Control of Liquid Migration to the Compressor During Shutdown

1. Liquid Refrigerant Migration to Compressor During Shutdown

When a compressor is shut down for an extended period, its temperature will obviously drop to around the ambient temperature. There can be times when the compressor will be the coldest component in the system. An example of this situation is an air conditioner that is switched off overnight. When the outdoor temperature falls below the indoor temperature, then the outdoor components will be at a lower temperature than those indoors. As the day starts to warm, an internally-sprung compressor with its greater mass and having a pump assembly with little mechanical connection to the housing, will warm up more slowly than the outdoor heat exchange coil and piping.

Refrigerant in a refrigeration or air conditioning system will always, if given the opportunity, migrate to the coldest part of the system. When the compressor is the coldest component, then the liquid refrigerant settles in the bottom of the compressor with the lubricating oil. If we were able to watch through a sight glass, it would appear that the oil level was rising. In fact we now have oil that has been diluted with refrigerant. This is a problem in more ways than one.

The first effect is that the lubricating properties of the oil will be greatly depleted. Liquid refrigerant is an excellent solvent, but a poor lubricant.

The level of the refrigerant/oil mixture is now higher than the normal oil level. It is probably sufficiently high that, when the compressor is started, the liquid will be agitated by the rotor or the crankshaft eccentric and connecting rod. This agitation, combined with the sudden drop of pressure inside the compressor housing, will cause a violent change of state of the refrigerant, from liquid to vapor. The result is that the oil will foam, and be carried out of the compressor.

The compressor can therefore experience a loss of lubricant quality, washout of oil from the bearings, a sudden reduction of the amount of oil in the compressor, the potential for mechanical damage to the compressor due to liquid slugging as oil is carried through, as well as very high compressor discharge pressures which further add to the possibility of mechanical component failure.

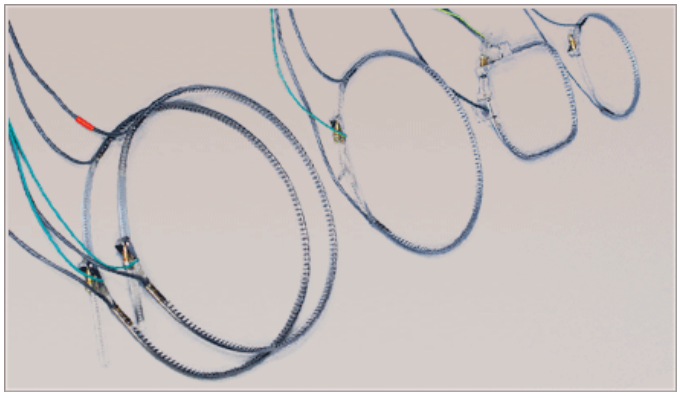
We should not regard this as a problem associated only with air conditioners. It is true that a refrigeration system that is not switched off, and which cycles regularly, will always maintain a sufficiently high compressor temperature. There are, however, occasions when units are shut down overnight or for longer periods. They are then susceptible to refrigerant migration, also sometimes referred to as liquid migration.

The purpose of the CCH is to ensure that liquid refrigerant will not accumulate in the compressor as a result of migration. It does this by maintaining a compressor temperature that is higher than the temperatures of other system components.
It needs to be stressed that **a CCH does not offer protection against liquid flood back** on start-up or during operation. Different measures are required to prevent liquid refrigerant returning in damaging quantities to the compressor while it is running.

Two types of CCH are commonly used on Kulthorn compressors

External (Wraparound) Heater

This type of CCH is attached around the lower part of the compressor housing, below the level of the oil. It should be sufficiently flexible, and be attached sufficiently tightly, that it will maintain close contact with the housing around its full profile.



The external CCH should be active whenever the compressor cycles off, but should be isolated when the compressor is running. It is counterproductive, and a waste of energy, to apply electrical heat to a compressor when it is operating.

The external CCH is rated for a specific nominal voltage, which will normally be the same as the compressor supply voltage.

Insertion Heater

Some compressors are made with a well in the housing, below the oil level, into which a small heater can be inserted. This largely eliminates the loss of heat to the atmosphere that is a characteristic of external heaters, and the heat is transmitted more directly to the oil.

The insertion type heater is a solid state device, and its output varies according to its temperature. When a compressor is hot, the heater output is reduced. Its maximum heat output is achieved when the compressor is cold. For this reason, the heater should be continuously active. Another feature of the insertion CCH is that it is not voltage-critical. The insertion heaters supplied with Kulthorn compressors can utilize any supply voltage up to 600V.

Because the shapes of the heater and the surface of the well will not match perfectly, and there needs to be clearance to allow easy assembly, heat transfer will be impeded unless a thermal paste is used when locating the heater in the well. This thermal paste fills the gaps, and assists in the transfer of heat from the CCH to the compressor.

Because the shapes of the heater and the surface of the well will not match perfectly, and there needs to be clearance to allow easy assembly, heat transfer will be impeded unless a thermal paste is used when locating the heater in the well. This thermal paste fills the gaps, and assists in the transfer of heat from the CCH to the compressor.

To Summarize

An external CCH

- is intended for a specific supply voltage.
- should be active when the compressor is off, but not when it is running.
- is subject to inefficient loss of heat to the atmosphere.

An insertion CCH

- can be used with any supply voltage up to 600V.
- should be continuously active.
- should be assembled with the use of thermal paste to maximize heat transfer.

Another Important Point

When power is first applied to a refrigeration or air conditioning unit after installation or an extended shutdown**, it is important that the compressor is not started until the CCH has been active for at least 12 hours, and preferably 24 hours.** This ensures that any liquid refrigerant present in the compressor will be driven out before the compressor is started.