

Variable Speed Compressors – Capillary and Charge Determination

Capillary Determination

The capillary tube is generally the counterpart for the compressor. It can be optimized for only one working condition. So it has to be determined for the appliance working conditions and fit to the compressor size. The subcooling in front of the capillary inlet should be at least 1 K. The capillary has to be adapted to:

- Refrigerant
- Refrigeration capacity at working conditions
- Suction tube length

The recommended capillary tube length is around 2 meters, then a sufficient internal heat exchanger can be built-in connection with the suction tube.

- To provide a high level of energy efficiency, the capillary tube should be determined at the cabinet running conditions which appear under energy efficiency measurements.

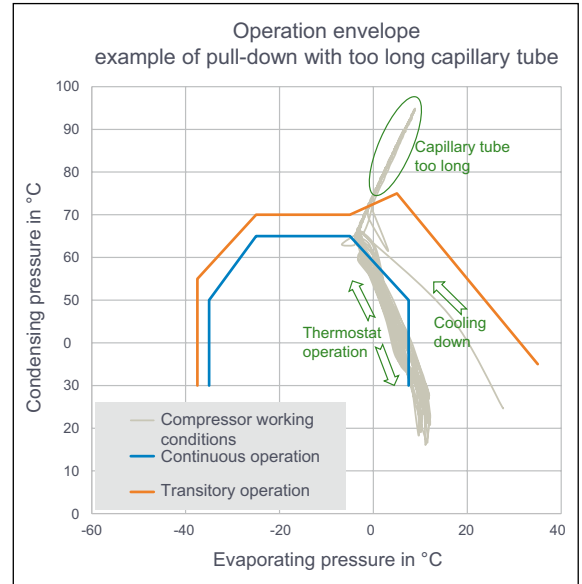
As variable speed compressors are usually optimized for low speed, these running conditions should also be at low compressor speed.

- For high pull-down speed, the capillary tube can be calculated at the same running conditions as for energy efficiency but with maximum compressor running speed.
- After each calculation, the capillary tube has to be tested for fitting to the appliance.

If too high condensing pressure levels occur in pull-down, then the capillary tube length has to be shortened (see the following diagram).

In addition, too small condenser areas can lead to unallowed high condensing temperatures.

- Once the capillary tube has been designed, the refrigerant charge has to be determined.



Charge Determination

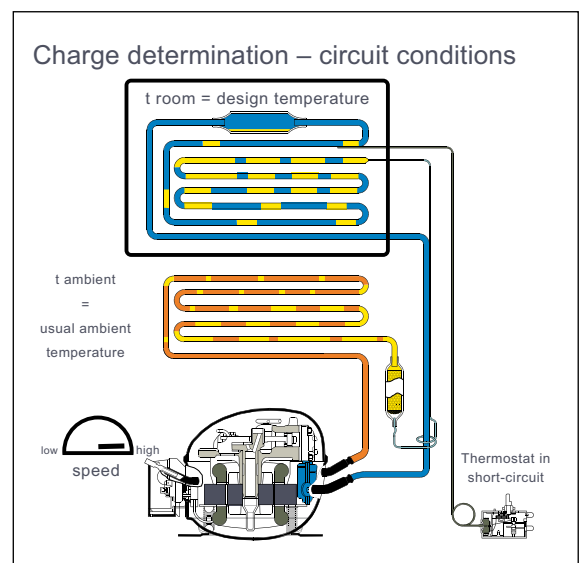
Determining the charge can be done when the following points are fulfilled:

- System components are selected
- Capillary tube size is fixed

Then the charge determination should be done during continuous operation within the main appliance (running condition at normal ambient temperature¹ and at maximum compressor speed²).

When conducting the test, the following parameters should be measured to get an overview of the appliance running conditions:

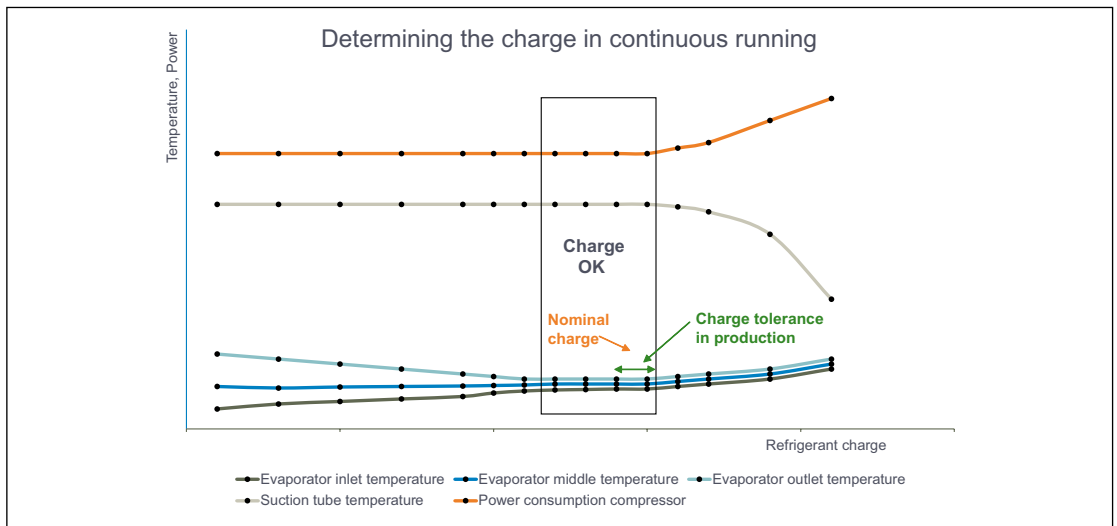
- Compressor power consumption
- Compressor speed
- Return gas temperature of the compressor
- Temperature of the evaporator inlet, middle, and outlet



The test is started using a lower charge. Afterwards, the filling has to be increased stepwise until there is a small overcharge. The following diagram indicates in which area the charge is okay.

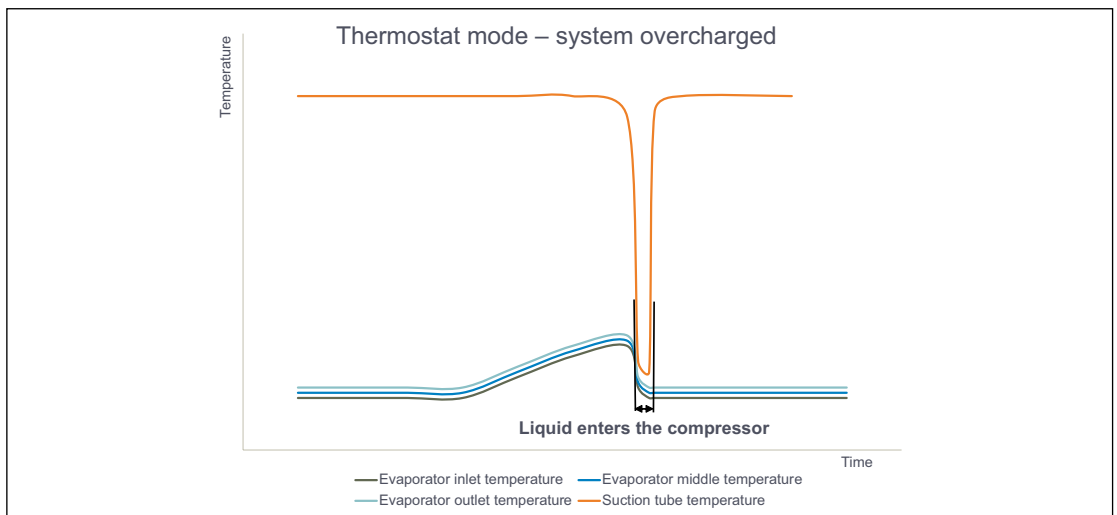
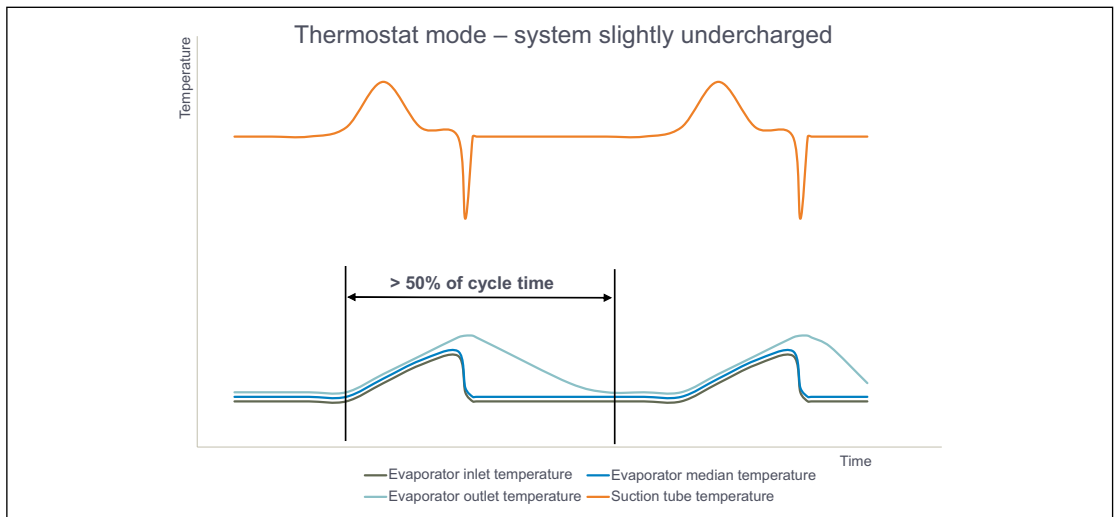
¹ With higher ambient temperatures less refrigerant charge is necessary due to higher thermal load in the evaporator.

² At maximum compressor speed the lowest refrigerant charge is necessary for the system.



Thermostat Operation Mode

Followed by the charge determination in continuous running the appliance should be checked in thermostat operation mode. The compressor should run for several running cycles in thermostat operation mode. Afterwards there must be superheating for all conditions. Otherwise, the liquid enters the compressor from the evaporator. Then the optimal charge has to be adapted to a lower charge.



Capillary Tube Size and Refrigerant Charge

Measurements showed, that different capillary tube size within the same cabinet leads to a different refrigerant charge required.

Capillary tube size	Capillary volume flow	Refrigerant charge
long	low	more
medium	average	average
short	high	less

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