

# *SRC-W & SW series compressors*

## *Oil management*

### *(WA-02-05-E)*

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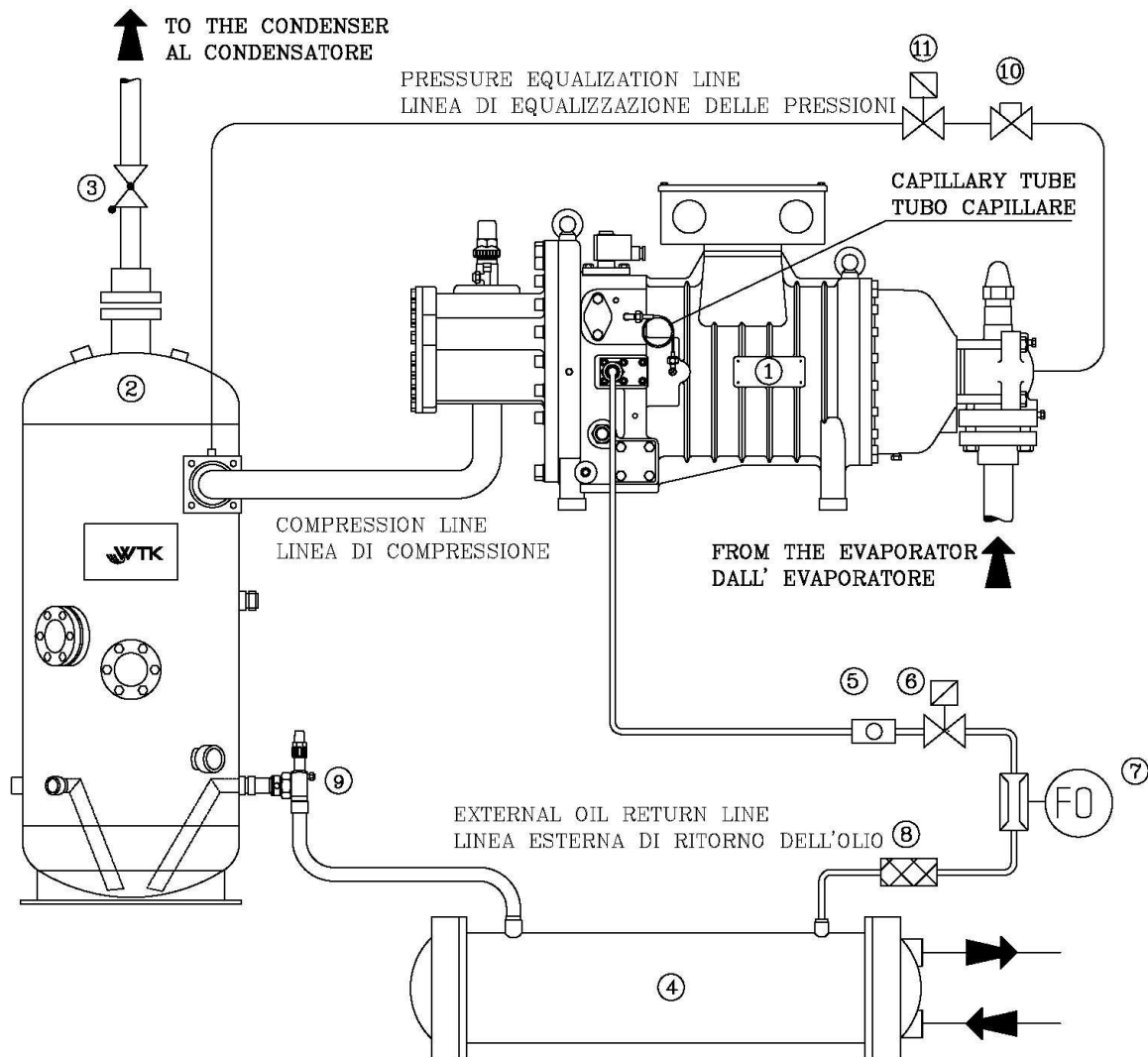
## 2. Oil management

### 2.1 Oil circuit

In the W series compressors the oil fulfils the following purposes:

- Dynamic seal between contiguous chambers
- Bearing lubrication
- Control of slide valve for capacity modulation
- Cooling

The following Picture 2-A shows the oil circuit and involved components:



**Picture 2-A: example of oil circuit scheme**

- |                  |                    |
|------------------|--------------------|
| 1) Compressor    | 6) Solenoid valve  |
| 2) Oil separator | 7) Oil flow switch |
| 3) Check valve   | 8) Oil filter      |
| 4) Oil cooler    | 9) Shut-off valve  |
| 5) Sight glass   | 10) Shut-off valve |
|                  | 11) Solenoid valve |

Referring to Picture 2-A, the lubricant is stored in an external oil separator (position 2) that permits the compressor oil supply to the compressor after the separation between oil and gas mixture. The oil circulation results from the pressure difference between the oil separator - at discharge pressure - and the injection points - where the pressure is slightly higher than the suction pressure.

From the reservoir the oil flows in the oil cooler (position 4), in case of take heat away is necessary, then through a filter (position 8) to the suction bearings, the injection point on the rotor profiles and the discharge-bearing chamber. The oil feeding back line is monitored by means of a flow switch (position 7), a solenoid valve (position 6) and a sight glass (position 5). At the same time, for the SW series through an external capillary, the oil is led to the slide valve control cylinder.

The oil leaving the slide valve control cylinder, the suction bearings and the discharge-bearing chamber is led to the suction side of the rotors and it is then compressed through the rotors together with the suction gas and the mixture flows in the oil reservoir.

The oil and gas are separated in the upper part of this vessel (position 2). The oil proportion flows downwards to the reservoir space from where it again flows to the compressor (position 1). According to the application conditions the circulating oil has to cooled down by an oil cooler. Under certain conditions direct refrigerant injection can also be used as an alternative (consult RefComp).

Picture 2-A illustrates also the equalization pressure line which permit to reduce the pressure value inside the oil separator during the stop time, so it's possible:

- to start the compressor at minimum capacity
- to reduce the dilution of refrigerant in the lubricant.

For this reason, it's necessary to use a check valve between the oil separator and the condenser, and to use a solenoid valve to control the equalization pressure line from the oil separator to the compressor.

This equalization line can be opened only when the plant is stopped or, in case of compounding system, when all the compressors are switched off.

## 2.2 Oil flow rate

Since the oil circulation is generated by a pressure difference, the oil flow rate depends upon the difference between discharge and suction pressure, according to the following equation:

$$V_{OIL} = K \cdot \sqrt{P_S - P_A}$$

Where:

$V_{OIL}$  = volumetric oil flow rate through the oil filter [l/min]

$K$  = coefficient dependent upon compressor model (see Table A)

$P_S$  = discharge pressure [bar]


$P_A$  = suction pressure [bar]

SW-1H	4000	5000	6000	7500	9000	10500	11500	12500	14000	16000	19000	21000	24000	25000
SW-1L	3000	4000	5000	6500	8000	9500	10500	11500	13000	15000	17000	20000	22000	23000
SRC-WS	40	50	60	70	80									
SRC-WL	30	40	50											
K	5,5			6			6,75			7,5				

**Table A: K coefficient**

The minimum oil flow rate to fulfil all the purposes (lubrication - sealing - slide valve control) is ensured when the compressor operates within the fixed application range.

During the starting phase, since pressures are always equalised in the compressor, there is no oil circulation; however bearings and rotors are designed to tolerate some seconds of dry operation before the necessary pressure difference is reached.

	<b>Attention!</b> ✓ Within 20 seconds after start the compressor must operate inside the application range (minimum pressure difference)
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In case of air-cooled condenser and low ambient conditions, and in general when the minimum pressure difference is not easily reached, it may be necessary to adopt special measures such as:

- delayed start of condenser fans
- pressure regulating valve between compressor and condenser (consult RefComp for further information)
- external oil pump (consult RefComp for further information)

## 2.3 Lubricants

The lubricants have been chosen based on the following requirements:

- Sealing of the gaps
- Adequate bearing lubrication
- Good viscosity behaviour at high temperatures and pressures
- Good miscibility at low temperatures

	<b>Attention!</b> ✓ Do not charge other lubricants than the suggested ones. ✓ The following oils are hygroscopic and must not come in contact with air.
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### 2.3.1 Approved lubricants for HCFC (R22)

Brand/Supplier Marca/Fornitore	Name Nome	Chemical composition Composizione chimica	Density Densità 15°C [g/ml]	Cinematic viscosity Viscosità cinematica 40°C [cSt]	Flash point Punto di infiammabilità [°C]	Pour point Punto di scorrimento [°C]	Flock point Punto di flocculazione [°C]
CPI	CP 4214-150	Complex ester Esteri complesso	1.01	168	290	-43	None Nessuno
TOTAL FINA ELF	Lunaria SK 100	Alchilbenzene Alchilbenzenico	0.874	94	200	-33	<-58
ESSO	Zerice S 100	Alchilbenzene Alchilbenzenico	0.868	98	196	-30	<-60

Table A: properties of oil for R22

### 2.3.2 Approved lubricants for HFC (R407C, R134a, R404A, R507)

Brand/Supplier Marca/Fornitore	Name Nome	Chemical composition Composizione chimica	Density Densità 15°C [g/ml]	Cinematic viscosity Viscosità cinematica 40°C [cSt]	Flash point Punto di infiammabilità [°C]	Pour point Punto di scorrimento [°C]	Flock point Punto di flocculazione [°C]
FUCHS	Reniso Triton SE 170	POE	0.98	170	260	-24	None Nessuno
CASTROL	SW 220 HT-EU	POE	0.98	220	280	-22	None Nessuno

Table B: properties of oil for R407C/R134a/R404A/R507

## 2.3.3 Standard lubricants: operating conditions range

Refrigerant Refrigerante	Oil olio	Cond. temperature Temperatura di condensazione.	Evap. Temperature Temperatura di evaporazione.	Discharge gas temp. Temp. gas di scarico	Oil injection temp. Temp. iniezione olio
		[°C]			
R22	Zerice S100	$\leq 45$ (55) <sup>1</sup>	$\geq -50$ $\leq +5$	$\leq 80$ <sup>2</sup>	Max 80
	Lunaria SK 100			$\leq 100$ <sup>2</sup>	Max 90
	CP 4214-150	$\leq 60$	$\geq -40$ $\leq +12.5$		Max 100
R404A, R507	SW 220 HT-EU	$\leq 52$	$\geq -50$ $\leq +7.5$		
	Reniso Triton SE 170				

**Table C: lubricants operating conditions range**

Notes:

<sup>1</sup>: temperature of working conditions only for short period of time;

<sup>2</sup>: it's necessary to assure that the gas discharge temperature should be at least 30K higher than the condensing temperature;

The lubricant Zerice S100 and Lunaria SK100, thanks to their low viscosity, are particularly suitable to low condensing and evaporating temperatures. The additional cooling can be performed only by means of an external heat exchanger (air-oil, water-oil and refrigerant-oil heat exchanger).

The liquid injection is allowed only for lubricant:

- CP 4214-150
- SW 220 HT-EU
- Reniso Triton SE 170

## 2.4 Oil separator

The vertical oil separator, installed on the discharge gas line (position 2, Picture 2-A), has the purpose to separate the oil from the refrigerant, to the aim of:

- increasing the efficiency of the plant reducing the amount of oil dragged in the circuit;
- creating an oil reservoir available to feed continuously the compressor.

Available in different sizes, the oil separators are delivered complete with oil heater(s), oil thermostat, oil level control, sight glass. For the correct sizing consult RefComp.

The refrigerants that can be used are: HCFC, HFC, NH<sub>3</sub> and other ones if only they are compatible with material of other components.

The oil separators consist of a vessel specifically designed following severe international standard specifications to perform an optimal separation in the upper volume and to carry out an oil reservoir in the lower part. Since that they can operate with refrigerant displacements from 200 to 2250 m<sup>3</sup>/h, it's important to select the correct one by mean of Table D.

For dimensional drawings of oil separator see chapter WA-08 "Dimensional drawings and packing".

Model Modello	Weight Peso [kg]	Volume		Application range: max. suction volume flow Range applicativo: max. portata volumetrica aspirata					N° of compressors N° di compressori
		Oil Olio [dm <sup>3</sup> ]	Total Totale [dm <sup>3</sup> ]	Air conditioning Condizionamento dell'aria		Normal cooling Refrigerazione		Low temperature Basse temperature	
				R22	R404A and R507	R22	R404A and R507		
				[m <sup>3</sup> /h]					
RS-180	60	19	40	220	220	300	300	300	Max 2
RS-400	130	50	120	490	440	660	620	660	Max 3
RS-900	195	90	220	940	840	1320	1180	1320	Max 6
RS-1300	230	130	330	1320	1180	1650	1470	1650	
RS-2300	273	230	560	1650	1470	2250	2009	2250	
RS-182	29	3	30	220	220	300	300	300	(1)
RS-402	52	7	75	490	490	660	660	660	(1)
RS-902	66	10	140	940	940	1320	1320	1320	(1)

(1) Economic oil separators

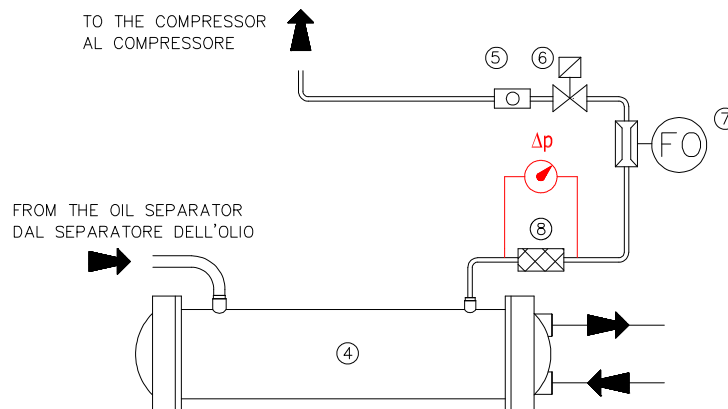
**Table D: Oil separators characteristics**

## 2.5 Oil filter

As illustrated in Picture 2-A, the oil return line to the compressor is provided with an high efficiency oil filter which has to be particularly clean to assure the correct oil feed to the compressor. The cleanness of the filter is determinate by measuring the pressure drop  $\Delta p$  on itself: on normal working conditions with a new filter, the pressure drop should be less than 0.8 bar. It must be take care about the oil return line during the start-up operation: it's possible that the filter will be soon choked by dirt if the cooling plant has not be cleaned properly. Picture 2-B shows detailed indication on the common system to measure the pressure drop corresponding to the oil filter. If this pressure drop exceeds the values indicated in Table E, then it means that it's necessary to replace the oil filter.

Since that the oil filter used in RefComp compressors has a very fine net, sometimes it should be necessary to substitute this component after few working hours, and of course when the value measured exceeds the set-up one.

RefComp recommends to order a spare part oil filter with the compressor.



**Picture 2-B: oil feed-back circuit, system to measure the pressure drop on to the filter (8);**

## 2.6 Oil heater

The aim of the oil heater is to prevent an excessive dilution of refrigerant in lubricant during the stop period. The oil heater must be used in the following cases:

- Installing the compressor and the oil separator outside (if it's necessary, the use of insulation material is suggested);
- Long stop period of the system.

	<p><b>Attention!</b></p> <ul style="list-style-type: none"> <li>✓ Before starting up for the working season, the heater must be on for at least 24 hours before starting the compressor.</li> <li>✓ The oil temperature must be at least 20K greater than the environment temperature</li> </ul>
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See chapter WA-04 “Components” to get more information about technical characteristics and dimensional drawings.

## 2.7 Oil level

The maximum and the minimum oil level inside the separator can be monitored by means of two sight glass. Anyway it's possible to install a electronic oil level switch to monitor the amount of oil. Table D indicates the charge of oil referred to each kind of separators. See chapter WA-04 “Components” to get more information about technical characteristics and dimensional drawings for the sensor.

## 2.8 Lubrication monitoring

### 2.8.1 Oil temperature monitoring

Normally the lubrication can be indirectly monitored by checking the discharge temperature of the oil: lack of lubrication leads to an increase of that value.

Hence a temperature sensor is available (optional with the INT 69 VS module, standard with the INT 69 RCY module), to monitor the discharge temperature of the oil (see chapter WA-05: “Electrical devices”).

Whenever this accessory is not used, a safety thermostat should be installed on the discharge pipe to switch off the compressor as the temperature reaches 120°C.

	<p><b>Attention!</b></p> <ul style="list-style-type: none"> <li>✓ The additional cooling of the oil (chapter WA-11) does not guarantee the indirect monitoring of the lubrication through the discharge temperature value.</li> </ul>
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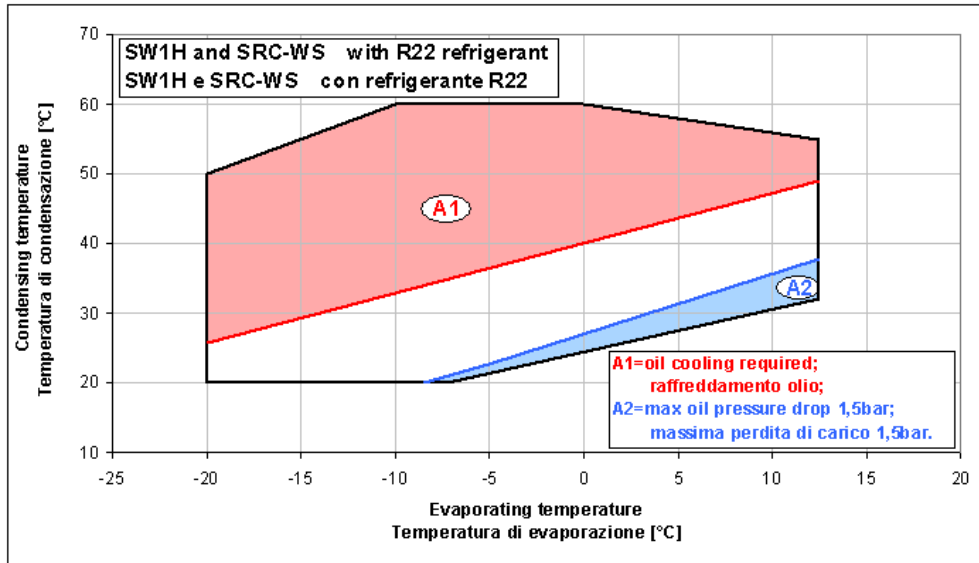
Depending on the operating conditions, however, the discharge temperature may be quite different from the alarm condition (120°C). Consequently, the delay in the increase and in reaching the critical temperature of 120°C must be considered, as the correct operation of the compressor may be affected in this period. As a result, RefComp suggests further alternative methods for monitoring the correct lubrication. They are described hereinafter.

### 2.8.2 Static pressure control

The correct circulation of the oil is guaranteed by the fact that both the filter is clean and the compressor operates in the admissible field of operation (see chapter WA-10: “Application range”). The external oil return line has to be dimensioned to minimize total pressure drop between the oil separator and the compressor. Table E gives the condition for pressure drop and Picture 2-C shows the working conditions that influence the oil circulation.

<i>Compressor model</i>	<i>Maximum pressure drop</i>	<i>Application range</i>
SW1L & SRC-WL	3.5 bar	Full application range
SW1H & SRC-WS	1.5 bar	Inside area A2
	3.5 bar	Outside area A2

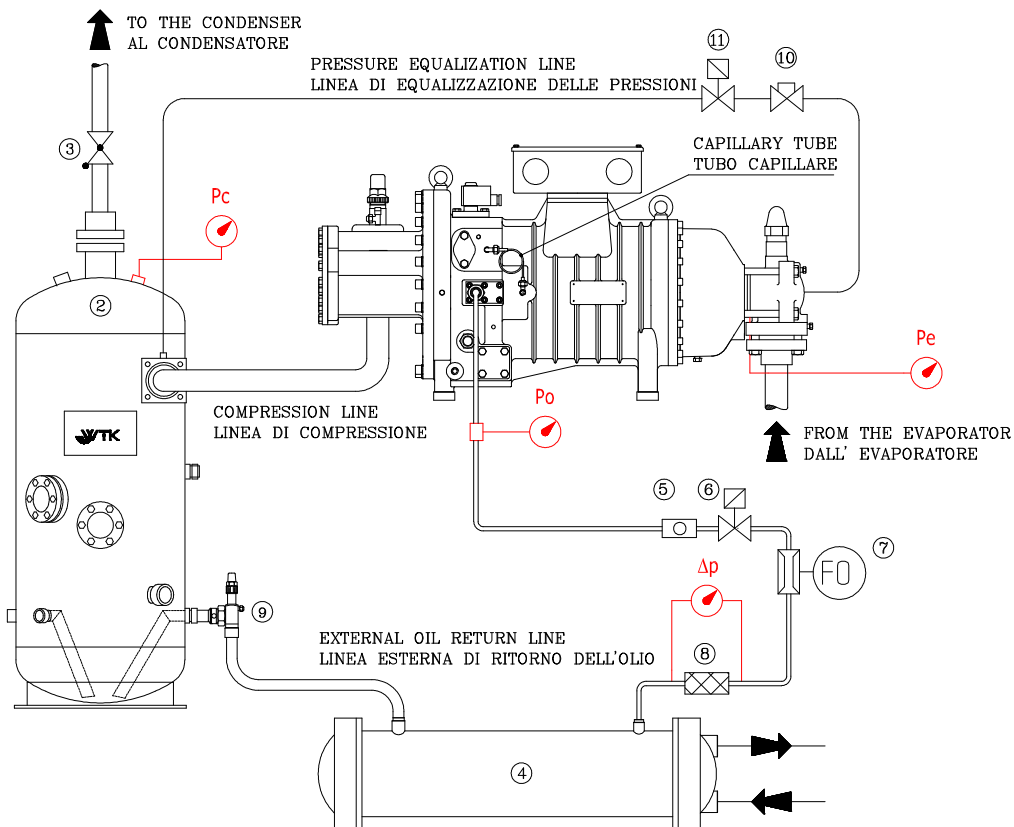
**Table E: pressure drop values for SRC-W & SW compressor series**



Picture 2-C: area of maximum pressure drop for SRC-WS & SW1H compressor series

With reference to Picture 2-D, to protect the compressor against insufficient lubrication, the following three pressure values need to be measured:

- $P_c$ : pressure inside the oil separator;
- $P_o$ : pressure of oil injected in the compressor;
- $P_e$ : pressure at the suction cover;
- $\Delta p$ : pressure drop on the oil filter.



Picture 2-D: points of measuring the pressure values on the circuit.

Given this input data, it's possible to verify:

- $P_c, P_e \Rightarrow$  fix working condition;
- $P_c, P_o \Rightarrow$  give the total oil line pressure drop:  $P_c - P_o$
- $\Delta p \Rightarrow$  gives the oil filter pressure drop:  $\Delta p < 0.8bar$


See chapter WA-08 “*Dimensional drawings*” to get more information about the points on the compressor where to measure the pressure values.

### 2.8.3 Level control

The oil level sensor, optical or floating depending on the models (see chapter WA-04: “*Components*”), can be installed on the oil separator to ensure that the vessel always contains a sufficient amount of oil.

### 2.8.4 Flow control

In addition, a flow switch kit is available (see chapter SA-04: “*Components*”) to monitor the flow of oil to the compressor.

	<p><b>Attention!</b></p> <ul style="list-style-type: none"><li>✓ The most reliable system is the flow control. Whenever this type of control is not used, pressure control and level control must be used together. Not combining the systems, in fact, may lead to unexpected situations that could undermine the reliability of the compressor.</li></ul>
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