

3. SUCTION AND DISCHARGE LINES

3.1 Suction Line

The gas velocity in the common suction line between evaporators and the suction header must be minimum 4 m/s in horizontal lines and minimum 8 m/s in vertical lines (recommendation 8 to 12 m/s). Gas velocities greater than 12 m/s will create high noise levels and high suction line pressure drop which will decrease system capacity.

The suction line diameter should be calculated according to the minimum refrigerant flow (at minimum evaporating temperature and maximum condensing temperature).

The common suction line when horizontal shall be sloping down toward the suction header (0.5% slope, 5mm rise for every 1m of run). If the suction line must rise over 6 meters, multiple suction risers must be created every 4 meters as shown in fig.3.1.

This is necessary to increase the velocity of returning gas and therefore insure proper oil return. To avoid large quantities of oil accumulation, create U-trap(s) as short as possible.

It is important to note that standard size suction rotolock valves ordered through Danfoss Maneurop are designed for general-purpose applications. It is important to select rotolock valve sizes according to the gas flow and not only according to pipe size. Gas velocity in suction lines of parallel systems may vary considerably due to fluctuations in load and the number of

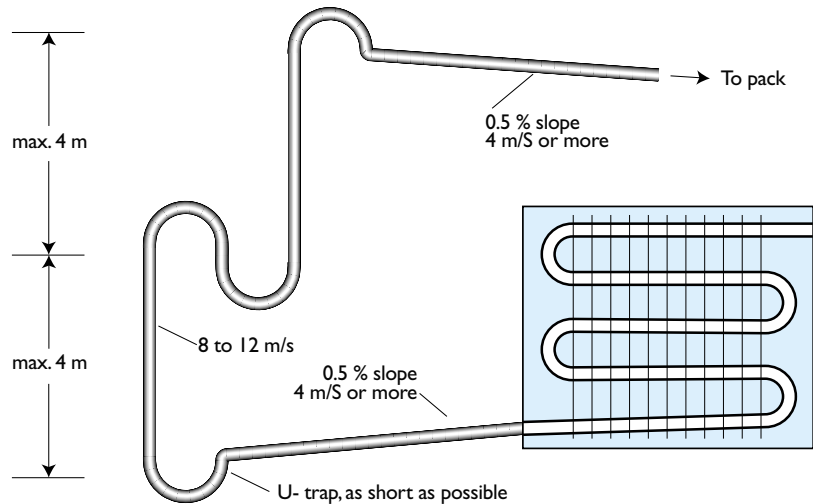


Figure 3.1 Suction line design

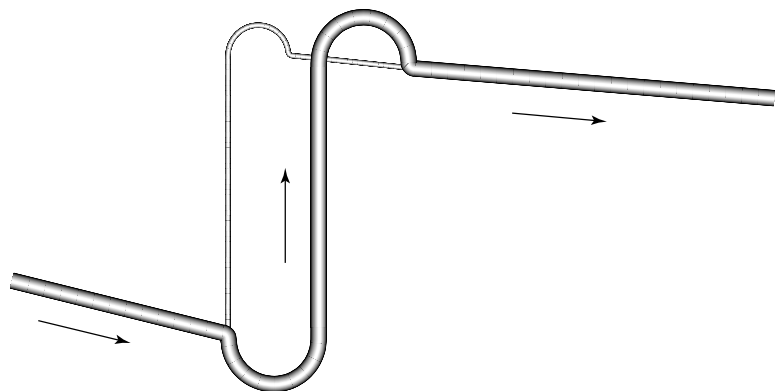


Figure 3.2 Double suction riser with U-traps

compressors running. It is important to ensure sufficient oil return under any load. In

general this means that double suction risers with U-traps are imperative. See figure 3.2.

3.2 Suction Header

The suction header must be placed as close as possible to the compressors.

The lines between the suction header and the compressor suction connection must be flexible, i.e. equipped with vibration absorbers.

The suction lines from the header towards each individual compressor must be

fitted into the suction header and the end tube cut at an angle of 60° (see figures 3.4 & 3.5). This configuration will result in higher gas velocity at pick up tube inlet and proper oil return when the oil level in the suction header rises. The compressor suction lines must always enter the suction header on the topside. A recommended suction header design is shown in figure 3.3.

To insure ideal pressure

equalization with an oil equalization line system, the header must be symmetrical and the lines from the suction header to each compressor must be short & identical. These precautions are not as critical when an oil level regulator is used.

The following recommendations are necessary for secure installation:

- The suction line "A" and the suction header "B" must

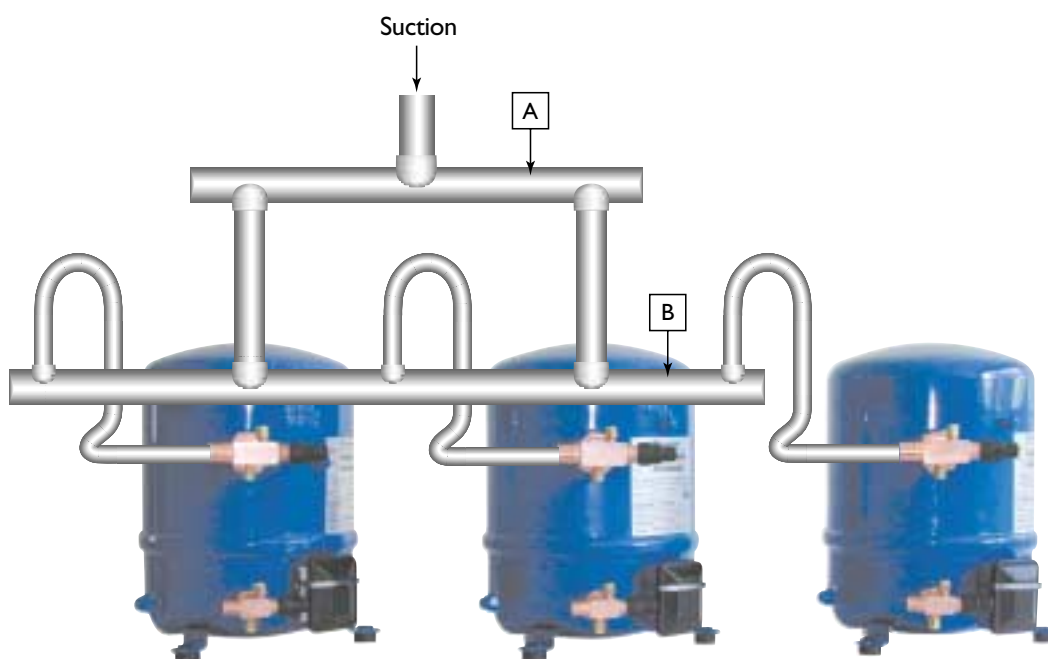


Figure 3.3 Suction header configuration with header below the compressor suction connections.

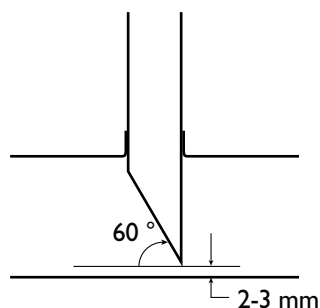


Figure 3.4 Detail of suction line inside the suction header

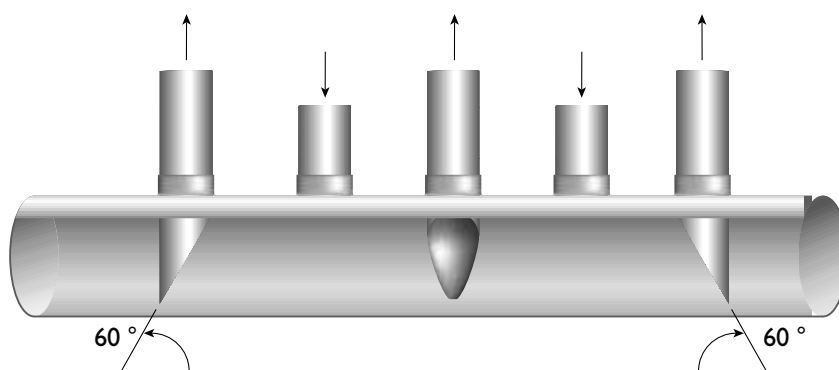


Figure 3.5 Construction of suction header above the compressor suction connections

be horizontal to avoid unbalanced oil distribution.

- The gas velocity in the suction header must be a maximum of 4 m/s.
- The suction line and the suction header must be insulated to limit the suction gas superheat.

Note: An alternative to the construction of a suction header is to purchase a pre-made multiple compressor suction accumulators.

3.3 Discharge Header

A properly constructed discharge header will not allow liquid flood back or migration of the oil back to the compressor. Furthermore it must restrict hot discharge gas from returning to switch off compressors where it will condense and cause liquid hammering at compressor start up.

Therefore the following construction details are of importance:

- Whenever possible, mount the discharge header below the compressor discharge connections (see figure 3.6). The compressor discharge lines are below the compressors and enter the discharge header from above. This design eliminates the risk of liquid flood back. Check valves (or non return valves), such as Danfoss' NRV, located between the compressor discharge connection and the discharge header must be installed to prevent liquid condensation

In non-running compressors.

- If it is impossible to mount the discharge header below the discharge connections a special construction is required. The key is to ensure

the discharge lines enter the discharge header from the top. (See figure 3.7).

- To avoid operational noise the check valve dimension must always be selected according to the compressor capacity and not the pipe size. Contact your check valve supplier for correct selection.
- The discharge header cross section must be the sum of each discharge tube cross section. In an effort to avoid oil traps never oversize the discharge header.

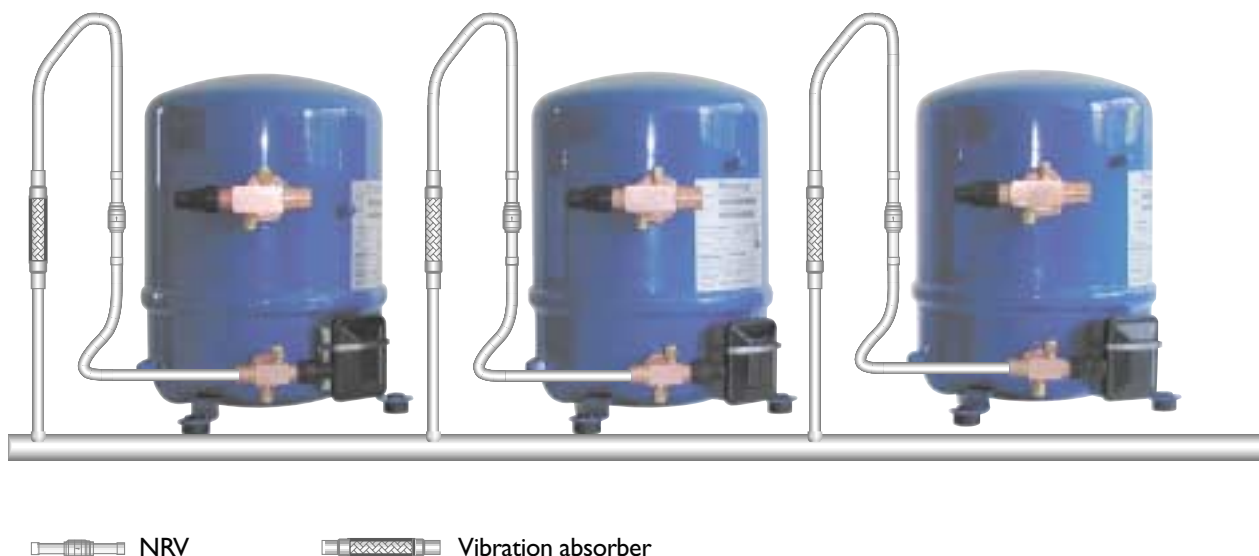


Figure 3.6 Discharge header below compressor discharge connections.



Figure 3.7 Discharge header above compressor discharge connections.

4. COMPRESSOR CONTROL SEQUENCE

By starting only one compressor at a time the peak load on the power supply will be reduced.

Parallel installations also offer many possibilities for efficient capacity control.

For example, three compressors of different capacity mounted in parallel offer 7 different rated capacities. The control system should be designed to match the cooling demand of the system by staging compressors on and off, thus reducing the amount of wasted energy in a system.

A secondary function of the control system is to ensure the compressors have an equal number of running hours and

reduce the risk of refrigerant migration in compressors stopped over long periods of time.

One example of a compressor control sequence:

- First start: Start compressors in order 1, 2, 3 and also stop in order 1, 2, 3
- Second start: Start compressors in order 2, 3, 1 and also stop in order 2, 3, 1
- Third start: Start compressors in order 3, 1, 2 and also stop in order 3, 1, 2

Repeat sequence to balance each compressors number of running hours. Recommendations for proper control:

- There shall be no more than 12 starts per hour per compressor. A higher number reduces the service life of the compressor. It is necessary to use an anti-short cycle timer in the control circuit to limit the number of starts.
- If a risk of long minimum load operation exists, it is recommend to install a timer which will force run the entire system at 100% capacity for 5 minutes every 5 hours. This will insure proper oil return.

5. SYSTEM COMPONENTS

Typical system requirements and recommendations for parallel installations are listed below:

5.1 Suction line accumulator

For parallel installations, it is recommended to always use a suction line accumulator. Be sure to select the proper size suction line accumulator according to manufacturer recommendations. In systems with an oil level regulator it is best to use either one suction line accumulator per compressor or a multi-line accumulator having a connection for each compressor.

5.2 Suction filter

It is strongly recommended to install a large suction filter just before the suction header or suction accumulator. This will filter all foreign particles out of the installation to protect the compressors. Danfoss DCR filters with interchangeable strainer type 48-F are recommended. These filter shells provide the

possibility to install filter drier cartridges (type 48-DN), or burn out cartridges (type 48-DA), while allowing easy after sales service.

5.3 Crankcase heater

Compressors must be installed with continuously energized self-regulating crankcase heaters (PTC elements). These heaters are to be installed with heat conductive paste. The use of an additional belt crankcase heater may be necessary in some cases. That belt crankcase heaters must be switched on only when the compressor is not running.

The compressors should be installed in a room of moderate temperature to avoid refrigerant condensation in non-running compressors.

References of crankcase heaters are given in the selection and Application Guidelines" for MT/MTZ or LTZ compressors. Contact your local Danfoss Maneurop

organization for further information.

5.4 Thermostatic Expansion Valve

When the parallel installation is serving a single evaporator system the dimensioning of the thermostatic expansion valve (TEV) becomes critical and must be made in relation to both minimum and maximum capacity. This will ensure correct superheat control in all situations.

5.5 Condensing pressure control

A condensing pressure control should be installed to maintain the minimum condensing pressure according to the application range published for each compressor / refrigerant combination. This condensing pressure control will also allow for an ideal liquid distribution in the system (expansion valve operation).

6. INSTALLATION & SERVICE

Installation and service procedures for a parallel system are similar to basic system installations. The selection of additional system components for parallel installations follows the basic system common rules. Therefore refer to the "Selection and Application Guidelines" of the compressor for detailed installation and service procedures.

6.1 Compressor mounting

Individual compressors must always be mounted using the provided mounting grommets. If this is not done the system will transmit vibration and in turn reduce compressor life. A common base frame, rigid enough to support the weight of the compressors, must be used for installation. The common frame may be mounted on grommets to reduce transmission of vibration to the floor. It is recommended to install all control and safety devices on an independent frame. These devices should be connected to the common frame using flexible tubing.

Suction and discharge lines must have adequate 3 dimensional flexibility. For parallel systems the simplest means of acquiring this is by the use of vibration absorbers.

The connecting suction and discharge header pipes must be as short as possible. Therefore it is a benefit to mount compressors as close together as possible. All compressors must be mounted on the same level.

6.2 Rotation direction

Compressors should run with the same rotation direction. This can be achieved by having the same phase sequence on each compressor motor terminal (L1-T1, L2-T2, L3-T3).

6.3 Total capacity and application envelope

The total cooling capacity of a parallel installation is slightly less than the sum of the cooling capacities of the individual compressors. This is due to the extra pressure drop in suction and discharge headers. In general this loss is about 1% of the total

capacity. The application envelope of a parallel installation is the same as for the individual compressors.

6.4 Pressure switch settings

The pump down pressure switch (for example Danfoss type KPI) must have a set point slightly higher than the lowest compressor safety pressure switch set point. The high-pressure safety switch shall stop all compressors.

6.5 Failure analysis

When one compressor in a parallel system fails the chance of foreign particles entering other compressors is greatly increased. Therefore a failure analysis must be done quickly to insure further proper running conditions for the overall installation (i.e.: oil analysis).

7. MANEUROP COMPRESSOR CHARACTERISTICS

All Maneurop reciprocating compressors MT, MTZ, LT & LTZ are available in VE version, specially designed for parallel installation.

These compressors are provided with an oil equalization connection and a threaded oil sight glass (see figure 7.1).

The standard compressors are not suitable for parallel mounting.

7.1 Oil level regulator and oil sight glass

An oil level regulator can be mounted on the compressor oil sight glass connection

7.2 Oil equalization connection

A 3/8" oil equalization line can be connected to the 3/8" flare connection (see figure 7.2).

Recommended torque is 30 Nm. Note that older Maneurop

compressors (until 1988) had a 1 1/4" rotolock connection for this purpose (see figure 7.3).

For compressor replacement in a parallel system with compressors fitted with this rotolock connection, an adapter is available through Danfoss Maneurop (ref. 7754010).

The position of the 3/8" flare oil equalization fitting has recently been modified so that equalization only occurs when the oil level in the compressor reaches the maximum.

Further, to prevent oil drainage from the non-running compressors during part load operation, the flare connector protrudes into the compressor shell (see figure 7.2).

FSA adapter (023 U 8014) is available to convert the flare connection to a brazed connection design.

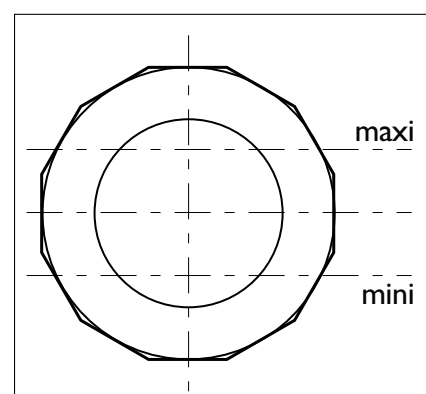


Figure 7.1 Correct oil level in sight glass

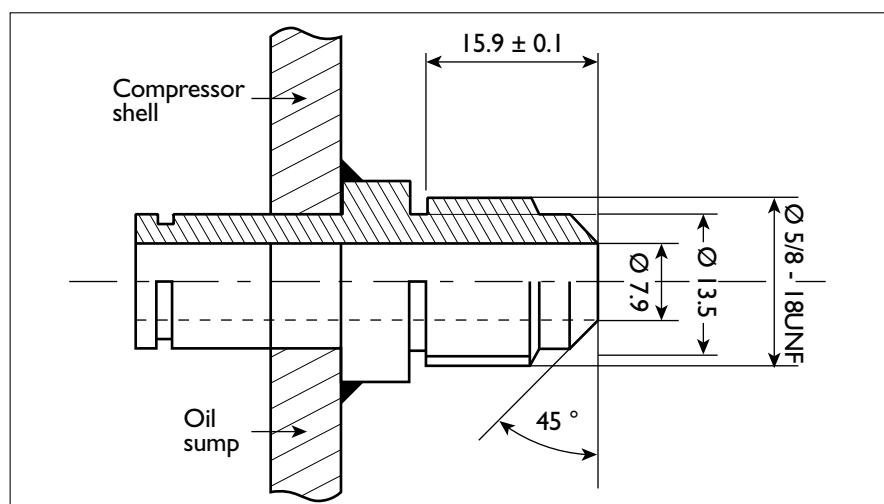


Figure 7.2 Oil equalization connection, 3/8" flare connection

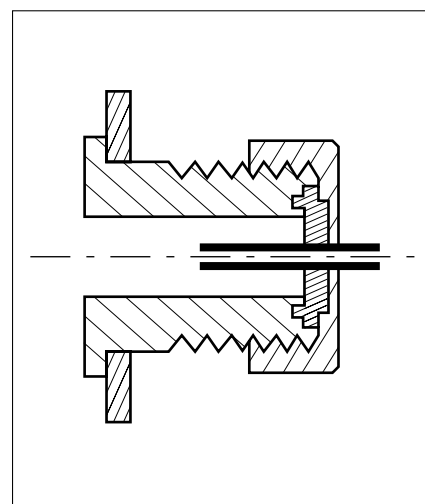


Figure 7.3 Former rotolock with adaptor accessory.

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