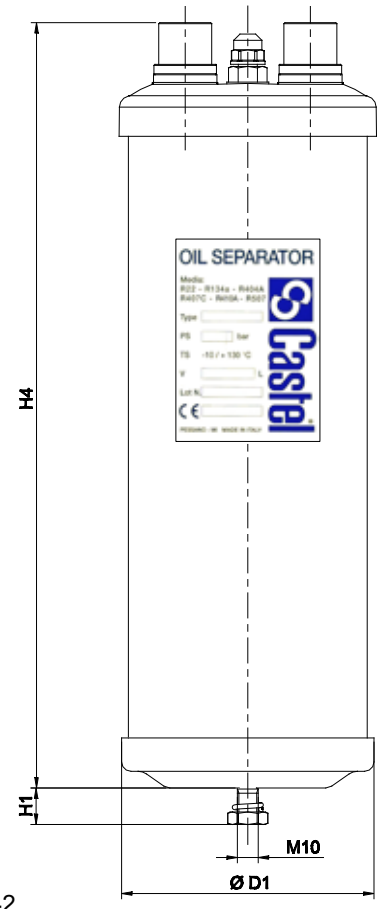
Catalogue Number	Solder Connections				Couple of solder connections IN / OUT			Oil connection [SAE Flare]	Oil addition [kg]	Max. differential pressure [bar]	PS [bar]	TS [°C]		TA [°C]		Volume [l]	Risk Category according to PED Recast
	ODS		ODM		Catalogue Number	ODS (1)						min.	max.	min.	max.		
	Ø [in.]	Ø [mm]	Ø [in.]	Ø [mm]		Ø [in.]	Ø [mm]										
5540/4	1/2"	–	5/8"	16	–	–	–	1/4"	0,4 / 0,5	30	45	– 10	+130	– 20	+50	2,40	I
5540/5	5/8"	16	3/4"	–												3,03	
5540/7	7/8"	–	1"	–													
5540/9	1.1/8"	–	1.3/8"	35												3,52	
5540/11	1.3/8"	35	1.5/8"	–													
5540/13	1.5/8"	–	–	–				3/8"	0,6 / 0,7	21	32					7,00	II
5540/M42	–	42	–	–													
5540/17	2.1/8"	54	–	–													
5520/C	–				5590/5	5/8"	16	1/4"	0,4 / 0,5	30	45					2,95	I
					5590/7	7/8"	–										
5520/D	–				5590/9	1.1/8"	–									3,45	
					5590/11	1.3/8"	35										
5520/E	–				5590/13	1.5/8"	–									3,45	
					5590/M42	–	42										

(1) : The dimensions of the separator's connections must agree with the discharge diameter of the compressor

TABLE 2: Dimensions and weights of oil separators										
Catalogue Number		Solder Connections		Dimensions [mm]						Weight [g]
Separator	Connections	ODS		Ø D_1	Ø D_2	H_1	H_2	H_3	H_4	
		Ø [in.]	Ø [mm]							
5540/4	–	1/2"	–	123	–	17,5	–	–	280	4200
5540/5		5/8"	16						367	4960
5540/7		7/8"	–							5030
5540/9		1.1/8"	–						428	5835
5540/11		1.3/8"	35							5800
5540/13		1.5/8"	–	163,5					471	10000
5540/M42		–	42							
5540/17		2.1/8"	54						481	10460
5520/C	5590/5	5/8"	16	121	149		336	61	397	6980
	5590/7	7/8"	–							
5520/D	5590/9	1.1/8"	–				391	67	458	7760
	5590/11	1.3/8"	35							
5520/E	5590/13	1.5/8"	–					92	483	7680
	5590/M42	–	42							



5520/C
5520/D
5520/E



5540/4
5540/5
5540/7
5540/9
5540/11
5540/13
5540/4M42
5540/17

TABLE 3: Refrigerant flow capacity

Catalogue Number	Catalogue Number of solder connections	R134a					
		Condensing temperature [°C]					
		+40			+50		
		Evaporating temperature [°C]			Evaporating temperature [°C]		
		-20	-10	+5	-20	-10	+5
5540/4	–	5,4	5,7	6,3	6,2	6,7	7,3
5540/5		10,7	11,5	12,6	12,4	13,3	14,7
5540/7		13,4	14,4	15,7	15,5	16,6	18,4
5540/9		16,1	17,2	18,8	18,6	20,0	22,0
5540/11		18,8	20,1	22,0	21,7	23,3	15,7
5540/13		30,6	32,7	35,8	35,3	37,9	41,9
5540/M42							
5540/17		38,3	40,9	44,8	44,1	47,4	52,4
5520/C	5590/5	10,7	11,5	12,6	12,4	13,3	14,7
	5590/7	13,4	14,4	15,7	15,5	16,6	18,4
5520/D	5590/9	16,1	17,2	18,8	18,6	20,0	22,0
	5590/11	18,8	20,1	22,0	21,7	23,3	15,7
5520/E	5590/13	21,5	23,0	25,1	24,7	26,6	29,4
	5590/M42						

TABLE 3: Refrigerant flow capacity

Catalogue Number	Catalogue Number of solder connections	R22									
		Condensing temperature [°C]									
		+40					+50				
		Evaporating temperature [°C]					Evaporating temperature [°C]				
		-40	-30	-20	-10	+5	-40	-30	-20	-10	+5
5540/4	–	6,0	6,5	7,0	7,5	8,2	6,7	7,3	7,9	8,5	9,3
5540/5		12,0	13,0	13,9	14,9	16,4	13,4	14,6	15,8	16,9	18,6
5540/7		15,0	16,2	17,4	18,6	20,5	16,8	18,2	19,7	21,2	23,3
5540/9		18,0	19,5	20,9	22,4	14,6	20,2	21,9	23,7	25,4	28,0
5540/11		21,0	22,7	24,4	26,1	28,7	23,5	25,5	27,6	29,6	32,6
5540/13		34,2	37,0	39,7	42,5	46,8	38,3	41,6	45,0	48,3	53,1
5540/M42											
5540/17		42,8	46,2	49,6	53,1	58,5	47,9	52,0	56,2	60,4	66,4
5520/C	5590/5	12,0	13,0	13,9	14,9	16,4	13,4	14,6	15,8	16,9	18,6
	5590/7	15,0	16,2	17,4	18,6	20,5	16,8	18,2	19,7	21,2	23,3
5520/D	5590/9	18,0	19,5	20,9	22,4	14,6	20,2	21,9	23,7	25,4	28,0
	5590/11	21,0	22,7	24,4	26,1	28,7	23,5	25,5	27,6	29,6	32,6
5520/E	5590/13	24,0	25,9	27,9	29,8	32,8	26,9	29,2	31,5	33,9	37,3
	5590/M42										

(1) : Refrigerant flow capacity with overheating values of vapour sucked by compressor of 10 °C. No liquid subcooling.

Continued

Maximum pressure drop of 0,15 bar

TABLE 3: Refrigerant flow capacity

Catalogue Number	Catalogue Number of solder connections	R404A									
		Condensing temperature [°C]									
		+40					+50				
		Evaporating temperature [°C]					Evaporating temperature [°C]				
		-40	-30	-20	-10	+5	-40	-30	-20	-10	+5
5540/4	–	6,6	7,2	7,9	8,5	9,4	6,8	7,6	8,3	9,1	10,2
5540/5		13,2	14,5	15,8	17,1	18,8	13,6	15,1	16,7	18,2	20,4
5540/7		16,5	18,1	19,7	21,3	23,5	17,0	18,9	20,8	22,8	25,5
5540/9		19,8	21,7	23,7	25,6	28,2	20,3	22,7	25,0	27,3	30,6
5540/11		23,1	25,3	27,6	29,9	32,9	23,7	26,5	29,1	31,9	35,7
5540/13		37,6	41,2	45,0	18,6	53,6	38,7	43,1	47,5	52,0	58,2
5540/M42											
5540/17		47,0	51,5	56,3	60,8	67,0	48,3	53,9	59,4	65,0	72,7
5520/C	5590/5	13,2	14,5	15,8	17,1	18,8	13,6	15,1	16,7	18,2	20,4
	5590/7	16,5	18,1	19,7	21,3	23,5	17,0	18,9	20,8	22,8	25,5
5520/D	5590/9	19,8	21,7	23,7	25,6	28,2	20,3	22,7	25,0	27,3	30,6
	5590/11	23,1	25,3	27,6	29,9	32,9	23,7	26,5	29,1	31,9	35,7
5520/E	5590/13	26,4	28,9	31,6	34,1	37,6	27,1	30,3	33,3	36,5	40,8
	5590/M42										

TABLE 3: Refrigerant flow capacity

Catalogue Number	Catalogue Number of solder connections	R407C									
		Condensing temperature [°C]									
		+40					+50				
		Evaporating temperature [°C]					Evaporating temperature [°C]				
		-40	-30	-20	-10	+5	-40	-30	-20	-10	+5
5540/4	–	7,0	7,6	8,2	8,8	9,7	7,6	8,4	9,1	9,8	10,9
5540/5		14,0	15,2	16,4	17,6	19,4	15,3	16,7	18,2	19,6	21,8
5540/7		17,5	19,0	20,5	22,0	24,3	19,1	20,9	22,7	24,5	27,3
5540/9		21,0	22,8	24,6	26,4	29,1	22,9	25,1	27,3	29,4	32,7
5540/11		24,4	26,6	28,7	30,8	34,0	26,7	29,3	31,8	34,3	38,2
5540/13		39,8	43,4	46,8	50,2	55,3	43,5	47,7	51,8	55,9	62,2
5540/M42											
5540/17		49,8	54,2	58,5	62,7	69,1	54,4	59,7	64,8	69,9	77,7
5520/C	5590/5	14,0	15,2	16,4	17,6	19,4	15,3	16,7	18,2	19,6	21,8
	5590/7	17,5	19,0	20,5	22,0	24,3	19,1	20,9	22,7	24,5	27,3
5520/D	5590/9	21,0	22,8	24,6	26,4	29,1	22,9	25,1	27,3	29,4	32,7
	5590/11	24,4	26,6	28,7	30,8	34,0	26,7	29,3	31,8	34,3	38,2
5520/E	5590/13	27,9	30,4	32,8	35,2	38,8	30,5	33,5	36,4	39,2	43,6
	5590/M42										

(1) : Refrigerant flow capacity with overheating values of vapour sucked by compressor of 10 °C. No liquid subcooling.

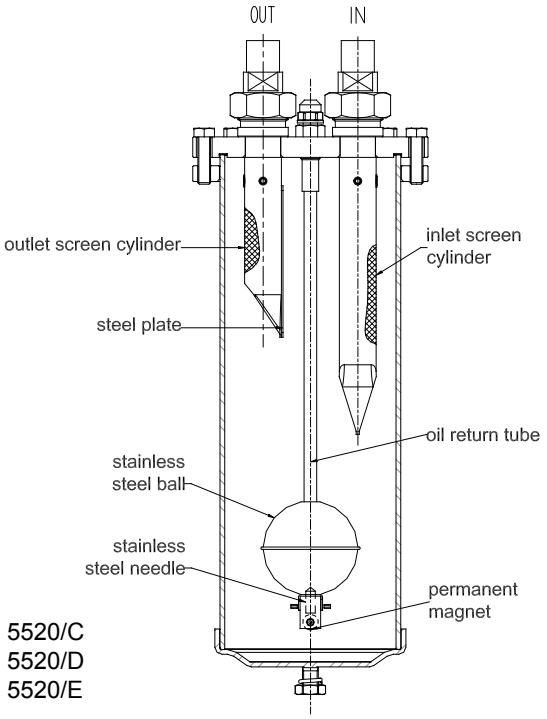
Continued

Maximum pressure drop of 0,15 bar

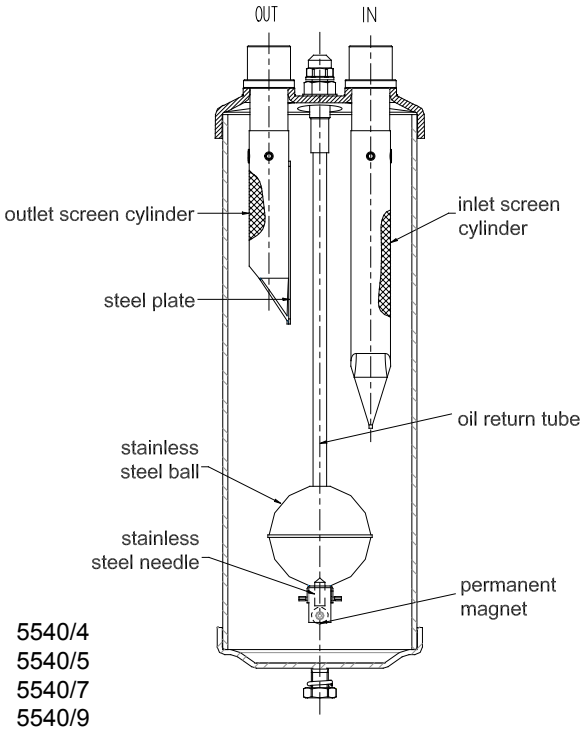
TABLE 3: Refrigerant flow capacity							
Catalogue Number	Catalogue Number of solder connections	R410A					
		Condensing temperature [°C]					
		+40			+50		
		Evaporating temperature [°C]			Evaporating temperature [°C]		
		-20	-10	+5	-20	-10	+5
5540/4	–	10,1	10,9	12,0	11,0	11,8	13,2
5540/5		20,2	21,7	23,9	22,0	23,6	26,4
5540/7		25,3	27,1	29,9	27,5	29,5	32,9
5540/9		30,3	32,6	35,9	33,0	35,4	39,5
5540/11		35,4	38,0	41,9	38,5	41,3	46,1
5540/13		-	-	-	-	-	-
5540/M42							
5540/17		-	-	-	-	-	-
5520/C	5590/5	20,2	21,7	23,9	22,0	23,6	26,4
	5590/7	25,3	27,1	29,9	27,5	29,5	32,9
5520/D	5590/9	30,3	32,6	35,9	33,0	35,4	39,5
	5590/11	35,4	38,0	41,9	38,5	41,3	46,1
5520/E	5590/13	40,4	43,4	47,9	4,0	47,2	52,7
	5590/M42						

(1) : Refrigerant flow capacity with overheating values of vapour sucked by compressor of 10 °C. No liquid subcooling.

Maximum pressure drop of 0,15 bar



5520/C
5520/D
5520/E



5540/4
5540/5
5540/7
5540/9
5540/11
5540/13
5540/4M42
5540/17

CHAPTER 2
OIL RESERVOIRS
FOR REFRIGERATION PLANTS THAT USE HCFC, HFC OR HFO REFRIGERANTS

APPLICATIONS
The oil reservoirs illustrated in this chapter are designed for installation on commercial refrigeration systems and on civil and industrial air conditioning plants that use the following refrigerant fluids:
- HCFC (R22)
- HFC (R134a, R404A, R407C, R410A, or R507)

belonging to Group 2, as defined in Article 13, Chapter 1, Point (b) of Directive 2014/68/EU, with reference to EC Regulation No. 1272/2008.
For specific applications with refrigerant fluids not listed above, please contact Castel Technical Department.
These reservoirs are used in "Low pressure oil control systems" and act as an oil supply. The amount of oil circulating in a refrigerating system varies depending on the operating conditions. The oil reservoir buffers these fluctuations, ensuring an additional oil flow rate.

CONSTRUCTION
Castel manufactures three oil reservoir models:
- 5740/2G: with a nominal volume of 2 US Gallons
- 5740/3G: with a nominal volume of 3 US Gallons
- 5740/4G: with a nominal volume of 4 US Gallons

The three models are supplied with:
- Two sight glasses with level indicator balls inside, to check the oil level in the reservoir. These sight glasses are already screwed on the vessel by the manufacturer.
- Two rotalock valves for connect oil fill and drain. These valves are not assembled on the reservoir by the manufacturer. Rather, they are supplied in the package, including suitable PTFE gaskets. In this way, the customer is free to choose the orientation for the assembly of the valves on the reservoir, based on its operational conditions.
- A 3/8" SAE Flare connection on the top header of the reservoir to allow the assembly of a calibrated pressure relief valve.

The calibrated pressure relief valve is not supplied with reservoir. If required to set a differential pressure between the oil reservoir and the compressor crankcase, the customer can select from two different valve models:
- 3150/X01 (with a differential pressure of 0,35 bar)
- 3150/X02 (with a differential pressure of 1,4 bar)
- 3150/X03 (with a differential pressure of 3 bar)

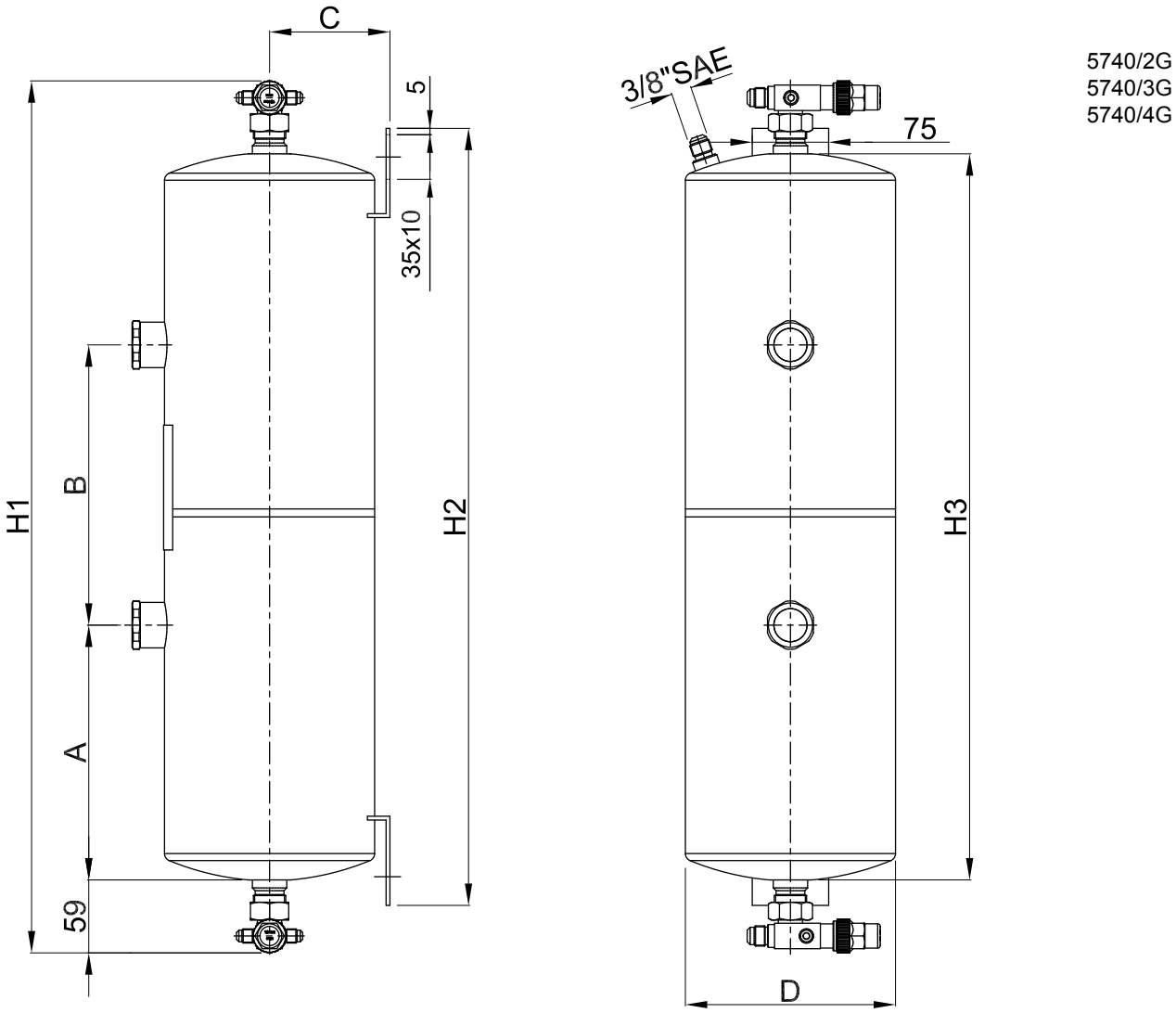
Note: When screwing the calibrated relief valve onto the 3/8" SAE connection, remember to insert the tapered copper gasket 7580/3 between reservoir and valve.

The reservoir is composed by two half bodies in carbon steel of adequate thickness. All threaded connections are manufactured by machining steel bar EN 10277-3 11S Mn Pb 37 + C.
The rotalock valves have two service connections, 1/4" SAE Flare. One of these can be excluded by back sealing the spindle. The two service ports have blind threaded unions. The valve body and stem are manufactured by machining steel bar EN 10277-3 11S Mn Pb 37 + C.

INSTALLATION
On new system start-up, oil must be added to the oil reservoir to the upper sight glass. During the first two working days of the refrigerating system, oil should be added to maintain a level between the two sight glasses. This procedure may require several top-ups, as the oil is partly adsorbed by the refrigerant and partly coats the lower portion of the piping when starting-up the system. Once the refrigerating system is fully operational, the oil level in the reservoir must be checked during each periodic maintenance inspection and the oil level should be topped up if it falls below the lower sight glass.
When adding or replacing an oil reservoir to an existing system, it should only be filled to the lower sight glass. Check the oil level during the first two days of operation of the plant. If the level falls below the lower sight glass, top up. If the level rises above the upper sight glass, drain the excess oil from the reservoir.

TABLE 4: General characteristics of oil reservoirs									
Catalogue Number	Connections			Volume		TS [°C]		PS [bar]	Risk Category according to PED Recast
	Oil fill	Oil drain	Pressure vent valve	US Gallons	[l]	min.	max.		
5740/2G	1" UNS for 3/8" SAE Flare rotalock valve	1" UNS for 3/8" SAE Flare rotalock valve	3/8" SAE Flare	2	7	– 10	+100	33	Cat. II
5740/3G				3	10				
5740/4G				4	16				

TABLE 5: Dimensions and weights of oil reservoirs								
Catalogue Number	Dimensions [mm]							Weight [g]
	A	B	C	Ø D	H_1	H_2	H_3	
5740/2G	110	200	93	160	518	420	400	4656
5740/3G	110	250	103	180	568	470	450	6014
5740/4G	130	205	123	220	583	480	465	7842



5740/2G
5740/3G
5740/4G

CHAPTER 3
OIL RESERVOIR PRESSURE VALVES
FOR REFRIGERATION PLANTS THAT USE HCFC, HFC OR HFO REFRIGERANTS

APPLICATIONS

The calibrated pressure relief valves illustrated in this chapter are designed for installation on commercial refrigeration systems and on civil and industrial air conditioning plants that use the following refrigerant fluids:

- HCFC (R22)
- HFC (R134a, R404A, R407C, R410A, or R507)

belonging to Group 2, as defined in Article 13, Chapter 1, Point (b) of Directive 2014/68/EU, with reference to EC Regulation No. 1272/2008.

For specific applications with refrigerant fluids not listed above, please contact Castel Technical Department.

CONSTRUCTION

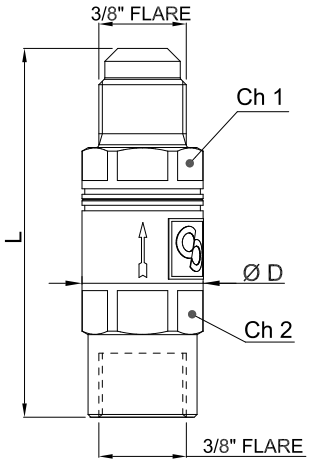
Castel manufactures four reservoirs calibrate pressure relief valves with differential pressures. A higher-pressure differential will increase the oil flow rate from the oil reservoir back to the compressor crankcase. The selection of the model must consider both the individual compressor crankcase pressures as well as the differential pressure range of the oil regulators.

The main parts of the valves are constructed with the following materials:

- Hot forged brass EN 12164 – CW 614N for body and cover Valves in series 3150W are equipped with laser welds between the body and the cover to ensure that the product is sealed hermetically.
- Austenitic stainless steel AISI 302 for the spring
- Laminated glass fibre fabric and PTFE for gasket seat seals

INSTALLATION

These valves are used to relieve pressure in the oil reservoir while maintaining a positive pressure differential between the reservoir and the compressor crankcase. This positive pressure ensures adequate oil supply to the oil level regulator. The calibrated pressure relief valve is mounted directly on the 3/8" SAE Flare connection of the reservoir and is piped to the suction line.



3150W/X01
3150W/X02
3150W/X03
3150W/X04

TABLE 6: General characteristics of oil reservoir pressure valves

Catalogue Number	SAE Flare Connections		Kv Factor [m³/h]	Pressure Differential [bar]	PS [bar]	TS [°C]		TAS [°C]		Dimensions and weights					Risk Category according to PED Recast
	IN	OUT				min.	max.	min.	max.	D	L	Ch1	Ch2	[g]	
3150W/X01	3/8"- F	3/8"- M	1,6	0,35	45	– 40	+150	– 40	+50	22	67	20	20	152	Art. 4.3
3150W/X02				1,4											
3150W/X03				3											
3150W/X04				7	140					35	96	32	32	394	

CHAPTER 4
ELECTRONIC OIL LEVEL REGULATORS
FOR REFRIGERATION PLANTS THAT USE HCFC, HFC OR HFO REFRIGERANTS

APPLICATIONS
The electronic oil level regulators illustrated in this chapter are designed for installation on commercial refrigeration systems and on civil and industrial air conditioning plants that use the following refrigerant fluids:
- HFC (R134a, R404A, R407C, R410A or R507)

belonging to Group 2, as defined in Article 13, Chapter 1, Point (b) of Directive 2014/68/EU, with reference to EC Regulation No. 1272/2008.
For specific applications with refrigerant fluids not listed above, please contact Castel Technical Department.
The regulators in series 5650 ensure monitoring and control of the oil level in the crankcases of both alternative reciprocating and scroll compressors. Specifically, these regulators are employed to resolve the problem of incorrect oil distribution in multiple compressor plants.

CONSTRUCTION
Regulator 5650 consists of an anodized aluminium body inside which are passages and the oil valve injection seat, while the oil supply connection and the integrated solenoid valve pipe are made from stainless steel.
In the body of the regulator are:
- The electronic board, protected by a plastic cover that guarantees an IP65 exterior seal. This board is connected to the outside of the body by two EN 175301-803 industrial standard Form C micro-connectors.
- The sight glass for visual control of the oil level

There are two symmetric versions of the electronic regulator: version 5650/R with oil supply on the left side and sight glass on the right; and version 5650/L with the oil supply on the right side and the sight glass on the left.
On both sides of the regulator, there are two transparent membranes which allow the four indicator LEDs of the board to be seen, which indicate the conditions of operation of the regulator.

The specific construction of the regulator makes it capable of minimizing emulsion, and foaming phenomena of the refrigerant and oil during the oil injection phase and always guarantees a correct level reading.

OPERATION
The electronic regulators in series 5650 operate by monitoring the oil level using a combination of opto-electric sensors. The principle of optical detection of the level is based on the fact that a light directed on a glass prism returns a different refraction if the glass is immersed in a gas rather than in a liquid.
The oil level control and relative alarm condition is governed by a control logic that is capable of maintaining the desired level by managing the number of “refill” and “wait” cycles and the relative opening and closing of the supply solenoid valve.
When a low level is detected, the electronic control unit commands the integrated solenoid valve. In incremental cycles, oil is injected into the compressor crankcase. Furthermore, the electronic control unit is equipped with an alarm relay capable of generating a cut-out signal for the compressor. Under normal operating conditions, this relay is energized. Otherwise, if the level remains low after a certain number of injection cycles, an alarm signal is generated, which de-energizes the relay.
NOTE:
Under alarm conditions, the injection cycles continue. The electronic control unit continues to command the integrated solenoid valve. If the opto-electric sensor once again detects a correct oil level, the alarm is automatically reset and the regulator returns to operating under normal operating conditions.

On the side of the regulator there are four LEDs that provide information about the operating conditions of the regulator.

Specifically:

- "POWER" LED - GREEN
  Remains always on when the regulator is powered
- "OIL GOOD" LED - GREEN
  Remains on and steady when the oil level is correct
  Blinks when the level is low, but the injection cycles are not active yet
  Off during active injection cycles
- "OIL FILLING" LED - YELLOW
  Off when the level measured is sufficient
  Blinks during the injection cycles with the solenoid valve open
  Remains on and steady during the injection cycles with the solenoid valve closed
- "ALARM" LED - RED
  Remains on and steady when the electronic controller triggers the alarm signal.

INSTALLATION

The electronic regulator in series 5650 must be assembled horizontally (and level) for correct level reading. The coil must be oriented upwards and a difference of +/- 1% from the vertical position is allowed.

Regulator 5650 cannot be coupled directly (without an adapter) to the seat of the level spy glass on the compressor crankcase. This connection must always be performed using one of the following adapters, sold separately:

- 5690/X11: two-flange adapter, the first flange is fixed and the second is mobile. Supplied with: 4 1/4" x 1-1/4" screws; 4, 1/4" K-Lock nuts; and O-Ring
- 5690/X12: flange adapter with 1-1/8" – 12 UNF threaded end. Supplied with: mobile flange with 3 holes; 3, 1/4" x 1-1/4" screws; and O-Ring
- 5690/X13: flange adapter with 1-1/8" – 18 UNF threaded end. Supplied with: mobile flange with 3 holes; 3, 1/4" x 1-1/4" screws; and PTFE gasket
- 5690/X14: flange adapter, with 3/4" NPT threaded end. Supplied with sliding flange with 3 holes, 3 1/4" x 1-1/4" screws

Table 10 shows the correspondence between the adapter kits and the compressor models of several manufacturers.

During installation of the electronic regulator in series 5650, make certain that:

- The gasket is fit between the adapter and the regulator and that it is well lubricated.
- The adapter fixing screws are tightened to the torque indicated in the instructions.
- The gaskets under the micro-connectors (board and alarms) are positioned correctly and that they are tightened to the torque indicated in the instructions.
- The gaskets under the coil connector is positioned correctly and the coil connector is tightened to the torque indicated in the instructions.
- The electric connections are performed according to the wiring diagram in the instructions and on the front of the regulator.
- Upstream from the oil supply connection a filter in series 4510 or 4520 is installed.

After installing the electronic regulator in series 5650, make certain that the system has been installed correctly by performing a tightness test.

Before starting up the plant, make certain that the oil level in the regulator, and consequently in the compressor crankcase, is at a level about half-way up the spy glass on the regulator.

CABLING AND ELECTRIC CONNECTIONS

Cabling is performed using two co-moulded cables with DIN connectors to guarantee a tightness level of IP67. One cable is used for power supply and the other is used for the level alarm management. The cable is about 3 m long. This cable kit must be purchased separately under p/n 9901/X26 and is supplied with gaskets and fixing screws.

Regulator 5650 has two, EN175301-803-C (9.4mm pitch) connectors on top. If there is an alarm, the relay is de-energized and the circuit is closed between contacts 1 (NC) and 3 (COM). During normal operation, the relay is energized, therefore the circuit is closed between contacts 2 (NO) and 3 (COM) (see the diagram).

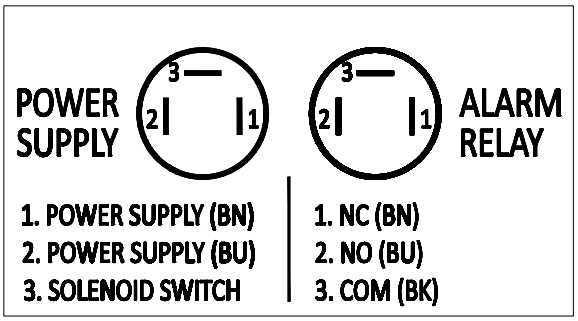


TABLE 7: General characteristics of electronic oil level regulators													
Part number	Version	Connections		Cables kit (1)	Opening Pressure Differential [bar]		PS [bar]	TS [°C]		TA [°C]		Weight [g]	Risk Category according to PED Recast
		Adapters (1)	Oil inlet SAE FLARE		Min	Max		Min	Max	Min	Max		
5650/RA2	Right	5690/X11 5690/X12 5690/X13 5690/X14 5690/X15	3/8"	9901/X26	2	30	45	-30	+130	-20	+50	990	Art. 4.3
5650/RA6													
5650/LA2	Left												
5650/LA6													

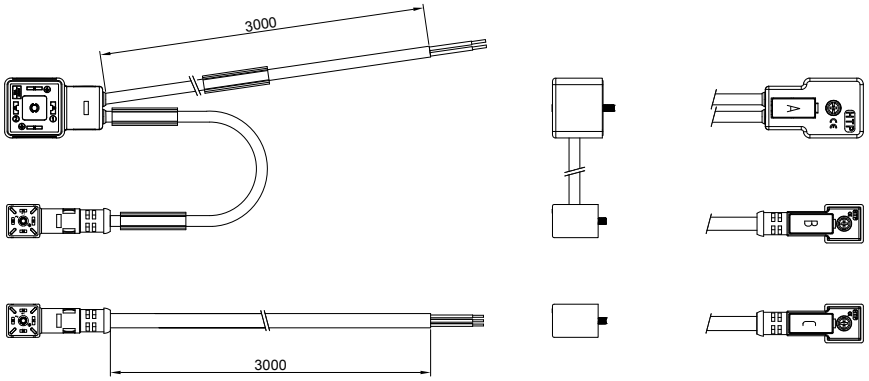
Note:
(1) To be ordered separately

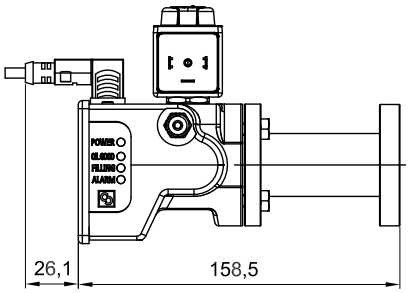
TABLE 8: Electrical characteristics										
Part number	Voltage [V]	Voltage Tolerance [%]	Frequency [Hz]	Coil (1)					Degree of protection	Alarm contact	
				Tipo	Insulation class EN 60730	Power [W]	Coil consumption at 20 °C [mA]			Admissible load	Max voltage
							Start	Working			
5650/RA2	24 A.C.	+10 / -10	50 / 60	9300/RA2	H	8	920	527	IP 65	3A	250 V
5650/RA6	220 A.C.	+10 / -10	50 / 60	9300/RA6	H	8	120	68			
5650/LA2	24 A.C.	+10 / -10	50 / 60	9300/RA2	H	8	920	527			
5650/LA6	220 A.C.	+10 / -10	50 / 60	9300/RA6	H	8	120	68			

Note:
(1) Enclosed into the package

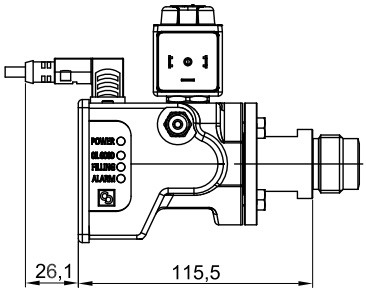
TABLE 9: Cables kit characteristics				
Part number	Use		Degree of protection	Cable length [m]
9901/X26	A	Power supply cable	IP 67	3
	B	Coil cable		
	C	Alarms cable		

9901/X26

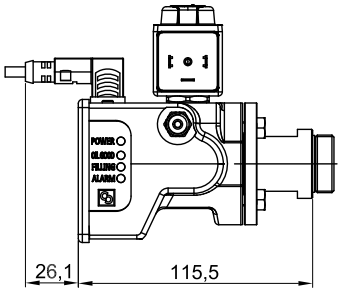




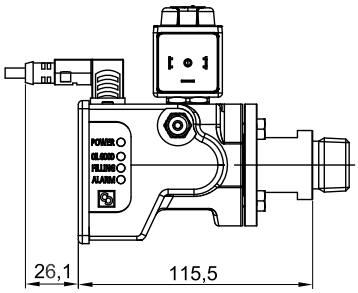
5690/X11



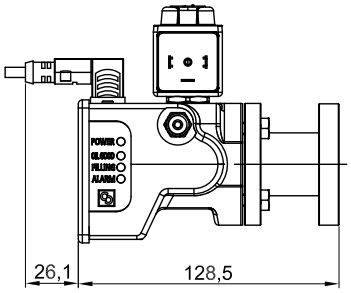
5690/X12



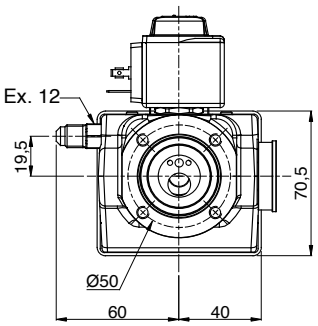
5690/X13

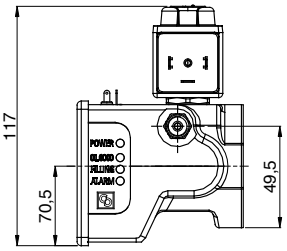


5690/X14

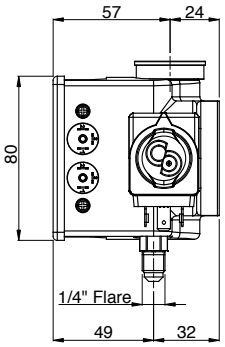


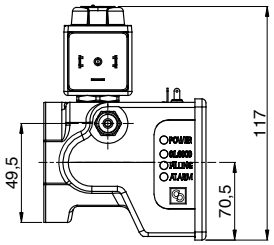
5690/X15

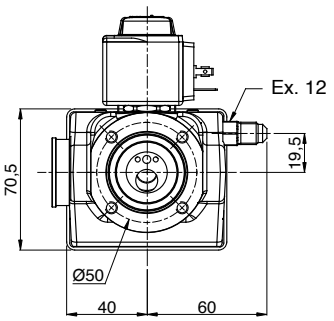


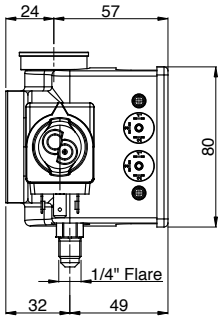


5650/R



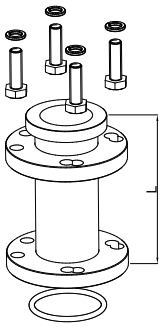




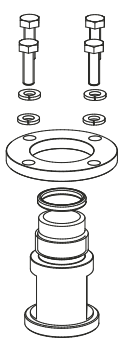


5650/L

TABLE 10: Adapters characteristics and their use			
Adapter		Compressors	
Catalogue Number	Connections	Manufacturer	Model number
5690/X11	Flanged with: 3 screws, distance between 1.7/8” 4 screws, distance between 50 mm L=83 mm	Arctic Circle	G2; G4; G6
		Bitzer	4NC….4VC; 6D; 6E; 2H; 2T; 4H; 4T; 4P; 4G; 4H; 4J; 6F; 6G; 6H; 6J; S4 ; S6
		Bock	HA3….HA5; HG3….HG5; HG7; AM; F; O series
		Carrier	EA; ER; 6E; OBE; OBCC
		Copeland	D2; D3; D4; D6; 4CC; 6CC; 4M; 6M; ZBH; DK; DL; DN ;DM
		Dorin	H2; H32; H34; H4; K5; Y6; 2S
		Frascold	Tutti
		Trane	M; R
		PrestCold	P2; P3; P4; P6
5690/X12	Threaded 1-1,8” - 12 UNF	Copeland	DK; DL; DN; ZR; ZZ; HA; KA; EA; 3A; LA; ER; 3R
		Tecumseh	P; R; S; PA; RA; SA; CK; CM; CH; CG
		PrestCold	Pk; PL (depend on size/model)
5690/X13	Threaded 1 - 1,8” - 18 UNEF	Bitzer	2CC …2KC; 4CC…4FC; ESH; 4KTC series
		Bock	HA(12,22,34); HG (12,22,34); HAX(12,22,34); HGX (12,22,34); EX Series
		Dorin	H1; K100……K400; SCC series
		Tecumseh	TAG; TAH
		PrestCold	PK; PL
		ManEurope	Tutti
5690/X14	Threaded 3/4” - 14 NPT	Bitzer	ZL; ZM
		Trane	K series
		Copeland	ZB; ZF; ZS; ZO; ZOD
5690/X15	Flanged with: 3 screws, distance between 1.7/8” 4 screws, distance between 50 mm L=53 mm	Arctic Circle	G2; G4; G6
		Bitzer	4NC….4VC; 6D; 6E; 2H; 2T; 4H; 4T; 4P; 4G; 4H; 4J; 6F; 6G; 6H; 6J; S4 ; S6
		Bock	HA3….HA5; HG3….HG5; HG7; AM; F; O series
		Carrier	EA; ER; 6E; OBE; OBCC
		Copeland	D2; D3; D4; D6; 4CC; 6CC; 4M; 6M; ZBH; DK; DL; DN ;DM
		Dorin	H2; H32; H34; H4; K5; Y6; 2S
		Frascold	Tutti
		Trane	M; R
		PrestCold	P2; P3; P4; P6



5690/X11
5690/X15



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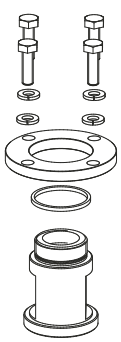

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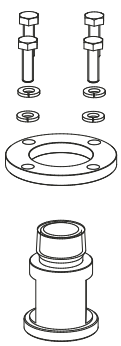


5690/X14

CHAPTER 5
STRAINERS
FOR REFRIGERATION PLANTS THAT USE HCFC, HFC OR HFO REFRIGERANTS

APPLICATIONS
The filters in series 45 illustrated in this chapter are designed for installation on commercial refrigeration systems and on civil and industrial air conditioning plants that use the following refrigerant fluids:
- HCFC (R22)
- HFC (R134a, R404A, R407C, R410A, or R507)

belonging to Group 2, as defined in Article 13, Chapter 1, Point (b) of Directive 2014/68/EU, with reference to EC Regulation No. 1272/2008.

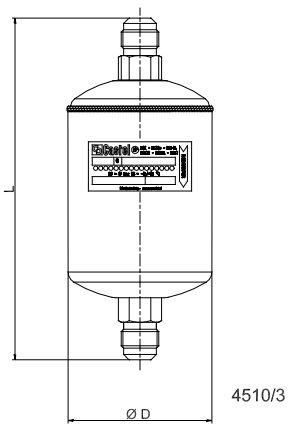
CONSTRUCTION
The filter body is completely manufactured in steel, with SAE FLARE copper-plated steel threaded connections. The product range also includes versions with copper plated solder connections, offering the possibility to solder the copper pipe inside the connections (ODS).
Inside the filters there is a screen basket, with large filter surface, made of austenitic stainless steel AISI 304. The mesh filters in series 45 are not inspectionable and therefore cannot be cleaned.

TABLE 11: General characteristics of strainers

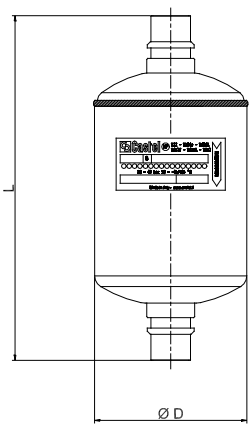
Catalogue Number	Filtering Surface [cm²]	Useful Passage Surface [%]	Mesh Opening [mm]	Connections					Kv Factor [m³/h]	PS [bar]	TS [°C]		TA [°C]		Risk Category according to PED Recast
				SAE Flare	ODS		ODM				min.	max.	min.	max.	
					Ø [in.]	Ø [mm.]	Ø [in.]	Ø [mm.]							
4510/3	58	36,6	0,166	3/8"	–	–	–	–	2,4	45	– 40	+80	– 20	+50	Art. 4.3
4520/3				–	3/8"	–	1/2"	–							
4520/M10				–	–	10	–	12							
4520/M12				–	–	12	–	14	3,4						
4520/4				–	1/2"	–	5/8"	16							

TABLE 12: Dimensions and Weights of Strainers

Catalogue Number	Dimensions [mm]		Weight [g]
	Ø D	L	
4510/3	52	110	195
4520/3		109	
4520/M10			
4520/M12		113	205
4520/4		122	215



4510/3



4520/3
4520/M10
4520/M12
4520/4

CHAPTER 6
LIQUID INDICATORS
FOR REFRIGERATION PLANTS THAT USE HCFC, HFC OR HFO REFRIGERANTS

APPLICATIONS
The liquid indicators illustrated in this chapter provide control of the regular return of oil to the compressor crankcase. They are designed for installation on commercial refrigeration systems and on civil and industrial air conditioning plants that use the following refrigerant fluids:
- HCFC (R22)
- HFC (R134a, R404A, R407C, R410A, or R507)

belonging to Group 2, as defined in Article 13, Chapter 1, Point (b) of Directive 2014/68/EU, with reference to EC Regulation No. 1272/2008.
For specific applications with refrigerant fluids not listed above, please contact Castel Technical Department.
Note: The indicator series 3680 are excluded from the scope of application of Directive 2014/68/EU as they are piping components.

CONSTRUCTION
Liquid indicators series 38 are manufactured in a total hermetic construction to avoid any possible oil leaks. The glass "lens", with suitable gasket, is housed inside the brass body and is fixed in its seat with a reflanging operation.
The main parts of these indicators are made from the following materials:
- Hot forged brass EN 12420 – CW 617N for the body
- Copper tube EN 12735-1 – Cu-DHP for solder connections
- Glass for lens
- PTFE for outlet gaskets

The liquid indicators in series 3680 are manufactured with the glass "lens" directly melted onto a steel ring, with proper surface protection, screwed on to the indicator body. Inside the ring, which is supplied with a hydrogenated nitrile butadiene (HNBR) gasket, is a Nylon ball, kept in position in front of the spy glass by a metal mesh disk. The presence of the Nylon ball in the spy glass facilitates immediate reading of the oil level.

INSTALLATION
The brazing of indicators with solder connections in series 38 should be carried out with care, using a low melting point filler material. Avoid direct contact between the torch flame and the indicator body or glass, which could be damaged and compromise the proper functioning of the indicator.
For indicators in series 3680 the ring must be disassembled before brazing.
Note: the PS declared in Table 13 for indicators in series 3680, refers only to the body plus the ring (with its o-ring), which the customer must tighten to the torque indicated on the product instruction manual. The aforesaid declaration doesn't cover any possible leakage or malfunctions due to brazing the body on the copper pipe. The customer is totally responsible for the success of this operation.

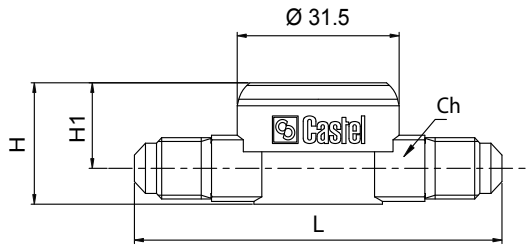
TABLE 13: General characteristics of liquid indicators

Catalogue Number	Type	Connections					PS [bar]	TS [°C]		TA [°C]		Risk Category according to PED Recast
		SAE Flare	ODS		for pipe			min.	max.	min.	max.	
			Ø [in.]	Ø [mm.]	Ø [in.]	Ø [mm]						
3810/22	male male	1/4"	–	–	–	–	45	– 30	+110	– 20	+50	Art. 3.3
3810/33		3/8"	–	–								
3810/44		1/2"	–	–								
3840/2	brazing	–	1/4"	–								
3840/3		–	3/8"	–								
3840/M10		–	–	10								
3840/M12		–	–	12								
3840/4		–	1/2"	–								
3680/7	saddle type	–	–	–	7/8"	22						excluded
3680/9					1.1/8"	28						
3680/11					1.3/8"	35						

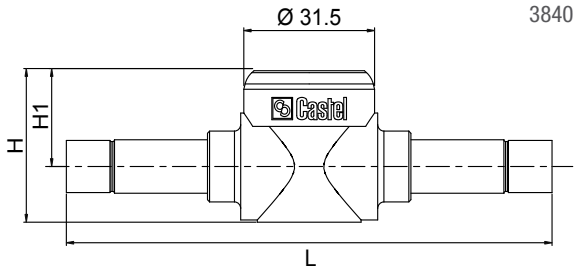
TABLE 14: Dimensions and weights

Catalogue Number	Dimensions [mm]				Weight [g]
	H	H1	L	Ch (pipe DIA)	
3810/22	22	16,5	71,5	12	110
3810/33	26,5	17,5	77,5	17	150
3810/44	30	18,5	81,5	22	196
3840/2	22	15,5	113	–	116
3840/3	34	21,5	117		185
3840/M10					
3840/M12					
3840/4					
3680/7	–	33	–	pipe 7/8”	90
3680/9		36		pipe 1.1/8”	
3680/11		39,5		pipe 1.3/8”	

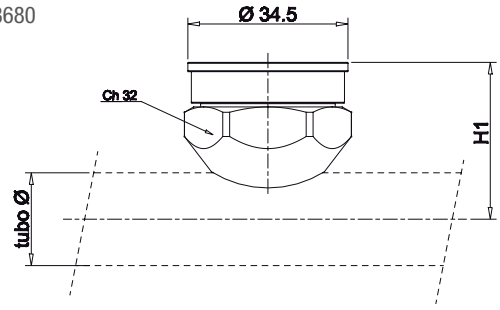
3810



3840



3680



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