Progress Supply Inc. THE INSIDE STORY

Helpful Information for HVAC Contractors from Progress Supply's George Story

This is one of a series of technical bulletins from your friends at Progress Supply

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FLOODBACK

The past articles have been a discussion of things that a good technician should be familiar with. These are items that one needs to know, especially when troubleshooting a problem job. Their understanding is also needed to properly install and start up a job.

In this article, and the next several articles, I want to take a different approach. I specifically want to discuss the causes of mechanical failure to compressors. The **"Mechanical Failure"** modes to be discussed are:

- **Floodback**
- **Flooded Starts**
- **Slugging**
- **Loss of Oil,** and
- **Overheat**

This series of articles will discuss each of these failure modes. Understanding the causes of these failures will help the technician prevent compressor failures, especially repeat failures.

This article will discuss "Floodback." By definition, Floodback is defined as, *"Liquid refrigerant returning to the compressor when it is running."* Liquid refrigerant is defined as any quantity of droplets of refrigerant. When these droplets are mixed with refrigerant vapor, the mixture is said to be saturated. It does not mean a solid column of liquid. A solid column of liquid is generally defined as subcooled liquid.

How does one know if the refrigerant is saturated? Measure the pressure and temperature at the point where one wants to know the condition of the refrigerant, for this discussion, at the compressor inlet. When the measured pressure is converted to saturated temperature and the actual temperature of the refrigerant is the same as the saturation temperature, the refrigerant is saturated.

So how does one convert pressure to saturation temperature? The well-known and used Pressure Temperature (P/T) chart is a chart of saturation temperatures. Some charts have temperature in the left column and some have pressure. In either case, when one measures the pressure, go to the column with pressure. At the read pressure, go to the temperature column directly across from the read pressure. The temperature at this point is the saturation temperature for the read pressure.

For example, if the read pressure for R-22 is 76 psig, the saturation temperature is 45 °F. If the actual temperature of the refrigerant at that point is 45 °F, the refrigerant is saturated. OK, how much liquid and vapor are in the refrigerant when saturated? It can be anything from no liquid up to 100% liquid, technically. 0% and 100% are not practical in the real world but can be done in the lab. So, how much liquid and vapor? From almost none, to almost 100%. For our discussion on Floodback failure modes, the quantity is not important. The fact that it is saturated is important.

To better understand the damage done to a compressor from Floodback, we need to have a short discussion on compressor construction. In smaller semi-hermetic compressors such as Copeland's KA and LA, for example, the refrigerant returns directly to the cylinders/pistons. It does not go across the motor or any other part of the compressor. As the liquid refrigerant enters the cylinder/piston area it may do no damage and may not make any noise.

Refrigerants, besides being cooling agents, are excellent degreaser/cleaners. Today's refrigerants are no exception. As the refrigerant enters the cylinder area during the suction stroke, the liquid will clean the lubricant off of the cylinder walls. The pistons and the cylinder walls now come into direct contact with each other. The damage to the compressor has now begun. During the compression stroke, the liquid refrigerant is heated as a result of the heat of compression. The heat will vaporize the refrigerant and there will not be any liquid in the discharge that can cause slugging damage.

The metal-to-metal contact of the pistons and the cylinder walls causes metal particles of both the pistons and the cylinder walls to drop down into the oil in the crankcase. The metal in the oil can now cause two types of failures.

The motor compartment and the crankcase are common to each other. The oil in the crankcase and motor compartment can and does flow back and forth between the two areas. These metal particles can get into the motor windings. As the motor heats up and cools down, the metal particles will rub through the motor insulation, causing a motor failure.

The second area within the motor that the metal particles can do damage is in the stator slots. In the air-cooled compressor, both the pistons and the cylinders are cast iron, therefore, the metal particles are cast iron. Cast iron being magnetic will collect in the lower stator slots. This occurs because of the electro-magnetism of the motor when energized. When enough metal is in the slots, the slot area will overheat and cause a burnout in that area of the motor. This is referred to as a slot burn. Either of these motor failures results in a failed compressor and the compressor must be changed. This has happened because of Floodback — liquid refrigerant returning to the running compressor.

Even if the motor is not damaged, the second area of compressor damage is the loss of capacity or efficiency. I stated that because of the cleaning effect of the liquid refrigerant, the cylinders and the pistons came into direct contact with each other. This results in no lubrication between them, no oil barrier. As the wear occurs, the clearance between the cylinders and the pistons is enlarged. This enlarged separation allows more and more high-pressure refrigerant to "blow by" the cylinders back into the crankcase. The compressor becomes less efficient. Less refrigerant is discharged to the system, therefore, a loss in capacity. In addition, the pressure in the crankcase is elevated and may prevent returning oil to be returned to the crankcase.

Liquid refrigerant — Floodback, is not a friend of the compressor. It is one of its deadly enemies.

Floodback causes a different type of damage in the refrigerant cooled compressor. The refrigerant and oil from the system return through the motor compartment. Liquid oil drops down and returns to the crankcase under the motor and through a check valve in the "fire wall" that separates the motor and crankcase compartments. Refrigerant vapor leaves the motor compartment at the top of the motor compartment.

Liquid refrigerant, like the oil, drops to the bottom of the motor compartment and travels with the oil. For a while, the motor heat will boil off the liquid refrigerant. At some point, the motor will be cooled enough and the liquid refrigerant will continue with the oil into the crankcase.

The refrigerant and oil mixture is heavier than the oil and sinks to the bottom of the crankcase. The oil pump picks up the oil from the bottom of the crankcase. The refrigerant and oil mixture is picked up and is discharged into the compressor driveline.

If the oil and refrigerant is less than about 15% refrigerant, the lube oil safety control will not trip and the compressor will continue to operate. When the mixture exceeds about 15% refrigerant, the refrigerant may flash off in the pump's pick up tube. This happens because of pressure drop. When this happens, the pump loses its prime, the differential pressure drops, and the lube oil safety control trips, stopping the compressor.

The real problem occurs when the refrigerant in the oil is less than the 15%-20%. As the mixture leaves the pump, the warm bearings will boil off the refrigerant. The oil pump moves a volume of liquid. In this case, a volume of oil and refrigerant.

As the refrigerant is boiled off, the volume of liquid is lessened; therefore, there is not enough oil to lubricate all of the bearings. The last bearings in the driveline to be lubricated are the motor and center bearings.

The rotor is on the crankshaft after the motor bearing. There are no additional bearings beyond the motor bearing, therefore, the rotor overhangs the last bearing. With the loss of lubrication to these bearings, the weight of the rotor causes the bearings to wear at the bottom of the bearings. This allows the rotor to drop down, narrowing the air gap between the rotor and the stator. This added heat might cause the motor's thermistors to heat up and cause the motor protector to trip, stopping the compressor. When the motor cools down, the protector will again close and the compressor will start and the damage continues.

Ultimately, the rotor will drop far enough so that it drags on the stator. This will cause enough heat to build up in the stator windings causing a burnout, killing the compressor. When this happens the compressor will have to be replaced. Yes, a Floodback failure, not a bad motor failure. Again, Floodback is not a friend of the compressor.

How do you know if Floodback is a problem? Measure the conditions at the compressor inlet, pressure and temperature. If there is no superheat, a problem has happened or is in the making. If there is superheat, no problem.

What should the superheat be? Most compressor manufacturers want to see 20° of superheat at the compressor under full load. This allows for a drop in superheat as the load falls off but not get to the saturation point.

And what do you do if your system is one of those that does allow saturated refrigerant to return to the compressor? As a last resort, add a suction line accumulator. This is a last resort and not a routine. The accumulator will assist in stopping the Floodback problem but does add pressure drop in the suction line. Pressure drop is not a friend of the compressor, either.

If the choice is pressure drop or floodback, take the pressure drop.

What else can be done? Good design, installation and absolutely good maintenance are the keys. Clean filters in the Air Conditioning systems, proper line sizing, proper control settings, proper thermostatic valve settings, proper deep vacuum of the system and, in general, proper installation, all add up to a good operating system.

SUGGESTIONS

If you would like to see a future article on a particular subject please write, fax or call.

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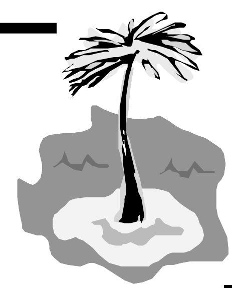

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