Progress Supply Inc.

THE INSIDE STORY

Helpful Information for HVAC Contractors from Progress Supply

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

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FLOODED STARTS

This is the second of five articles dealing with mechanical failures to compressors.

The last article dealt with "Floodback." A quick review—Floodback occurs when liquid refrigerant is allowed to return to the compressor when it is running. The key words, "when it is running." The damage to the air-cooled compressor generally occurs in the cylinder piston area, with wear occurring between the pistons and the cylinder walls. This can lead to motor damage.

The damage to the refrigerant-cooled compressor is generally bearing wear, leading to bearing seizure or motor damage. It can also cause Lube Oil Safety Control trips.

Flooded Start is an off cycle problem. By definition, Flooded Start is caused when refrigerant vapor migrates to the compressor when the compressor is off. Floodback, the compressor is running; ***Flooded Start, the compressor is off.***

There is a natural "love affair" between refrigerant vapor and oil. Refrigerant vapor wants to naturally mix with the oil used in refrigerant compressors. This "love affair" is good news when the compressor is running. It is one of the ways that oil is returned from the system to the compressor and this is good.

The term for this is **miscibility.** When the compressor is off and vapor returns to the compressor, it will settle in the crankcase and motor compartment. This can lead to a compressor failure.

Like the Floodback failure mode, the failure from Flooded Start can be different in the refrigerant-cooled and air-cooled compressors.

We said that it is easy to measure a Floodback. Measure the superheat at the compressor inlet. If there is superheat there is no Floodback. If there is no superheat then we have saturated refrigerant and there is Floodback.

Flooded Start is not that easy to identify. In fact, most Flooded Start failures are diagnosed by inspecting the failed compressor. There are no measurements that can be made because the compressor is not operating.

What a way to go, analyze the problem after the patient has died. The question is: **Can I see a Flooded Start?** *Yes, if the compressor is a refrigerant-cooled semi-hermetic compressor. Maybe, if it is a semi-hermetic air-cooled compressor. No, if it is a hermetic compressor.*

Semi-hermetic compressors have an oil level sight glass. If you are looking at the sight glass when the compressor starts and see a major eruption in the oil, a flooded start has occurred. As an aside, foaming oil does not necessarily mean that refrigerant is in the oil.

The small air-cooled compressor may not experience the major eruption. This is because of the construction of the compressor. The larger air-cooled compressor, like the refrigerant-cooled compressors, can experience this condition.

So let's look at the problem. Refrigerant vapor migrates to places in the system where oil has accumulated. Hopefully, there is oil in the crankcase. When the compressor is off and if liquid refrigerant remains in the evaporator and/or in the suction line, it will continue to boil off. The vapor will naturally, by all laws of physics and chemistry, travel to the oil, particularly in the compressor's crankcase and motor compartment.

The vapor pressure of the refrigerant is greater than the vapor pressure of the oil. The refrigerant vapor pushes its way into the oil and condenses. The refrigerant rich oil is more dense than oil alone and it will sink to the bottom of the crankcase. This is not a problem until the compressor starts.

When the compressor starts, the system's pressure is lowered. The boiling refrigerant now comes out of the oil.

The amount of refrigerant in the oil will determine how violently the boiling action is.

If there is a small amount of refrigerant in the oil, the boiling action will be very small and little to no damage to the compressor will occur.

When there is a large amount of refrigerant in the oil, the boiling action can be very severe and a major "eruption" of the oil and refrigerant will occur.

In the air-cooled compressors with or without an oil pump, the refrigerant exploding out of the crankcase can force itself between the crankshaft and the rod bearings. This action is random; therefore, one does not know which or how many rod bearings will be affected.

Because refrigerant is an excellent cleaner, the lubricant is washed out of the bearing area and the aluminum rod bearing will be "torn" out of the rod and deposited onto the cast iron crankshaft. Over time, this action will ultimately cause the rod to seize to the crankshaft, resulting in a broken rod.

In today's air-cooled compressors there is another type of damage that can occur. It is a type of damage that one sees in the refrigerant-cooled compressor as the result of Floodback.

Because the refrigerant is at the bottom of the crankcase and because the oil pump picks up liquid from the bottom of the crankcase, at start up, the oil pump will pick up liquid refrigerant. As in the air-cooled and refrigerant-cooled compressors, the last bearings to be lubricated are the motor end bearings.

If Flooded Starts are permitted to continue over a long period, the motor end bearings can wear allowing the rotor to drop against the stator and will destroy the motor.

In the refrigerant-cooled compressor, similar damage in the rod/crankshaft as in the air-cooled compressor area will occur. At start up, the refrigerant can wash the lubricant out from the rod bearing/crankshaft area. Like in the air-cooled compressor, the rod will seize to the crankshaft and break the rod. Again, this is a random failure occurrence and can happen to any or all of the rod bearings.

The oil, besides being in the crankcase, is also in the motor compartment. When the compressor starts, like in the crankcase, the refrigerant will erupt out of the oil and will take some of the oil with it.

Refrigerant gets to the compressors's cylinder/piston area out of the motor compartment. With a large enough eruption of the refrigerant and oil, a relatively large quantity of oil will enter any one or more cylinders.

Oil is not compressible. With the oil in the cylinder(s), during the compression stroke; damage will occur. The damage can be a broken rod; a broken reed; or broken valve plate. There have also been holes broken out in the tops of pistons.

How can you stop a Flooded Start? Because the migration of refrigerant to oil and because of miscibility between the oil and the refrigerant, this is a phenomenon that cannot be stopped. However, there are steps that can

be taken that can help to prevent the problem.

Any system that is off for prolonged periods of time is almost guaranteed to have a Flooded Start problem. Yes, crankcase heaters will help relieve the problem but are not a guarantee.

In compressors that are subject to cold ambient temperatures, especially below 50°F, the crankcase heater may not stop the problem.

If the application is strictly summer air conditioning, the crankcase heater will generally stop the problem.

The amount of refrigerant in the system can also determine if there may be a Flooded Start problem. In small systems, there is generally not enough refrigerant in the system to cause a problem. It is generally the large system or systems with long refrigerant lines where one has to be concerned.

To prevent a problem, keep the refrigerant out of the compressor. How do you do that, you ask? A continuous pump down is a very good solution. To have a continuous pump down the system must have a liquid line solenoid that is operated by the space thermostat and a low-pressure controller that turns the compressor on and off and is properly set. The liquid line solenoid should be close to the thermostatic expansion valve (TEV). This minimizes the amount of refrigerant that can migrate to the compressor during the off cycle.

The secret is the proper setting of the pressure control. The cut out setting should be approximately 10 psig lower than the operating pressure of the system. The cut in setting should be set to its minimum setting, approximately 10 psig higher than the cut out.

This statement generally causes two questions to be asked: **1)** Won't this cause short cycling? **2)** How will I get the compressor to start when the temperature is below the refrigerant's saturation temperature for the low-pressure switch setting.

I may be picking at words, but there is a difference between true short cycling and several restarts. When the space temperature is satisfied, the solenoid valve will close and the suction pressure will fall. When the cut out setting is achieved, the compressor will stop.

If any liquid is still in the evaporator or suction line, the boiling will continue and the suction pressure will rise and generally rise above the cut in setting.

The compressor will restart and again pump down the low side to the cut out setting. This may happen several times until all of the liquid is pulled out of the evaporator and suction line. Unless the solenoid valve is leaking, the compressor will be off until the space temperature warms up.

OK, what about us in the cold climates like here in Erie, PA, or even Dayton and Cincinnati, OH? Keep the low-pressure switch setting as explained. Install a by-pass timer around the low-pressure switch. This timer has a set of normally open contacts wired in parallel with the low-pressure switch contacts. When the solenoid valve is energized, the by-pass timer is energized and its contacts will close, permitting the compressor to start.

The timer should be set for two minutes. At the two minute point the timer deactivates, opening its contacts. The system operates in the normal manner. Should the pressure fall below a safe operating level, the low-pressure control will perform as designed. In a normal shut down, the system performs as designed and on the next call for cooling the by-pass timer will again allow the system to start.

Yes, like Floodback, **a Flooded Start is not a friend of the compressor.** Next time let's discuss ***Slugging.***

SUGGESTIONS

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

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