Refrigerant flood back occurs during the running cycle of the machine. This is where large volumes of liquid refrigerant are returned to the running compressor down through the Suction pipe work, in an uncontrolled manner. Depending on the degree of liquid returning to the compressor, determines as to what damage will occur. This can often be seen as foaming in the compressors’ oil level sight glass.

If liquid is drawn into the cylinder bores, the lubrication to the cylinders and pistons will be washed away causing scoring and overheating in the cylinder, which in turn will lead to small metallic particles contaminating the inside of the machine. This liquid will also dilute the lubricating oil in the compressor sump. As the oil becomes more and more diluted with liquid refrigerant, its ability to lubricate becomes compromised. When this liquid rich oil is drawn up through the crankshaft to lubricate the bearings, con rods, cylinder walls, etc due to friction the refrigerant in the oil starts to Flash Off into a vapour, this then prevents the oil being able to lubricate the necessary parts, and typically the main bearing and the con rods, furthest from the oil pick up point, will quickly dry out and then seize. Sometimes the upper main bearing will wear so badly that it can cause rotor / stator contact and a burnout, or more often, the upper most con rods seize onto the crankshaft and as the motor continues to rotate the crank, thereby breaking the
Flood back often occurs during night time operation when the duty requirements are low, and the equipment has excess capacity. Often expansion valves are oversized for the system duty and each time the compressor starts or large product loads are introduced to the plant, the expansion valve will be forced to open, and overfeeding of the evaporator, even more so if the superheat setting has been set too low, will be the result. Thermostatic expansion valves are forced to open by the suction pressure falling which causes a fall in pressure under the expansion valve bulb and initially the expansion valve is driven open. Until the bulb charge reacts and the bulb pressure starts to fall to help close the valve, liquid refrigerant will rush into the evaporator in a virtually uncontrolled manner (The bigger the valve the larger the liquid quantity). Once this liquid reaches the suction pipe work its next port of call is back to the compressor. Monitoring the expansion valve superheat setting under all conditions and setting the superheat to a point that is stable and can be maintained under all load conditions will often cure the problem. Fitting a smaller capacity orifice may be needed to achieve this stable control. Upgrading to an electronic expansion valve or by fitting a suction line accumulator may be necessary in systems that cannot be controlled by older conventional controls.

Here we can see the evidence of aluminium from the con rod being welded onto the crankshaft. This is caused when liquid refrigerant flashing off from the oil and washes the lubrication from the bearings.

aluminium con rods, and eventually the pistons as well. When liquid has caused con rods to seize onto the crankshaft the crankshaft journal will be found to have aluminium from the con rod welded onto the bearing surface of the crankshaft. This is caused by the liquid refrigerant virtually exploding from the oil due to the heat of friction from the bearing surfaces. As the con rods and pistons are broken, large pieces of debris are thrown around the compressor shell and motor area, these can cause motor winding insulation damage and motor burn out. Very often the initial diagnosis is the motor burn out, but the actual failure was refrigerant flood back.

In the above pictures we can see the extent of the damage caused by liquid flood back. In the first picture note the size and amount of fragments from the broken con rods and pistons. In the second picture we see three broken con rods from a four cylinder machine. In both cases this damage was caused after the con rods had seized to the crankshaft.

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Causes of Liquid Flood Back

1. Low Evaporator loads
2. Oversized equipment
3. Cold room product distribution (poor air circulation in cold room caused by lights, racking etc)
4. Faulty evaporator fans
5. Oil logging in evaporator
6. Poor evaporator defrosting or defrost schedules (Iced up evaporator / No air flow / Poor heat transfer)
7. Oversized Expansion Valve Orifice
   7a. Wrong type expansion valve
   7b. Expansion valve equalisation tube restricted or blocked (Capillary tube? Oil logged? etc)
   7c. Expansion valve bulb strap loose or bulb in the wrong position on the suction pipe.
   7d. Superheat Setting too low

Preventative measures to avoid Refrigerant Flood back

1. Expansion Valve duty must be checked for the correct size orifice
2. Superheat setting must be set for minimum 6-8 Degree K Superheat (Thermostatic). Can be lower if electronic EEV used
3. Fit correct size Suction Accumulator with proper oil return function
4. Check and reset Defrost control as necessary
5. Fully check the system operation or re-commission the plant

NOTE

Liquid Flood back very often occurs during LOW LOAD conditions, which tends to be during the night, due to the lack of activity such as Door Openings, product movements, fork truck and the cold room Personnel which all give an increase to the plant duty.

Therefore 24 hour logging of the plant operating conditions will often help to pinpoint plant problems that only occur during the night operation, when the plant is unattended.
Why Compressors Fail

This series of Field Service Notes has been designed to assist Technicians and Refrigeration Engineers in understanding the causes of compressor failures, their diagnosis, rectification and prevention.

There are 5 main reasons for compressor failure;

1. Refrigerant Flood Back
2. Flooded Starts
3. Liquid Slugging
4. Overheating
5. Lack of Lubrication

The first 5 of these Field Service Notes will cover the above topics and there will be further Notes covering other causes of failure such as Moisture, Acids, Electrics, Dirt (Copper debris, Welding debris, Ferrous particles etc.)

The answers to what caused a compressor to fail are, in 99.9% of cases, found inside the compressor. During the compressor strip down the evidence as to the cause will be revealed!

Simply replacing a failed compressor with a new compressor without finding out why the first compressor failed will most likely simply lead to another failed compressor.

We hope that the information in this series of Field Service Notes will be of assistance to engineers in preventing unnecessary compressor failures in the future.