

APPLICATION AND OPERATION OF TWO-STAGE COMPRESSORS

1 General

The two-stage DWM Copeland compressors were developed in order to meet low temperatures required in many of the application areas existing today. They were mainly designed for operation in plants with low evaporation temperatures using R22 or R404A/R507. The distinctive advantage of the application of two-stage compressors is that the operation with R404A allows evaporation temperatures down to $\sim -60^{\circ}\text{C}$. With single-stage compressors a minimum of $\sim -50^{\circ}\text{C}$ is reached.

Two-stage compressors are divided into the low pressure stage (LP) and the high pressure stage (HP). The 3 cylinder models have two cylinders in the LP and one cylinder in the HP stage; the 6 cylinder models have four cylinders in the LP and two cylinders in the HP stages. Suction gas enters the cylinders of the LP stage where it is compressed to a pressure between the suction pressure and the condensing pressure. This is called intermediate pressure. The gas is then fed from the cylinder heads of the LP stage into the intermediate pressure mixing line. At this point the gas has a relatively high temperature and liquid refrigerant is injected into the gas flow via an expansion valve in order to prevent overheating. The cooled gas flows through the intermediate pressure mixing line arranged externally to the compressor, into the motor housing and the motor, whereby the necessary motor cooling is effected and enters the cylinder of the HP stage in the usual manner where it is compressed to condensation pressure and discharged to the condenser. The discharge from the LP stage into the motor housing and the crankcase are under intermediate pressure. Forced air cooling of the motor and auxiliary ventilation of the cylinder head is not required. Diagrams 1 to 6 show the approximate intermediate pressure (motor housing and crankcase) as well as the temperature under various evaporating and condensing temperatures with R22 and R404A. Refrigeration capacities in the data sheets show the entire refrigeration effect with/or without liquid subcooling, i. e. the product of refrigerant mass flow times the difference of the specific enthalpy of the refrigerant at the inlet of the compressor LP stage and at the outlet of the condenser or liquid subcooler.

See diagram 5 without liquid subcooler and diagram 6 with liquid subcooler.

2 Pipe Connections

The connections for high and low pressure switches as well as the discharge and suction shut off valves are located in different positions to those of single-stage compressors. These, and the connections for the intermediate pressure mixing line are shown in Figures 1 to 10 together with the cylinders of the LP and HP stages.



Caution: Never operate a two-stage compressor without the external intermediate pressure mixing line being in position otherwise there is no outlet for the high pressure gas discharged from the low-stage cylinders making an explosive situation.

In the two-stage compressors a Schrader valve is installed to connect a pressure gauge thus enabling easy monitoring of the intermediate pressure. These valves open automatically when the line is connected, using a special coupling. They can be installed subsequently in all compressors which are already in use by removal of the connection plug on the motor side casing over. Schrader valves with 1/8" taper thread 27 NPTF and special connection couplings for them can be supplied by DWM Copeland.

3 Liquid Sub-Cooler

In order to increase the output and the efficiency of the system, a heat exchanger is used as liquid sub-cooler in two-stage compressors and installed between the expansion valve for the intermediate stage and the compressor intermediate pressure mixing line. See figures 7, 8 and 10 showing installation of the subcooler. The evaporated refrigerant first cools the liquid refrigerant on its way to the evaporator and subsequently the discharge gas coming from the cylinders of the low pressure stage. The temperature of the liquid coming from the sub-cooler is about 6K above the saturation temperature of the intermediate stage (saturated temperature corresponding with the intermediate pressure.) The liquid line must be insulated so that the advantages of liquid sub-cooler can be fully utilized. Figures 5 to 10 contain suggestions for plants with and without liquid sub-coolers. When soldering the connections of the sub-cooler, it must be protected against overheating in order to prevent damaging the insulation. If there is a possibility of liquid refrigerant leaving the sub-cooler gaining heat in a long pipe line up to the evaporator expansion valve, then the sub-cooling effect may be lost. In this case, a normal liquid to suction line heat interchanger, available on the open market, should be installed down stream of the evaporator to increase the capacity.

In general the application of liquid to suction heat interchangers at the evaporator outlet and/or the insulation of the suction line reduces or prevents the formation of condensation.

4 Liquid Solenoid Valve

In the liquid line to the intermediate stage, a solenoid valve must be installed directly before the expansion valve to prevent liquid flow during stand still periods. It is electrically connected in such a way that it is open when the motor runs and closed when the motor is off. A manual switch placed in the electric feed line the solenoid valve will facilitate service during pump down. A fine mesh filter also supplied must be installed in the liquid line to the expansion valve for the intermediate stage before the solenoid valve to protect both valves from impurities.

5 Oil Pressure Safety Devices

Oil pressure safety devices are standard equipment of all two-stage compressors. Their use is absolutely necessary. Please see further Technical Bulletins concerning these devices.

6 Oil Separator

As two-stage compressors are especially intended for operation with low evaporation temperatures, oil return from the plant is difficult, and the use of oil separators is mandatory. The oil separator not only reduces the circulating oil flow in the plant but also can act as a muffler and contribute to lower gas pulsations. However, oil separators only have a certain level of efficiency, and some oil will pass over into the low pressure side of the system. The plant must therefore be designed as far as possible to ensure consistent oil return from the suction side. Even this cannot always be achieved, but when for example, after defrosting several times per day the suction pressure at the end of defrost is briefly higher, the gas flow velocity is also higher and oil return can take place.

7 Suction Line Accumulator

In order to prevent damage to these compressors due to refrigerant and/or oil liquid slugging, especially in systems where there is the possibility of liquid or oil being returned to the compressor irregularly, the use of correspondingly dimensioned suction line accumulators is highly recommended. This is especially desirable in the case of two-stage compressors because the suction gas enters directly into the cylinder head. The motor housing, arranged ahead of the high pressure stage, is able to provide a certain separation function. This is only available in the interstage pressure area of two-stage compressors and as a result cannot be effective on the LP suction side. These accumulators must be designed in such a way that constant return of the gaseous refrigerant and oil is guaranteed.

8 Suction Line Filter

Suction line filters should be installed to prevent minute particles of scale, flux, sludge, dirt, copper filings, etc. from entering the compressor.

The selection of the filter must be made very carefully as it creates pressure drop and thus output losses.

9 Liquid Sight Glasses

A liquid line sight glass is supplied and must be installed directly before the intermediate stage expansion valve (de-superheating expansion valve). This enables the liquid supply to be checked.

If a sub-cooler is used a second sight glass should be installed between the receiver and sub-cooler in the main liquid line (figure 7) It should not be installed after the sub-cooler, because due to the sub-cooling the liquid bubbles will not appear, even though a shortage of refrigerant may exist.

10 Relief Valve

In order to protect the crankcase from excessive inter-stage pressure the two-stage compressors are equipped with a relief valve between the intermediate stage and the LP suction chambers. If the inter-stage pressure becomes too high the valve opens a passage to the suction side of the LP stage. The valve is installed in the valve plate on compressor models D6TA/H/J... in the low pressure top cylinder bank). These relief valves open when a differential pressure of 15 bar is exceeded.

11 Suction Pressure Control

During operation of two-stage compressors outside the application limits specified in the technical data sheets, i.e. if the saturation temperature of the suction gas is above the permissible maximum evaporation temperature shown in the technical data sheets, the motor is overloaded and switching off of the motor protector must be taken into consideration. Suction pressure can be limited to a certain maximum value by using a pressure limiting expansion valve (expansion valve with MOP) or by installing a crankcase pressure regulator. The pressure drop in this regulator should correspond to a maximum value of 1K under normal operating conditions.

12 Expansion Valve for Intermediate Stage

In all DWM Copeland two-stage compressors liquid refrigerant is injected via an expansion valve in the inter-stage pressure mixing line in order to decrease the superheat of the discharged gas from the low pressure stage. The expansion valves which are a part of the equipment of two-stage compressors are shown in Table 1 & 2. For 3 cylinder version “3” compressors non adjustable valves are standard delivery. For 4 & 6 cylinder compressors adjustable valves are used.

If the expansion valve does not function properly, check to determine whether this valve, the solenoid valve or the filter in the liquid line are blocked. The latter must be cleaned. The expansion valve must be flushed through thoroughly. If despite cleaning no satisfactory result has been reached, the valve must be changed. In case that the superheat of the valves has to be controlled or corrected see Table 1 & 2 and/or following recommendations:

Normally it will be necessary to control and alter the factory adjustment of the adjustable valve in order to achieve the corresponding output. The valve must be set in such a way that the temperature difference (superheat) of 8K to 16K is reached between the temperature of the inter-stage pressure line at the bulb and the saturation temperature of refrigerant under inter-stage pressure (gauge pressure reading).

Example

Use of R 22 with an inter-stage pressure of 3.19 bar (a)

| | | |
|---|-------|-------|
| Required super- heating limitation at 3.19 bar (a) | 8K | 16K |
| Saturation temperature | -13°C | -13°C |
| Resulting temperature limitation of the intermediate pressure mixing line | -5°C | 3°C |

The expansion valve for the intermediate stage must therefore be adjusted in such a manner that a temperature in the inter-stage pressure mixing line at the bulb is maintained between -5 °C and +3°C.

The following tables 1 & 2 are showing the de-superheating expansion valves for inter-stage injection, as well as the DWM Copeland Part Number with the relevant Sporlan or Alco model (adjustable or non-adjustable) for the corresponding compressor models. Subcoolers are also listed.

With adjustable de-superheating expansion valves superheating can be increased by rotating the superheat adjustment screw in a clockwise direction and decreased by rotating counter clockwise. Instructions for readjustment of the adjustable valves apply to the standard application range (see data sheet).

Our tests have shown that the same expansion valve for both R22 and R404A can be used with satisfactory results (approved compressors: see literature).

When using the compressors outside of the application limits specified in the technical data sheets, i.e. for R22 down to approximately -60°C and for R404A down to approximately -70°C evaporation temperature the use of such an adjustable expansion valve is necessary and must be adjusted. Wide fluctuation in pressure, caused by opening and closing of the expansion valve must be avoided. Superheating at the valve bulb is between 8 and 16K. False adjustment or malfunction of the expansion valve can lead to a return of liquid refrigerant in the motor and crankcase which among other things can cause oil dilution.

For operation of the compressor outside of the application limits specified by DWM Copeland the agreement of the Application Engineering department should be obtained.

NOTE: The connection of the liquid line to the expansion valve for the intermediate stage must be made very carefully. The line may not be smaller than 10 mm o.d. and must be connected to a horizontal line from below so that a constant liquid flow is ensured at all times. This line must never originate on the top of a horizontal line because then only gas may flow. In this case the temperature in the intermediate pressure mixing line would be too high and the motor would not be sufficiently cooled. Connection to a vertical line with low velocity is permissible.

13 Twin Operation

The Twin combination of two-stage compressors via connection of their motor sides by means of an intermediate manifold and allows if needed part-load operation (cycling one compressor from the Twin on & off). It is recommended to use one oil separator for each compressor. Further for two-stage Twin-compressors a connection line between the pressure shut off valves (HP side) must be provided on site. There is an external connecting line between the suction shut-off valves that is part of the scope of delivery for 6 cylinder twin compressors only. In each case the discharge line must be installed downward from the shut off valve in order to ensure that the oil is not forced from one operating compressor to the other compressor at standstill. An obligatory example of installation schemes for two-stage Twin compressors can be found on pages 14 and 15 figures 9 & 10.

Please note also that the Twin-compressor is mounted on its frame by means of employing rubber shims to equalize the manufacturing tolerances and to avoid stress that may arise during the installation of the Twin compressor. If the foundation base is light and if sound and vibration transmission have to be reduced additional absorbers should be installed between the frame and the foundation (installation on site).

In case that only one compressor of the Twin is operating it has to be ensured that the de-superheating expansion valve of this specific compressor is fed with liquid refrigerant so that the de-superheating of the inter-stage gas is working properly.

To ensure that the obtained liquid subcooling / cooling capacity is not wasted, the system has to be designed correctly. Also make sure that no hydrostatic pressure can occur in parts of the system, e.g. separated by magnetic valves.

14 Unloaded Start

For the prevention of system disturbances power companies limit the permissible size of motor for Direct- On-Line starting. A substantial reduction of the breakaway motor starting current can only be achieved if the load on the motor is reduced at the same time. Various starting methods are available like Star-Delta, Part Winding, Resistance, Phase Angle Control (Soft-starting) or Transformer Start.

In general an unloaded start (bypass) of the compressor is also necessary additional to the pre-mentioned starting methods. This is achieved by connecting the HP discharge side with the LP suction side of the compressor on site by means of a bypass line with solenoid valve. The discharge gas is returned to the suction side of the compressor thus equalizing the pressures across the compressor for starting. A check valve in the discharge line is also necessary.

While selecting and installing please observe Section 16 concerning discharge pulsation, chattering of the check valve due to pulsation must be avoided.

The unloaded start equipment offered by DWM Copeland for single-stage compressors is not suitable for two-stage compressors. Some basic recommendations concerning typical wiring of two-stage compressors are shown on pages 16 & 17.

15 Defrost Equipment

15.1 Electric

With electric defrost equipment, the compressor is not in operation during the defrost cycle, thus no special precautionary measures are necessary in addition to the normal measures for single-stage systems.

15.2 Hot Gas

In two-stage compressors the motor cooling depends on the adequate supply of liquid refrigerant for the expansion valve for the intermediate stage. If hot-gas defrost equipment is used it is absolutely necessary that a sufficient amount of liquid with sufficient pressure is supplied to the expansion valve at all times. As hot gas defrost equipment vary widely in design it is not possible to establish general rules on which special monitoring devices are necessary. Many manufacturers have tested their devices thoroughly; during application of the defrost, however, throttle valves may be necessary to maintain the liquid pressure together with additional refrigerant charge or other special monitoring equipment.

16 Pulsation/Vibrations

All reciprocating compressors cause gas pulsation in the discharge line. The intensity of the pulsation increase with the decreasing number of cylinders, which discharge into a common discharge line and with the increase of volume and density of the supplied gas.

Two-stage compressors operate with gas of higher density in the HP stage. In compressor models D9 only one cylinder and D6 two cylinders discharge into the discharge line therefore the pulsation of two-stage compressors can be larger than that of single-stage compressors.

Normally these pulsation do not create any problems. Sometimes, however, the combined reaction of operating conditions, mounting and pipe arrangement can result in a resonant condition, which tends to magnify the pulsation and cause vibration.

In order to solve this problem muffler plates for D9 and D6 two-stage compressors have been developed. These muffler plates fit between the compressor casing and the discharge shut off valve. These plates give an effective dampening of compressor pulsations. They are now being installed in all new two-stage compressors as standard equipment. If pulsation problems exist in already operating systems, the installation of muffler plates is recommended. These plates are available from us under the part number listed in our spare parts list.

If the size of pipes and connections are such that resonance is created and the muffler plate does not dampen it sufficiently, it may be necessary to bolt the compressor to the supporting base with rubber vibration dampers, whereby vibration frequency is altered. Top and bottom vibration damper can be found in our spare parts list.

Inter-stage Expansion Valves and Liquid Subcoolers

| Compressor Model | Subcooler (separate) | Interstage TXV (can also be used on a compressor without subcooler) | |
|------------------------------|----------------------------------|--|---|
| | | With Internal Pressure Equalisation | |
| Variation 3 | Co-axial HX to be fitted on site | Non Adjustable | Adjustable |
| Valid until Feb. 2001 | Part Number of Subcooler | Type Part Number | a) Type b) Part Number c) Adjustment |
| D9TK3 - 0760 D9TL3 - 0760 | 2932627 | Sporlan NIV-2-Z,32 psig 2502433 | a) Sporlan CV-2-Z,32 psig b) 2829238 c) 2 turns in |
| D9TH3 - 0760 | | Sporlan NIV-3-Z,37 psig 2051004 | a) Sporlan CV-3-Z,37 psig b) 2829249 c) 1/4 turn in |
| D9TH3 - 1010 | | Sporlan NIV-3-Z,32 psig 2502455 | a) Sporlan CV-3-Z,32 psig b) 2829250 c) 2 turns in |

| Compressor Model | Subcooler (mounted) | Interstage TXV (can also be used on a compressor without subcooler) | |
|---|--------------------------|--|--|
| | | With External Pressure Equalisation | |
| Variation 4 | Plate HX | Adjustable | |
| From Mar. 2001 | Part Number of Subcooler | Type & Part Number | |
| D9TK4 - 0760 D9TL4 - 0760 D9TH4 - 0760* D9TH4 - 1010 | 2979360 | ALCO TCLE-GT 2744 (Pre-set) 2979371 | |

Table 1: Three Cylinder Two-Stage Compressor - R22 only

NOTE: Compressor model designation varies with type of subcooler and interstage expansion valve. Do not use interstage expansion valves with internal pressure equalisation with plate heat exchangers

* Model phased out January 2005

| Compressor Models | Plate HX Subcooler | Interstage TXV |
|---|------------------------|--|
| D6TA - 1500/X D6TH - 2000/X D6TJ - 2500/X | Spare Part No. 6611253 | With external pressure equalisation Sporlan BFVECC 6611048 (for use with subcooler) |
| | | With internal pressure equalisation Sporlan BFV-C-C 6611037 (for use with subcooler) |

Table 2: Six Cylinder Two-Stage Compressor - R22 & R404A

NOTE: The "X" in compressor model designation indicates compressor filled with ester oil. The D6T* compressors arrive with HX as a part of the standard delivery. Without HX is an option.

Standard delivery: with HX and TXV (non adjustable before February 2001).

Diagram 1

3 cylinder two-stage compressor without subcooler, R22

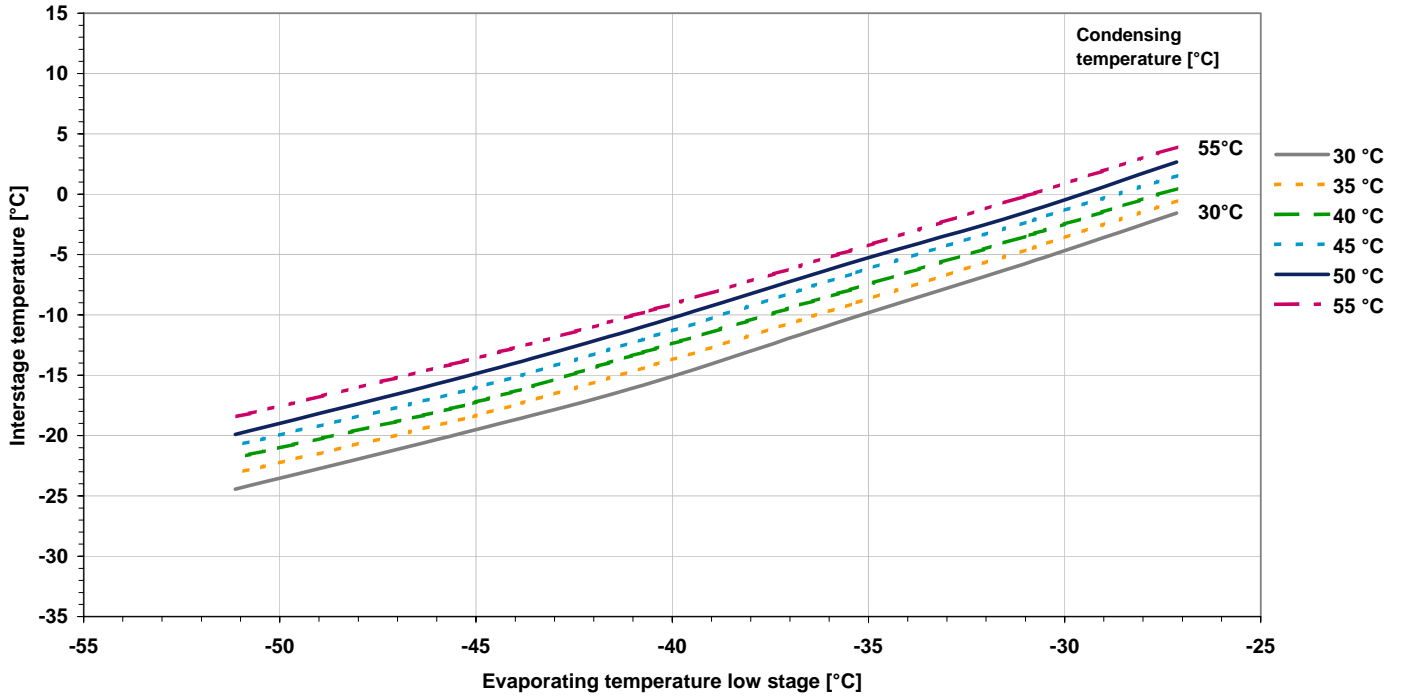


Diagram 2

3 cylinder two-stage compressor with subcooler, R22

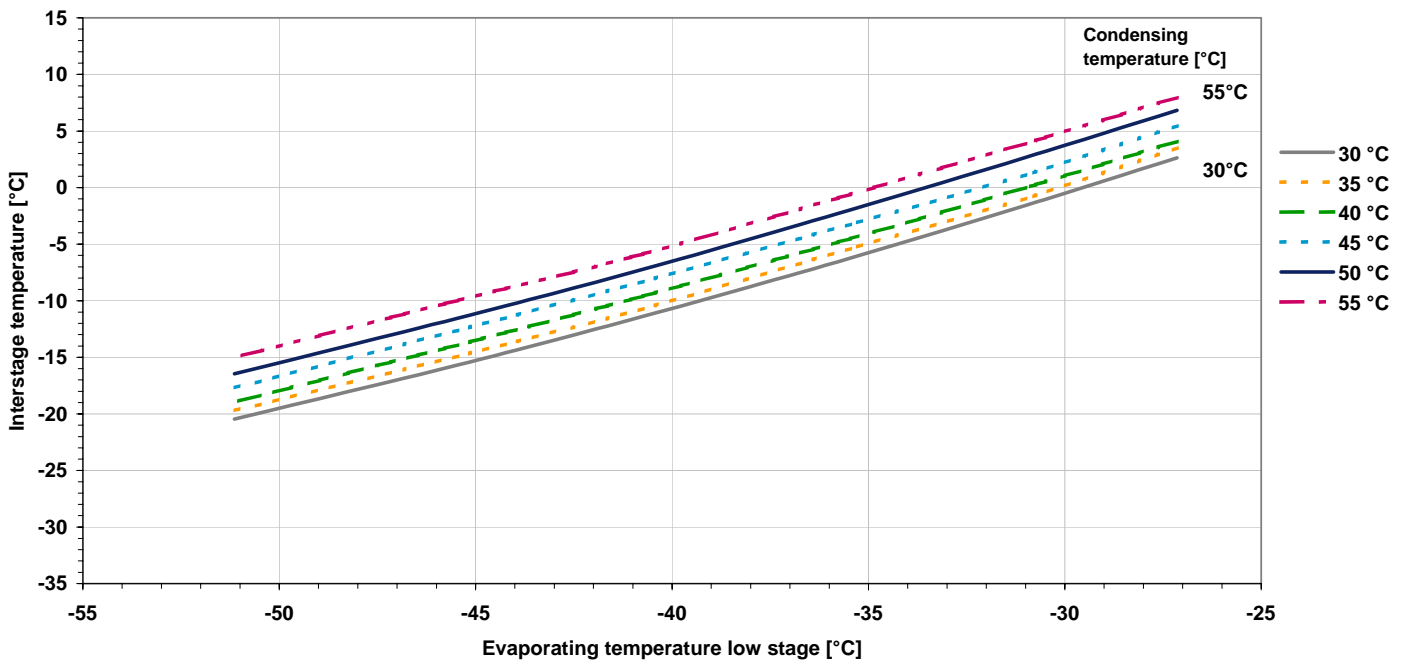
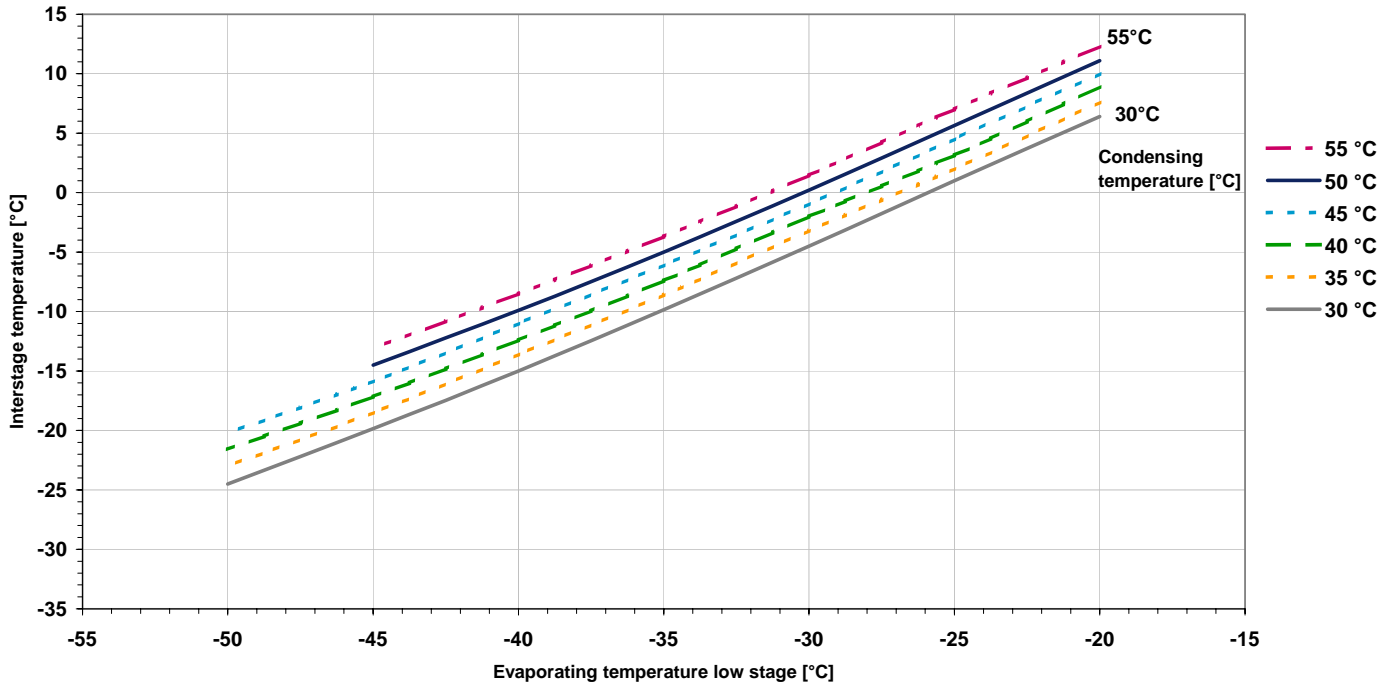


Diagram 3

6 cylinder two-stage compressor without subcooler, R22



6 cylinder two-stage compressor with subcooler, R22

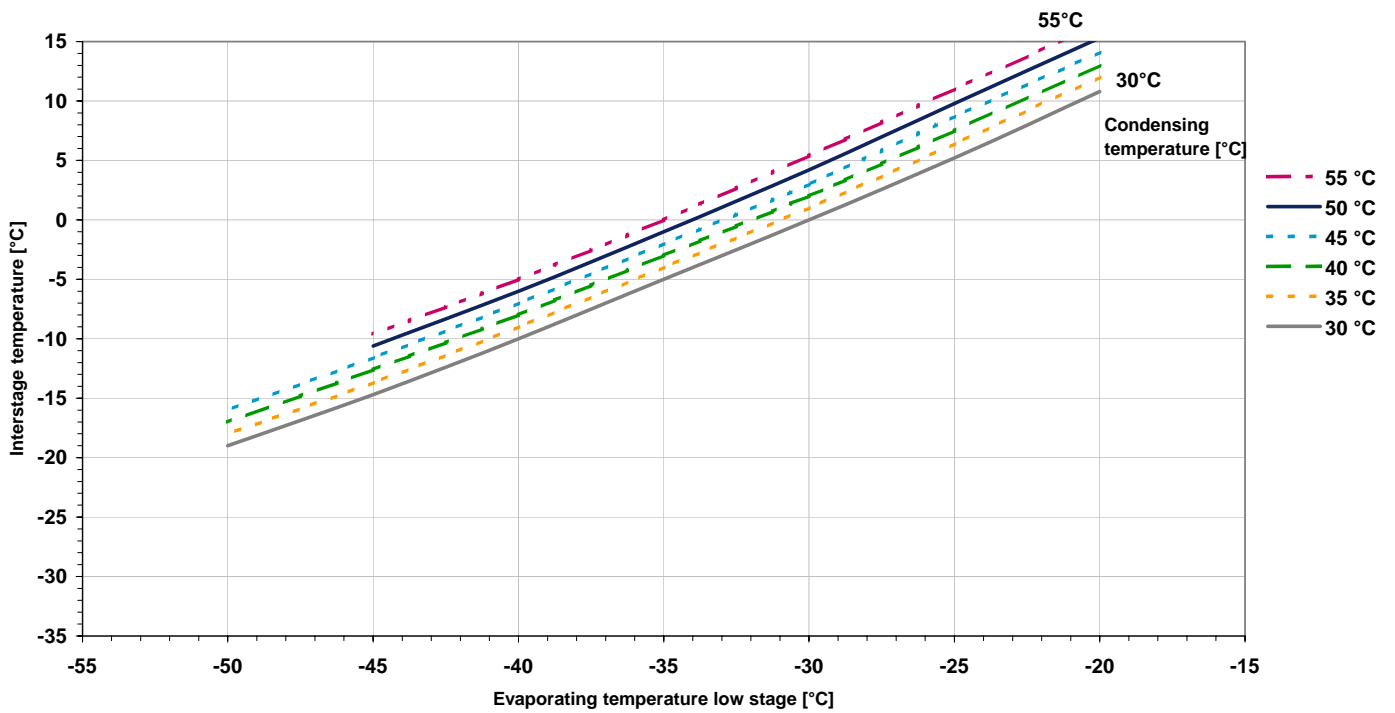


Diagram 4

Diagram 5

6 cylinder two-stage compressor without subcooler, R404A

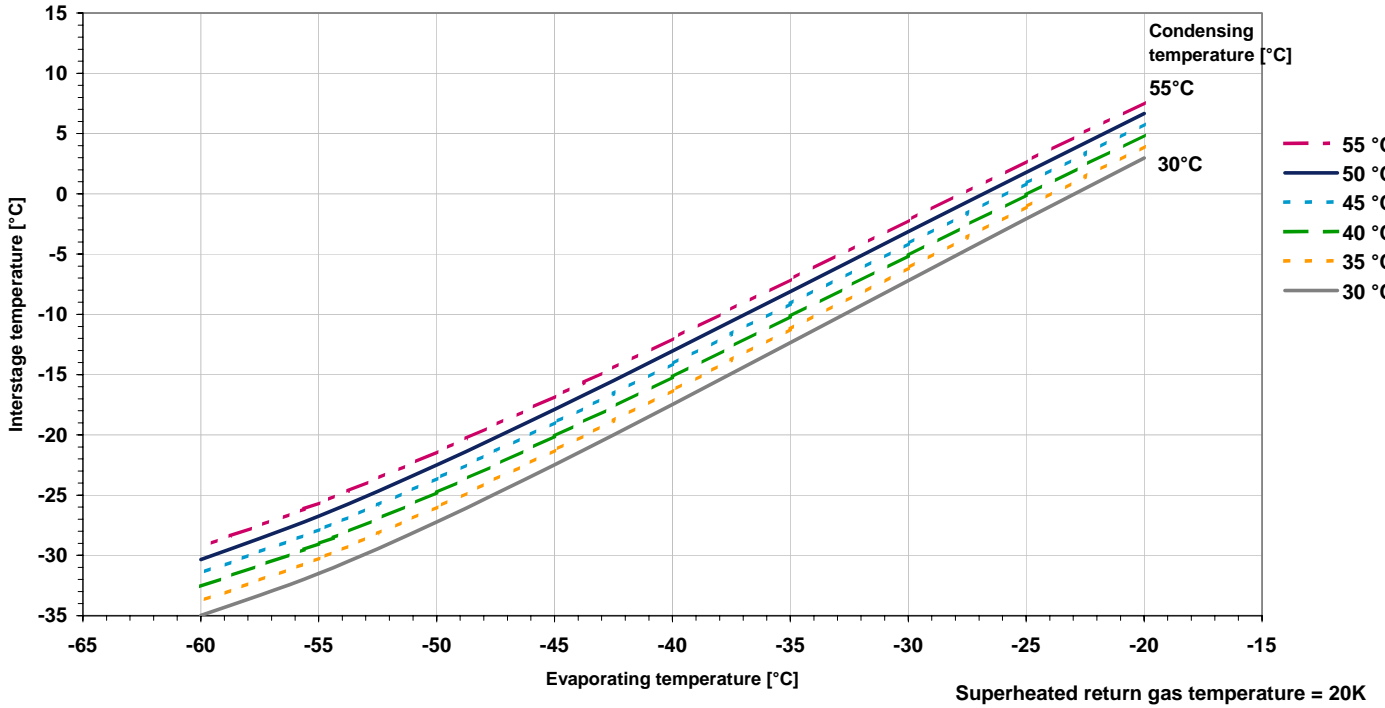


Diagram 6

6 cylinder two-stage compressors with subcooler, R404A

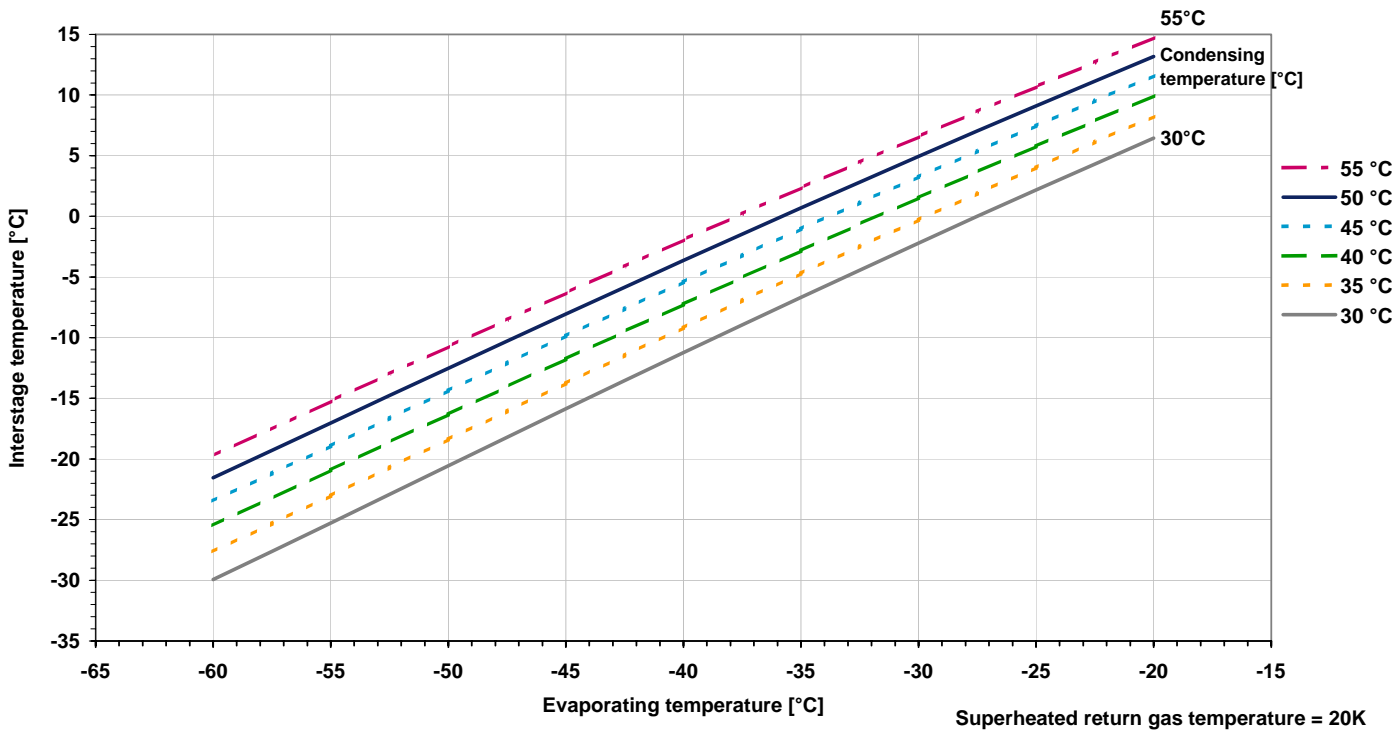


Figure 1: 3 cylinder two-stage compressor (Version D9T. 3..) without liquid subcooler - connections

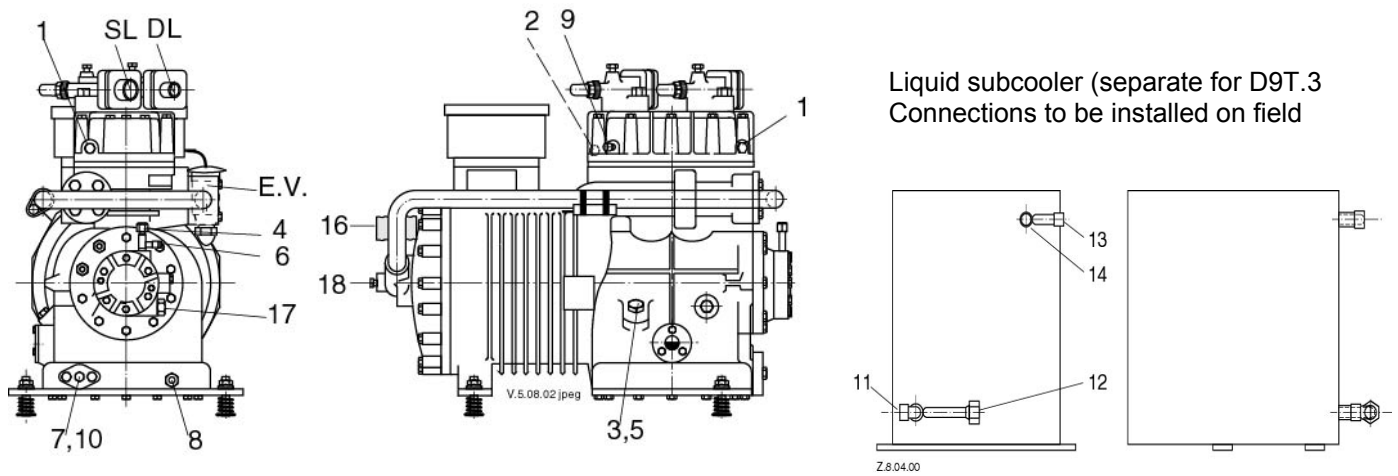
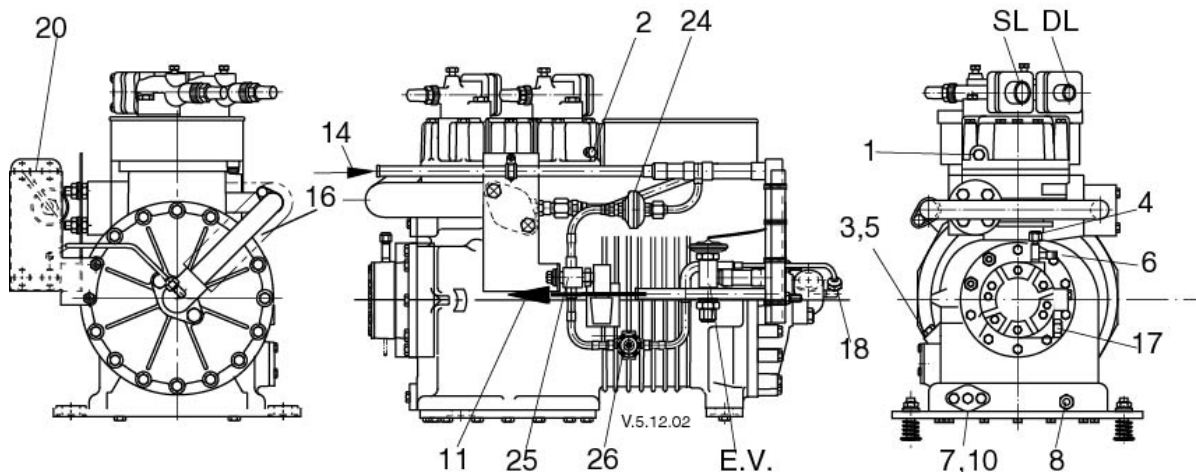


Figure 2: 3 cylinder two-stage compressor (Version D9T. 4..) with liquid subcooler mounted at compressor connections



- | | |
|---|--|
| SL = Suction shut-off valve | 10 = magnetic plug |
| DL = Discharge shut-off valve | 11 = liquid line to evaporator, sweat |
| E.V.= De-superheating expansion valve | 12 = connection de-superheating expansion valve |
| 1 = plug low-pressure connection | 13 = line to compressor interstage manifold, sweat |
| 2 = plug high-pressure connection | 14 = liquid line from receiver, sweat |
| 3 = plug oil charge | 16 = insulation |
| 4 = flare oil-pressure control H.P. | 17 = plug oil-pressure sensor |
| 5 = plug oil-pressure control L.P. | 18 = plug intermediate pressure connection |
| 6 = oil-pressure connection (Schrader) | 20 = liquid subcooler |
| 7 = oil screen (internal) | 24 = filter |
| 8 = sleeve (crankcase heater) | 25 = solenoid valve |
| 9 = intermediate pressure connection (Schrader) | 26 = sight glass |

Figure 3: 6 cylinder two-stage compressor without liquid subcooler connections Models with flat bottom plate shown

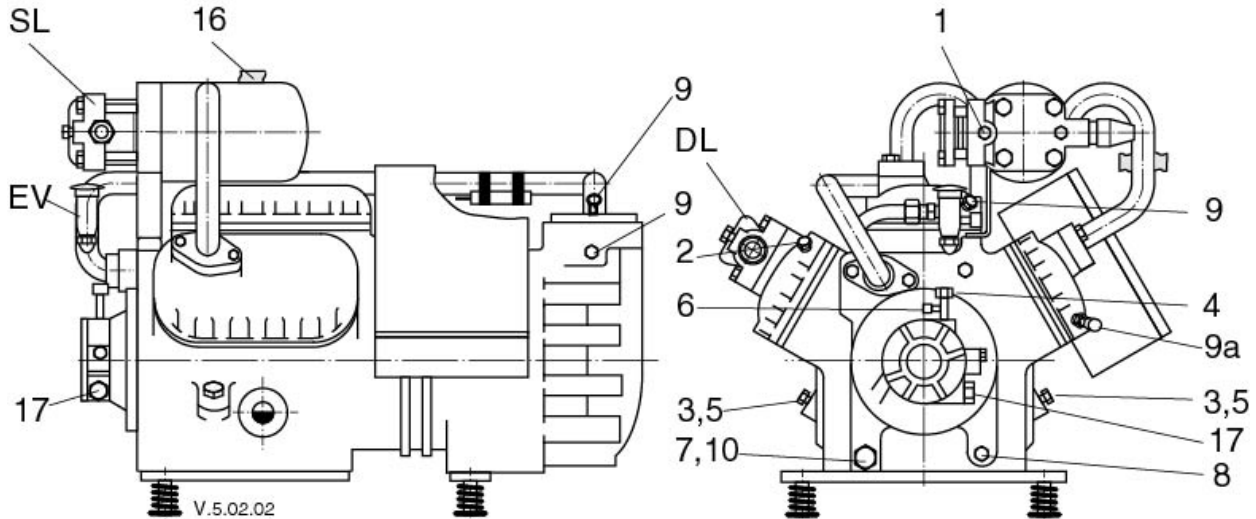
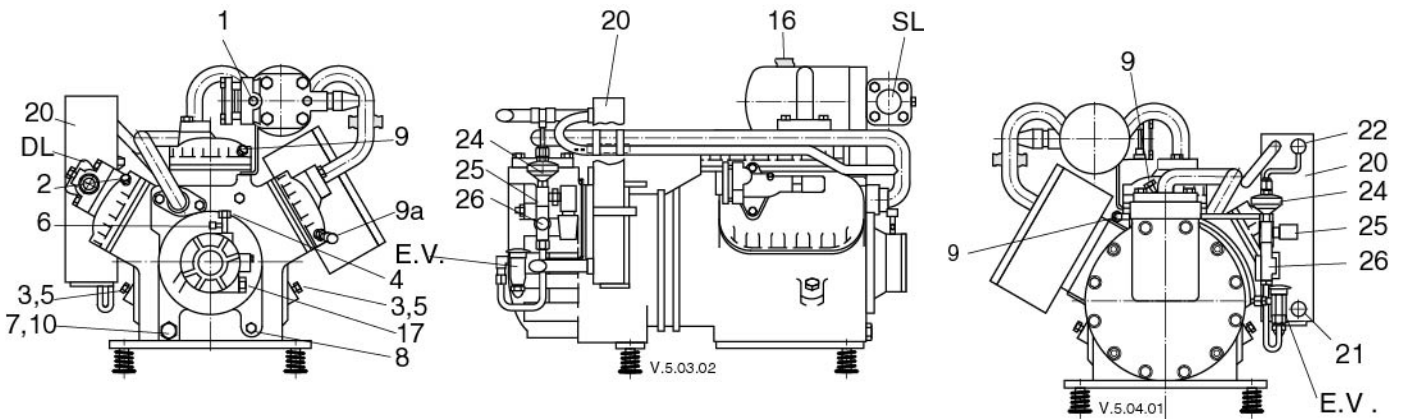


Figure 4: 6 cylinder two-stage compressor with liquid subcooler mounted at compressor-connections



- SL = Suction shut-off valve
- DL = Discharge shut-off valve
- E.V.= De-superheating expansion valve
- 1 = plug low-pressure connection
- 2 = plug high-pressure connection
- 3 = plug oil charge
- 4 = flare oil-pressure control H.P.
- 5 = plug oil-pressure control L.P.
- 6 = oil-pressure connection (Schrader)
- 7 = oil screen (internal)
- 8 = plug or sleeve (crankcase heater)

- 9 = intermediate pressure connection
- 9a = intermediate pressure connection (Schrader)
- 10 = magnetic plug
- 21 = liquid line to evaporator, sweat
- 22 = liquid line from receiver, sweat
- 16 = insulation
- 17 = plug oil-pressure sensor
- 20 = liquid subcooler
- 24 = filter
- 25 = solenoid valve
- 26 = sight glass

Figure 5: System with 3 cylinder two-stage compressor without liquid subcooler

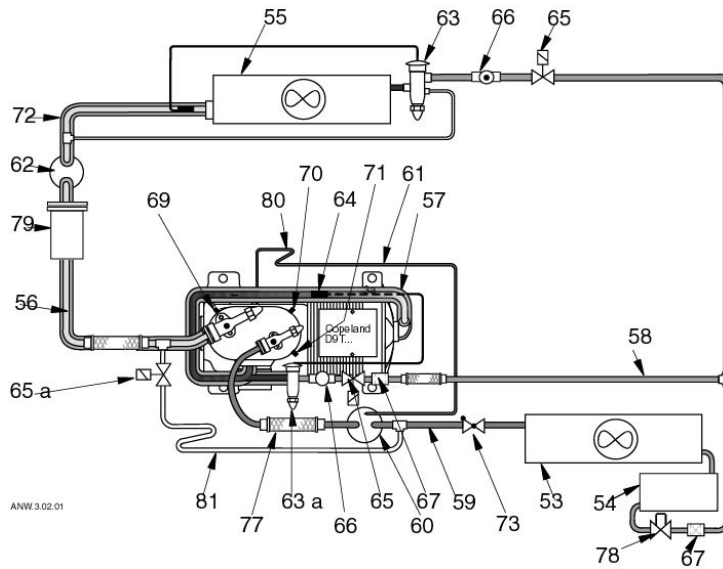
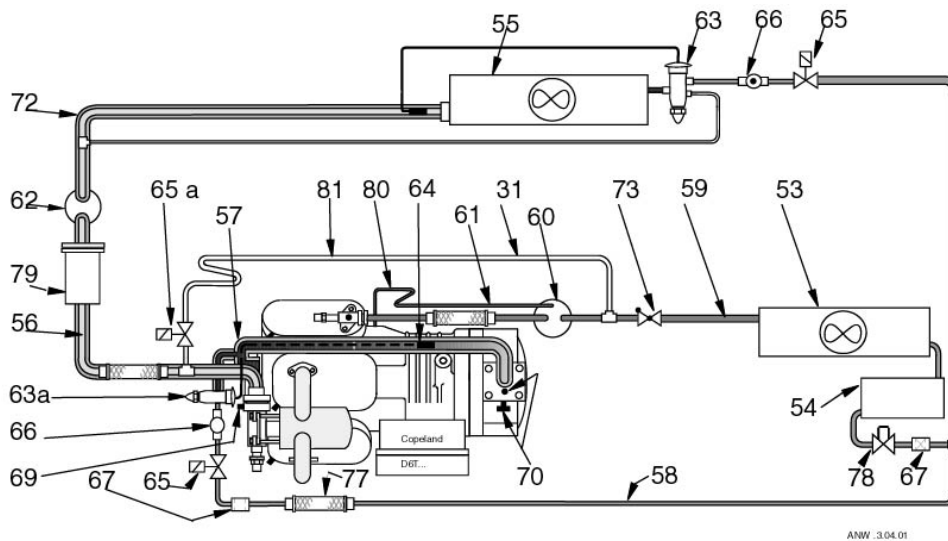


Figure 6: System with 6 cylinder two-stage compressor without liquid subcooler



- 53 = condenser
- 54 = receiver
- 55 = evaporator
- 56 = suction line (LP)
- 57 = interstage line (insulated)
- 58 = liquid line to thermostatic expansion valve 63a to be connected to main liquid line
- 59 = discharge line (HP)
- 60 = oil separator (close to compressor)
- 61 = oil return line to compressor
- 62 = suction accumulator (with built-in oil return) sized according to maximum Refrigerant charge
- 63 = thermostatic expansion valve at evaporator
- 63a = thermostatic expansion valve interstage injection
- 64 = bulb location for thermostatic expansion valve

- 65 = solenoid valve in liquid line (only open during compressor operation)
- 65a = solenoid valve in bypass for unloaded start
- 66 = sight glass
- 67 = filter (drier)
- 69 = low pressure connection
- 70 = intermediate pressure connection
- 71 = plug high pressure connection
- 72 = insulation
- 73 = check valve to be sized correctly in order to avoid noise from chattering
- 77 = vibration absorber
- 78 = shut-off valve
- 79 = filter
- 80 = loop for flexibility
- 81 = bypass for unloaded start

Figure 7: System with 3 cylinder two-stage compressor (Version D9T. 3..) with liquid subcooler (separate)

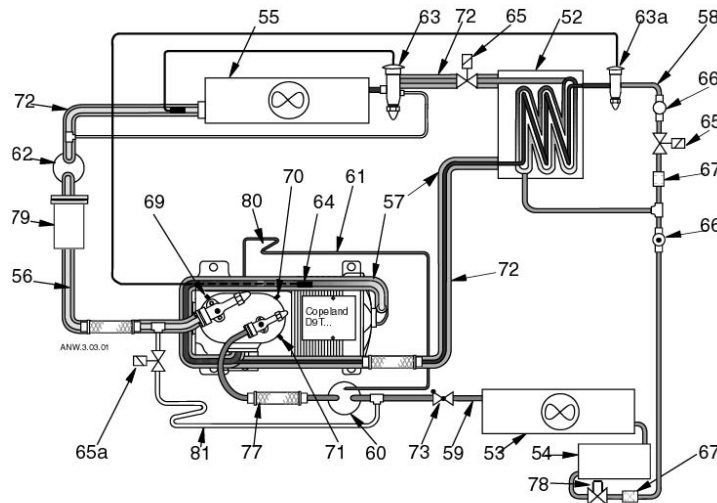
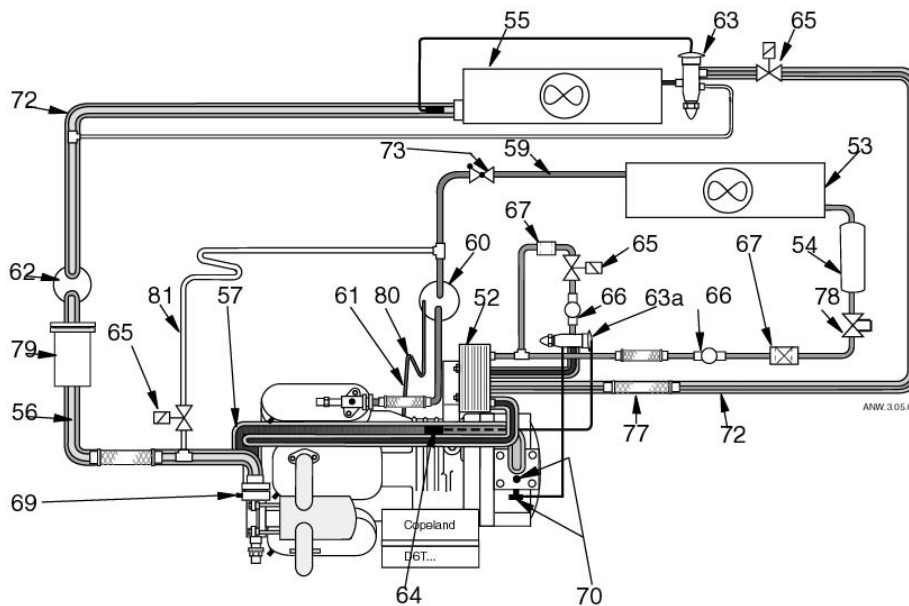


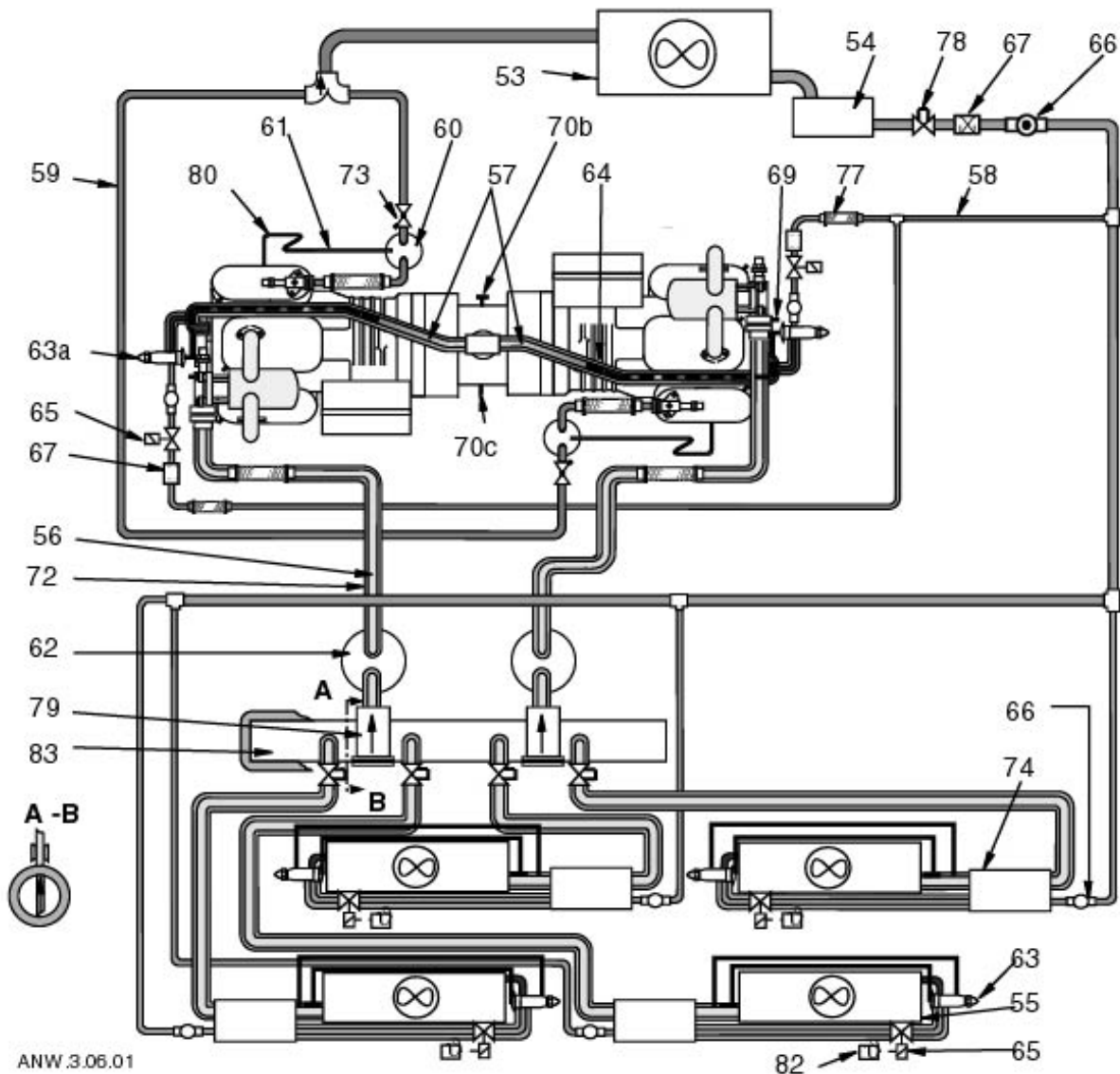
Figure 8: System with 6 Cylinder two-stage compressor with liquid subcooler (mounted at compressor)



- 52 = heat-exchanger (liquid-subcooler)
- 53 = condenser , 54 = receiver
- 55 = evaporator
- 56 = suction line (LP)
- 57 = interstage line (insulated)
- 58 = liquid line to thermostatic expansion valve 63a to be connected to main liquid line
- 59 = discharge line (HP)
- 60 = oil separator (close to compressor)
- 61 = oil return line to compressor
- 62 = suction accumulator (with built in oil return) sized according to maximum refrigerant charge
- 63 = thermostatic expansion valve at evaporator
- 63a = thermostatic expansion valve interstage injection
- 64 = bulb location for thermostatic expansion valve

- 65 = solenoid valve in liquid line (only open during compressor operation)
- 65a = solenoid valve in bypass for unloaded start
- 66 = sight glass
- 67 = filter (drier)
- 69 = low pressure connection
- 70 = intermediate pressure connection
- 71 = plug high pressure connection
- 72 = insulation
- 73 = check valve to be sized correctly in order to avoid noise from chattering
- 77 = vibration absorber
- 78 = shut-off valve
- 79 = filter
- 80 = loop for flexibility
- 81 = bypass for unloaded start

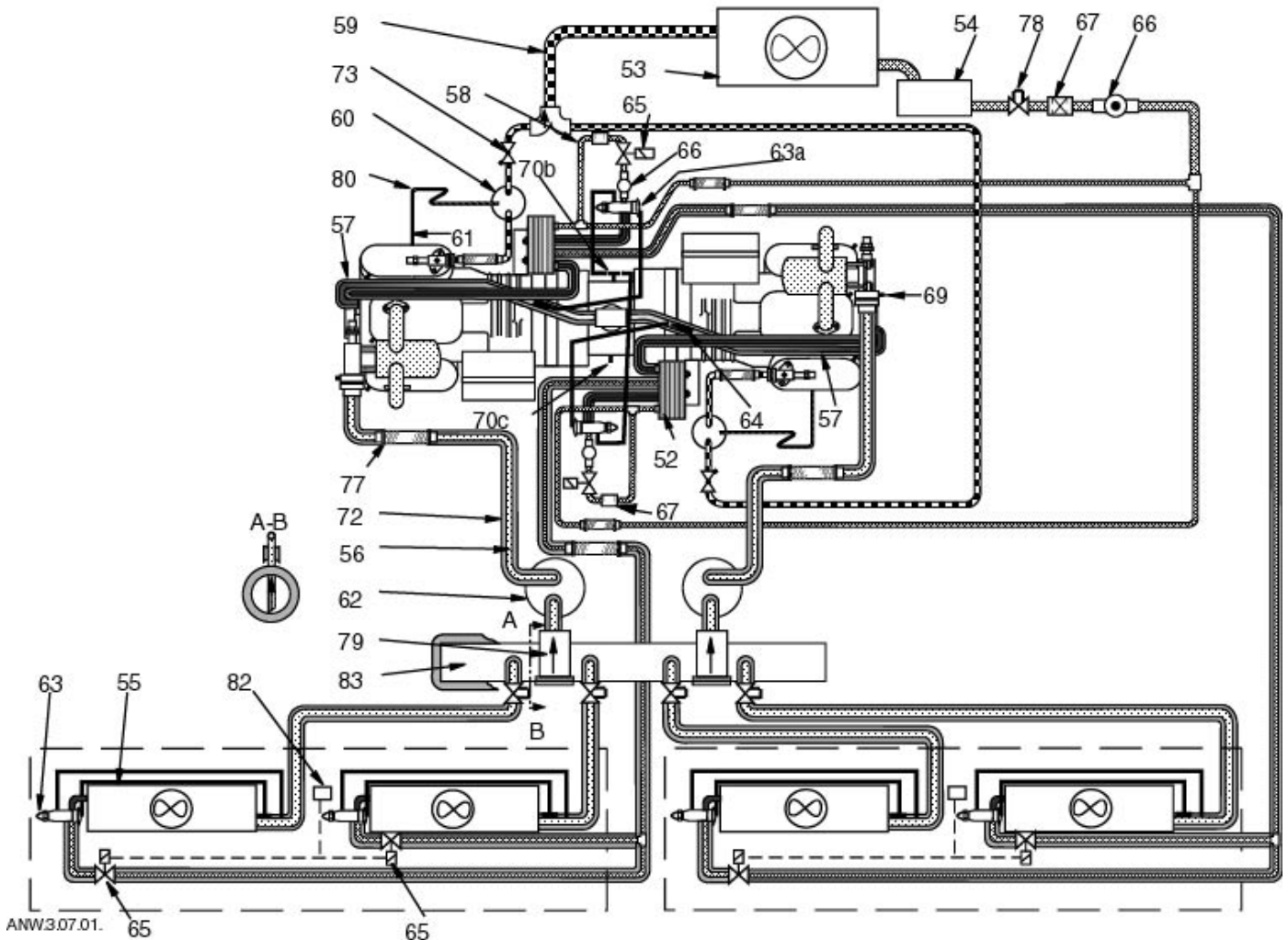
Figure 9: System with 6 cylinder two-stage Twin-compressor without liquid subcooler



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- | | |
|---|--|
| 53 = condenser | compressor operation) |
| 54 = receiver | 66 = sight glass |
| 55 = evaporator | 67 = filter(drier) |
| 56 = suction line (LP) | 69 = low pressure plug |
| 57 = interstage line (insulated) | 70b+c = intermediate pressure connections |
| 58 = liquid line to thermostatic expansion valve 63a to be connected to main liquid line | 72 = insulation |
| 59 = discharge line (HP) | 73 = check valve to be sized correctly in order to avoid noise from chattering |
| 60 = oil separator (close to compressor) | 74 = heat exchanger (suction/liquid) |
| 61 = oil return line to compressor | 77 = vibration absorber |
| 62 = suction accumulator (with built-in oil return) sized according to maximum refrigerant charge | 78 = shut-off valve |
| 63 = thermostatic expansion valve at evaporator | 79 = filter |
| 63a = thermostatic expansion valve interstage injection | 80 = loop for flexibility |
| 64 = bulb location for thermostatic expansion valve | 81 = bypass for unloaded start |
| 65 = solenoid valve in liquid line (only open during | 82 = e.g. room-thermostat |
| | 83 = suction header |

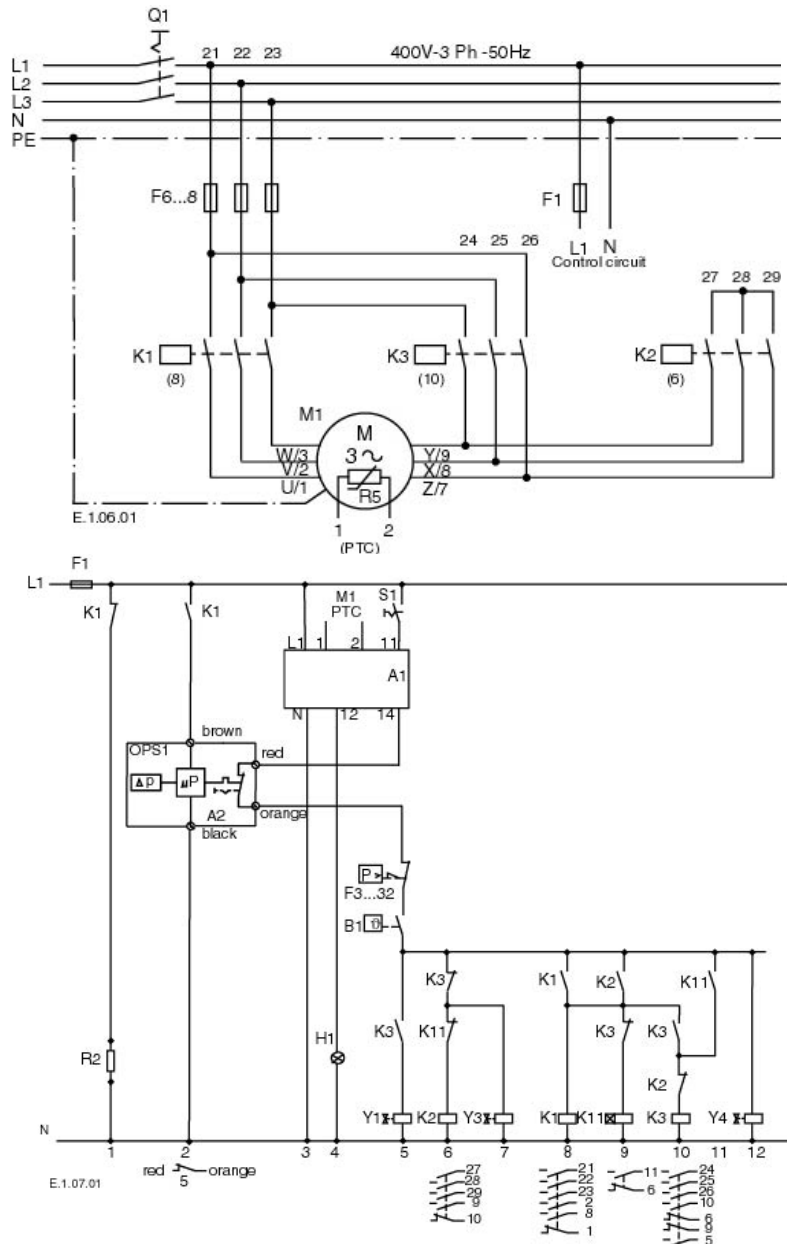
Figure 10: System with 6 cylinder two-stage Twin-compressor with liquid subcooler



- 52 = liquid subcooler
- 53 = condenser
- 54 = receiver
- 55 = evaporator
- 56 = suction line (LP)
- 57 = interstage line (insulated)
- 58 = liquid line to thermostatic expansion valve 63a
- 59 = discharge line (HP)
- 60 = oil separator (close to compressor)
- 61 = oil return line to compressor
- 62 = suction accumulator (with built-in oil return)
sized according to maximum refrigerant charge
- 63 = thermostatic expansion valve at evaporator
- 63a = thermostatic expansion valve interstage
injection
- 64 = bulb location for thermostatic expansion valve

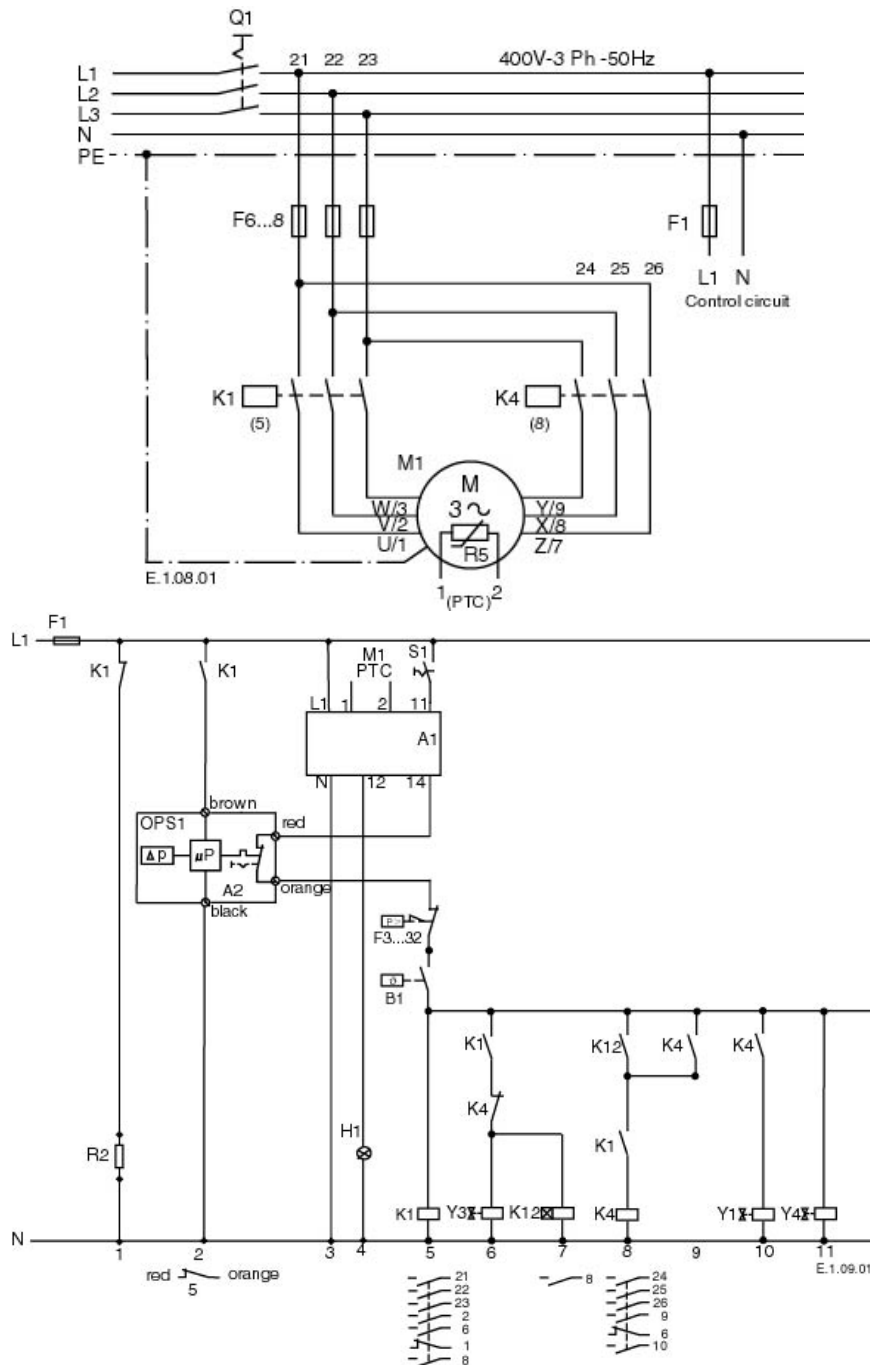
- 65 = solenoid valve in liquid line (only open during
compressor operation)
- 66 = sight glass
- 67 = filter (drier)
- 69 = low pressure plug
- 70b+c = intermediate pressure connection
- 72 = insulation
- 73 = check valve to be sized correctly in order to
avoid noise from chattering
- 77 = vibration absorber
- 78 = shut-off valve
- 79 = filter
- 80 = loop for flexibility
- 81 = bypass for unloaded start
- 82 = e.g. room-thermostat
- 83 = suction header

Figure 11: Schematic wiring diagram for Two-Stage compressors Y / Δ Start with unloading device



- Q1 = main switch
- S1 = auxiliary switch, when crankcase heater is to heat prior to starting the compressor
- K1 = compressor motor contactor
- K2 = star contactor for compressor motor
- K3 = delta-contactor for compressor motor
- K11 = time delay relay for change over of the motor from star to delta (1-3 seconds)
- F1 = fuse for control circuit (characteristics according to maximum load of contacts of control devices)
- A1 = module motor protection
- F3..32 = pressure cut out (according to local regulations)
- A2 = oil pressure safety control system OPS1
- F6 – F8 = fuses
- B1 = room thermostat
- M1 = compressor motor
- Y3 = solenoid valve for unloaded start Fig.11
- Δ p = pressure difference switch for A2

Figure 12: Schematic wiring diagram for Two-Stage compressors Part Winding Start with unloader



- K4 = Contactor for second winding of part-winding motor
- K12 = Time delay relay for second part-winding 1sec.(+/- 0,1)
- R2 = Crankcase heater
- R5 = Sensors in the compressor motors- must be connected to the electronic module A1
- Y1 = Solenoid valve for liquid line
- Y4 = Solenoid valve inter-stage liquid line
- A1 = Electronic module, system W
- A2 = Oil pressure difference control system OPS1
- H1 = Signal lamp

Information in this document are subject to change without notification.