HELICAL OIL SEPARATORS

The function of a Helical Oil Separator is to efficiently remove oil from the discharge gas and return it to the compressor, either directly or indirectly. This helps maintain the compressor crankcase oil level and raises the efficiency of the system by preventing excessive oil circulation.

A higher level of efficiency is to be expected compared to a conventional type oil separator.

Applications

Helical oil separators can be used in a wide variety of applications. Common applications include multi-compressor racks and remote condensing units.

Helical oil separators are intended for Low Pressure Oil Management Systems. These products are designed for use with scroll and reciprocating type compressors. They are not recommended for screw or rotary vane compressors.

The standard product range is designed for use with HCFC and HFC refrigerants, along with their associated oils. The SN range is suitable for use with HCFC, HFC and ammonia refrigerants. The SH high-pressure range is intended for R410A and sub-critical CO_2 applications.

Please contact Henry Technologies for new or special applications.

How it works

Upon separator entry, refrigerant gas containing oil in aerosol form encounters the leading edge of the helical flighting. The gas/oil mixture is centrifugally forced along the spiral path of the helix causing heavier oil particles to spin to the perimeter, where impingement with a screen layer occurs. The screen layer functions as both an oil stripping and draining medium. Separated oil flows downward along the boundary of the shell through a baffle and into an oil collection chamber at the bottom of the separator.

The specially engineered baffle isolates the oil chamber and eliminates oil re-entrapment by preventing turbulence. The virtually oil free refrigerant gas then exits through a second screen fitting just below the lower edge of the helical flighting. A float activated oil return needle valve allows the separated oil to return to the compressor crankcase or oil reservoir. There is a permanent magnet positioned at the bottom of the oil collection chamber to capture any system metal debris, which could impair the operation of the needle valve. With proper selection, an oil separation efficiency of up to 99% can be achieved.

Main Features

- Patented Henry Technologies Design#
- High oil separation efficiency - up to 99%
- Low pressure drop
- No blocked elements because of too much oil in the system
- No oil blow-out at start up from oil left in a coalescing element
- Cleanable/replaceable oil float assemblies for S-52*, SN52* and S-54* models

US Patents 5113671, 5404730 & 5271245; Mexico 173552; Denmark, France, UK & Italy 0487959; Germany P69106849.6-08; Taiwan UM-74863; & other worldwide patents pending

Technical Specification

For all models excluding SH series:-
Allowable operating pressure = 0 to 31 barg
Allowable operating temperature = -10°C to +130°C

For SH models:-
Allowable operating pressure = 0 to 40 barg
Allowable operating temperature = -10°C to +110°C

Materials of Construction

The main components; shell, end caps and connections are made from carbon steel. The oil float is made from stainless steel. The needle valve seat is made from either brass or steel, dependent on model.

STANDARD RANGE

Part No	Conn Size (Inch)	Dimensions (mm)							Mounting details	Drawing reference	Weight (kg)	Pre-charge qty (l)	CE Cat
		ØA	B	C	D	E	F	ØG					
S-5180	1/4 ODS	64	166	45	43	N/A	19.5	N/A	M10	fig.1	1.2	0.1	SEP
S-5181	3/8 ODS	64	195	45	71	N/A	19.5	N/A	M10	fig.1	1.4	0.1	SEP
S-5182-CE	1/2 ODS	102	333	69	64	N/A	58.5	N/A	M10	fig.2	3.4	0.4	CAT I
S-5185-CE	5/8 ODS	102	384	69	66	N/A	58.5	N/A	M10	fig.2	3.9	0.4	CAT I
S-5187-CE	7/8 ODS	102	434	74	76	N/A	58.5	N/A	M10	fig.2	4.6	0.4	CAT I
S-5188-CE	1 1/8 ODS	102	483	75	78	N/A	58.5	N/A	M10	fig.2	4.6	0.4	CAT I
S-5190-CE	1 3/8 ODS	152	384	108	91	N/A	60.5	N/A	M10	fig.2	8.9	1.1	CAT I
S-5192-CE	1 5/8 ODS	152	428	108	98	N/A	60.5	N/A	M10	fig.2	9.5	1.1	CAT I
S-5194-CE	2 1/8 ODS	152	436	114	105	N/A	60.5	N/A	M10	fig.2	9.7	1.1	CAT I
S-5285-CE	5/8 ODS	102	513	69	66	95	N/A	120.7	2 x Ø11mm holes	fig.3	6.3	0.7	CAT I
S-5287-CE	7/8 ODS	102	563	74	76	95	N/A	120.7	2 x Ø11mm holes	fig.3	7	0.7	CAT I
S-5288-CE	1 1/8 ODS	102	614	75	78	95	N/A	120.7	2 x Ø11mm holes	fig.3	7	0.7	CAT I
SN-5290-CE	1 3/8 ODS	152	508	108	91	99	N/A	113	2 x Ø14mm slots	fig.3	12	0.7	CAT I (see note 1)
SN-5292-CE	1 5/8 ODS	152	559	108	98	99	N/A	113	2 x Ø14mm slots	fig.3	12.5	0.7	CAT I (see note 1)
SN-5294-CE	2 1/8 ODS	152	559	114	105	99	N/A	113	2 x Ø14mm slots	fig.3	13	0.7	CAT I (see note 1)
S-5411-CE	1 5/8 ODS	219	641	148	164	100	N/A	166	3 x Ø14mm slots	fig.4	25	0.7	CAT III
S-5412-CE	2 1/8 ODS	219	641	148	164	100	N/A	166	3 x Ø14mm slots	fig.4	26	0.7	CAT III
S-5413-CE	2 5/8 ODS	273	750	183	201	100	N/A	223	3 x Ø14mm slots	fig.4	39	0.7	CAT III
S-5414-CE	3 1/8 ODS	324	821	215	229	100	N/A	273	3 x Ø14mm slots	fig.4	53	0.7	CAT IV

Notes:-
1. For use with ammonia, the CE Category increases to II

HIGH PRESSURE RANGE

Part No	Conn Size (Inch)	Dimensions (mm)							Mounting details	Drawing reference	Weight (kg)	Pre-charge qty (l)	CE Cat
		ØA	B	C	D	E	F	ØG					
SH-5182-CE	1/2 ODS	102	352	69	81	N/A	61	N/A	M10	fig.2	4	0.4	CAT I
SH-5185-CE	5/8 ODS	102	401	69	81	N/A	61	N/A	M10	fig.2	4.5	0.4	CAT I
SH-5187-CE	7/8 ODS	102	453	74	94	N/A	61	N/A	M10	fig.2	5.1	0.4	CAT I
SH-5188-CE	1 1/8 ODS	102	500	75	94	N/A	61	N/A	M10	fig.2	5.2	0.4	CAT I
SH-5190-CE	1 3/8 ODS	152	570	108	135	95	N/A	100	3 x Ø14mm slots	fig.5	9.4	1.1	CAT II

Adding the suffix "M" to the part number denotes that metric connections are preferred e.g. S-5192M-CE. The suffix "X" denotes that a 10mm ODS oil return is preferred instead of the standard 3/8 flare e.g. S-5185X-CE. Adding the suffix "XM" denotes the separator is to be fitted with both variations. Please contact Henry Technologies for availability of M, X and XM versions.

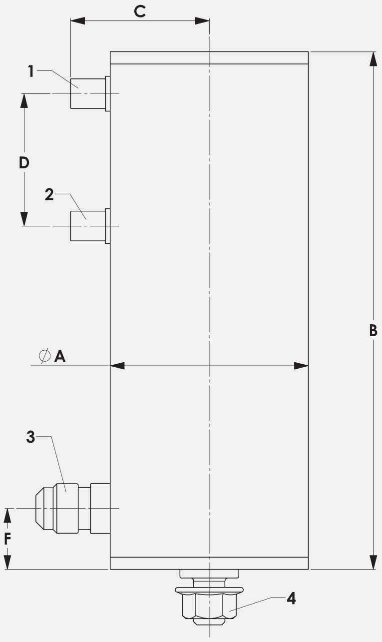

Fig. 1

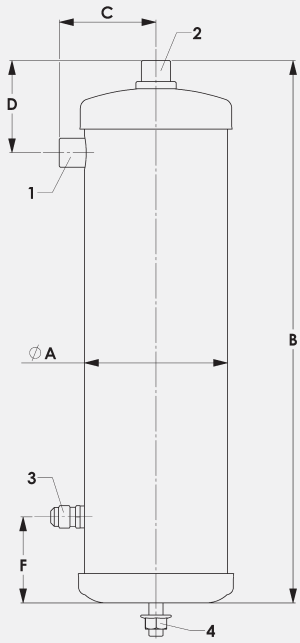

Fig. 2

1. Inlet
2. Outlet
3. Oil return, 3/8 SAE Flare
4. M10 stud and nut

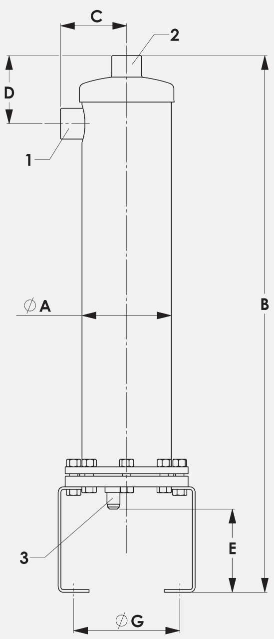

Fig. 3

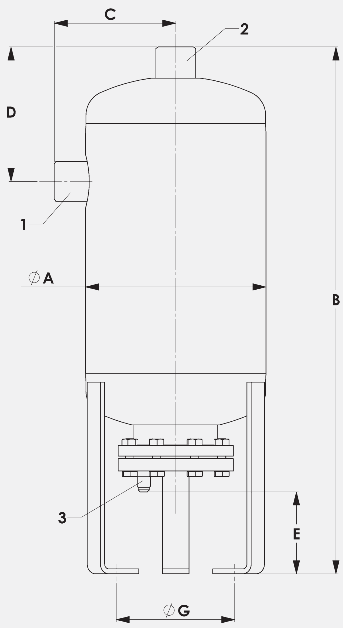

Fig. 4

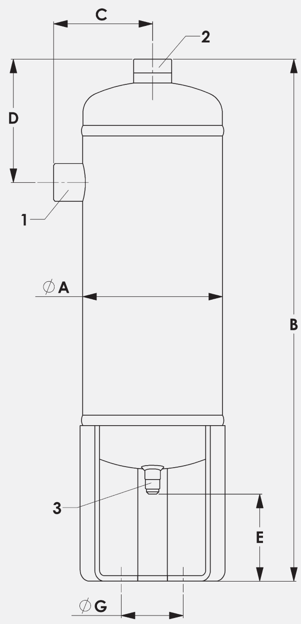

Fig. 5

HENRY TECHNOLOGIES

Performance data

This table provides a summary of the kW capacity of each separator for fixed evaporating and condensing temperatures. This table can be used as a quick reference guide. However, the Selection Guidelines are recommended for helical separator sizing.

Selection Guidelines

The most important parameter for selection is the discharge volumetric flow rate, expressed in m^3/hr. This is the calculated volume flow rate at entry to the oil separator. It is not to be confused with the compressor displacement or swept volume.

A quick method is to use the selection graphs. These graphs have been compiled for the common refrigerants R22 and R404A/R507.

A graph for R717 is also included. Graphs for other refrigerants are available on request.

The graphs are based on a simplified refrigeration cycle and hence the corresponding calculation of discharge volume flow rate is approximate. Although approximate, this method of selection has been used successfully for many years for standard refrigeration systems.

Where a higher degree of accuracy is required to calculate the m^3/hr, the flow rate calculation method is recommended. The flow rate calculation method is also recommended for CO_2 cascade and special applications.

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Part No	Capacity in kW of refrigeration at nominal evaporator temperature						Maximum discharge volume (m^3/hr)
	R404A/507		R 22		R 717		
	-40°C	5°C	-40°C	5°C	-40°C	5°C	
S-5180	2.6	3.5	2.6	3.5	N/A	N/A	1.3
S-5181	3.5	5.3	3.5	5.3	N/A	N/A	1.7
S-5182-CE, SH-5182-CE	5.3	7	5.3	7	N/A	N/A	2.6
S-5185-CE, S-5285-CE & SH-5185-CE	14.1	19.4	15.8	19.4	N/A	N/A	6.8
S-5187-CE, S-5287-CE & SH-5187-CE	23	30	24.6	28.2	N/A	N/A	10.2
S-5188-CE, S-5288-CE & SH-5188-CE	29.8	38.7	31.7	37	N/A	N/A	13.6
S-5190-CE, SN-5290-CE & SH-5190-CE	42.2	52.8	44.8	49.3	59.8 (note 1)	63.3 (note 1)	18.7
S-5192-CE & SN-5292-CE	52.8	66.9	56.3	63.4	77.4 (note 1)	80.9 (note 1)	23.8
S-5194-CE, SN-5294-CE & S-5411-CE	84.4	109	88	106	120 (note 1)	127 (note 1)	37.4
S-5412-CE	109	144	123	137	N/A	N/A	49.3
S-5413-CE	225	292	250	281	N/A	N/A	102
S-5414-CE	352	461	394	447	N/A	N/A	159.8

Notes:-
1. Ammonia capacity only applicable for SN models
2. All data is for a 38°C condensing temperature, 18°C suction temperature and a connection size the same as the compressor discharge valve

Helical Separator Selection using the Graphs

To use the selection graphs, the refrigerant type, maximum refrigeration capacity, minimum refrigeration capacity, evaporating temperature and the condensing temperature is required.

Example

Refrigerant R404A
Maximum refrigeration capacity = 40 kW
Minimum refrigeration capacity = 25 kW
Evaporating temperature = -35°C
Condensing temperature = +40°C

From the R404A graph, follow the -35°C evaporator temperature line to the intersection of the 40°C condensing temperature line. Extend a line horizontally from this point to the m^3/hr/kW factor. Multiply this factor by the maximum and minimum refrigeration capacities to compute the maximum and minimum discharge volume flow rates.

From the R404A graph, the [m^3/hr/kW factor] = 0.42

Therefore:
Maximum discharge volume flow rates = (0.42 x 40) = 16.8 m^3/hr
Minimum discharge volume flow rates = (0.42 x 25) = 10.5 m^3/hr

The maximum and minimum m^3/hr figures should be compared with the rated capacity of the helical separator. Refer to the Performance Data Table for the rated capacities.

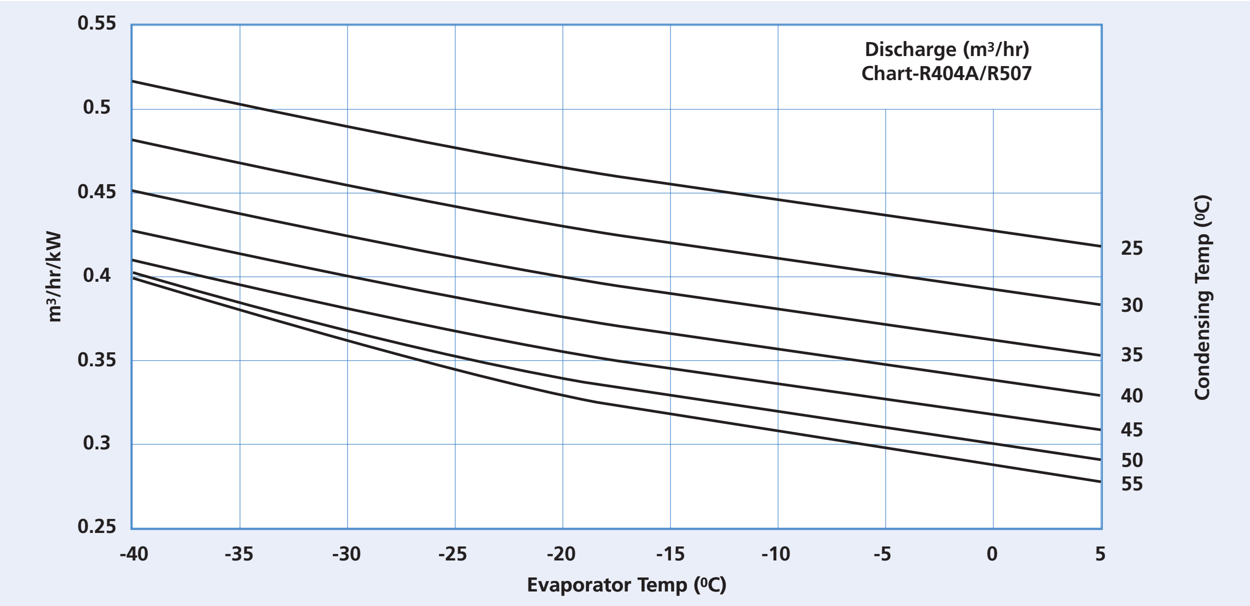
The general recommendation is that the calculated maximum flow should not exceed the rated capacity of the separator. Also, the minimum flow should not be below 25% of the rated capacity. Using these m^3/hr figures, the recommended helical separator selection is either model S-5190-CE or SN-5190-CE, both with a rated capacity of 18.7 m^3/hr. The final selection depends on whether or not the user requires a separator model with a removable/cleanable oil float assembly.

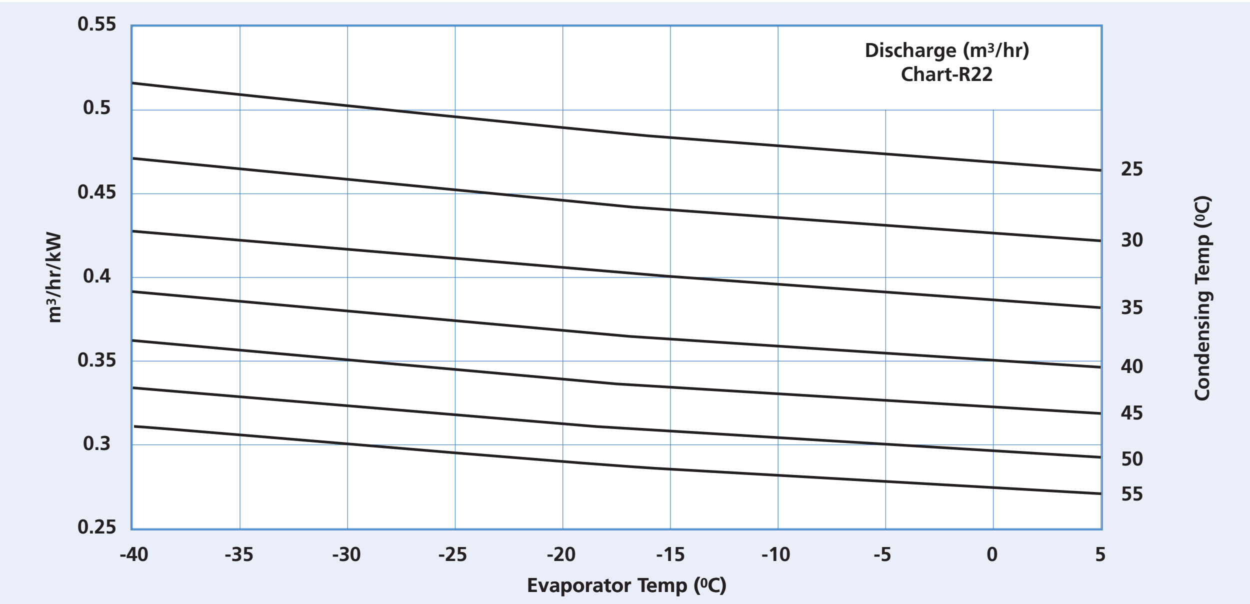
Additional notes on selection:-

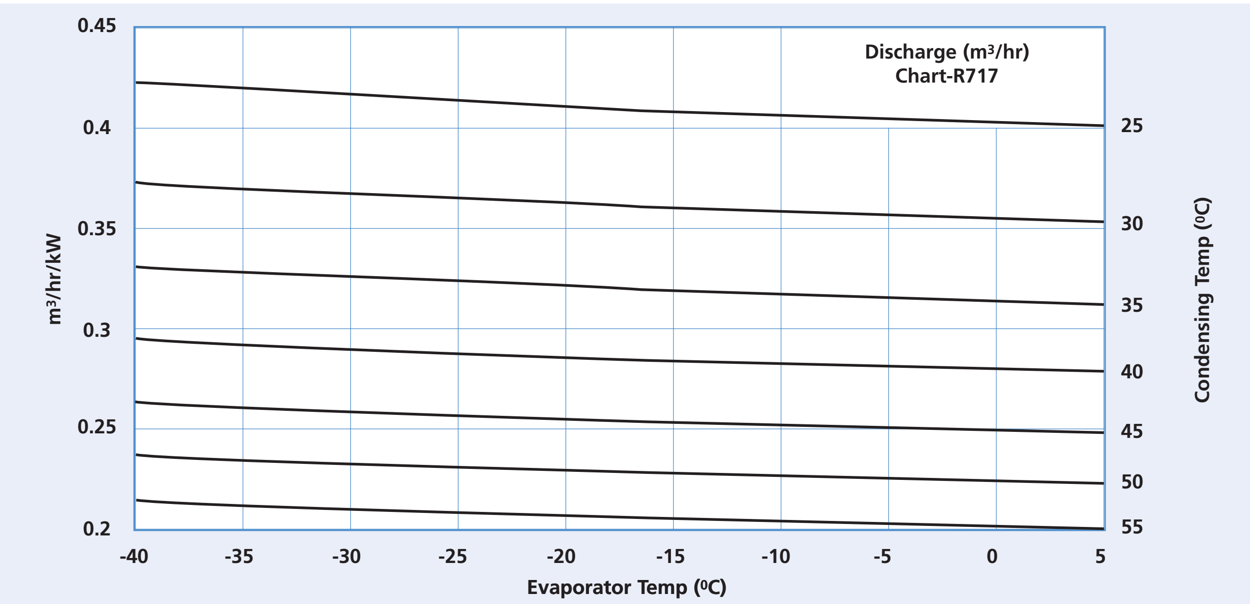
1. The 25% of minimum rated recommendation capacity rule is to optimise efficiency. Below this load factor, the efficiency of the separator will decrease. On systems with extreme unloading conditions, one separator per compressor should be used rather than one separator for a common discharge line.

2. Understanding the system refrigeration capacity and the percentage of full and low load run times can also be helpful in selecting the separator.

3. In cases where the maximum discharge has been exceeded by only a minimal amount and the system has unloading characteristics, select the smaller separator. It is not recommended to oversize.


Discharge (m³/hr)
Chart-R404A/R507
m³/hr/kW
0.55
0.5
0.45
0.4
0.35
0.3
0.25
-40
-35
-30
-25
-20
-15
-10
-5
0
5
Evaporator Temp (ºC)
25
30
35
40
45
50
55
Condensing Temp (ºC)


Discharge (m³/hr)
Chart-R22
m³/hr/kW
0.55
0.5
0.45
0.4
0.35
0.3
0.25
-40
-35
-30
-25
-20
-15
-10
-5
0
5
Evaporator Temp (ºC)
25
30
35
40
45
50
55
Condensing Temp (ºC)


Discharge (m³/hr)
Chart-R717
m³/hr/kW
0.45
0.4
0.35
0.3
0.25
0.2
-40
-35
-30
-25
-20
-15
-10
-5
0
5
Evaporator Temp (ºC)
25
30
35
40
45
50
55
Condensing Temp (ºC)

Helical Separator Selection using the Flow Rate Calculation

To use the Flow Rate Calculation method, the maximum and minimum system mass flow rates are required along with the density of the gas at the inlet to the separator. These mass flow rates can either be calculated from first principles or by using refrigeration cycle analysis software. In this way, superheating (useful and un-useful), sub-cooling, etc. can be accounted for in the mass flow rate calculation.

The gas density at inlet to the separator is a function of both pressure and temperature. The gas density should be taken at a pressure equal to the condensing saturation pressure. The inlet gas temperature is dictated by a number of system design factors including compressor performance. The gas will be in a superheated state.

Example
Refrigerant CO_2 (R744)
Maximum refrigeration capacity = 62 kW
Minimum refrigeration capacity = 40 kW
Evaporating temperature = -35°C
Condensing temperature (Cascade) = 0°C
Degree of superheat, useful = 5K
Degree of superheat, un-useful = 6K
Degree of sub-cooling = 2K

From calculation:-
Maximum mass flow rate = 904 kg/hr
Minimum mass flow rate = 583 kg/hr
Gas density, superheated, at inlet to separator = 63.5 kg/m^3
(for a separator inlet temperature of 60°C)

Note: Mass flow rate = [(kW refrigeration/ refrigerating effect) x 3600]

Use the equation:-

$$\text{Discharge volume flowrate} = \frac{\text{Mass flow rate}}{\text{Gas density}}$$

Hence for this example:-

$$\text{Calculated maximum discharge volume flowrate} = \frac{904}{63.5} = 14.2\ \text{m}^3\text{/hr}$$

$$\text{Calculated minimum discharge volume flowrate} = \frac{583}{63.5} = 9.2\ \text{m}^3\text{/hr}$$

Using these m^3/hr figures,the recommended helical separator selection is model SH-5188-CE (reference additional note 3 for guidance on minimal under-sizing).

Installation – Main Issues

1. Oil separators are not 100% efficient, so installing an oil separator should not be viewed as a replacement for oil traps, suction line accumulators or good oil return piping practices.
2. To avoid damaging the needle valve, oil pre-charge is required. Refer to the Performance Data Table for pre-charge quantity.
3. Install the oil separator vertically and reasonably close to the compressor. Proper piping practice should be adopted to prevent excessive loads or vibration at the inlet and outlet connections. The separator must be properly supported at the bottom M10 stud or mounting feet interface.
4. A check valve should be located downstream of the outlet connection. This check valve is to prevent liquid refrigerant migrating from the condenser.