

Oil Pressure Problems in Refrigeration Systems

by Steve Maxson, Heatcraft Inc. – Refrigeration Products

Many refrigeration compressors serviced today have positive displacement oil pumps to help lubricate the internal compressor parts. Most compressors that have positive oil pumps also have a control which senses oil pressure and acts as a safety device whenever the oil pressure falls below a certain threshold level. It is the action of the oil safety control we will discuss in this text.

OIL SAFETY CONTROLS

There are several types of oil safety control devices on the market today. The two basic controls we are most familiar with are the 'mechanical differential control', and the 'pressure sensing electronic control'. The mechanical control uses tubing that senses the suction pressure of the compressor and the outlet oil pressure of the pump. The electronic control has a special pressure-sensor which mounts in the outlet of the pump and connects only with an electrical cable. In the mechanical control, the total pressure from the pump, less the suction pressure is the actual net oil pressure. The control used most often on Copeland™ compressors is set to open the safety contact points after a short time delay whenever the net oil pressure falls below nine psig. The control requires manual reset once it has tripped. In the electronic control, the pressure sensor sends a signal to the control module whenever the pressure sensed falls below 7 - 9 psig. This signal causes the control module to open the safety contact points after a time delay. This control also requires manual reset once it has tripped. On

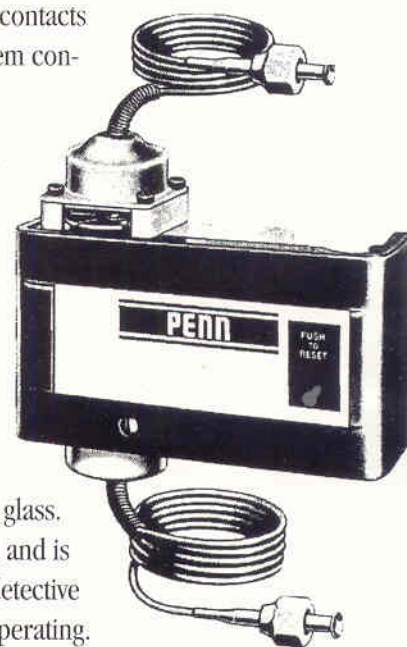
both controls, the opening of the safety contacts breaks the electrical current in the system control circuit.

When the service person gets a call that the refrigeration system is not operating, one thing checked is whether the oil safety control has tripped. If it has tripped, the fun begins when the mechanic must figure out what caused the oil failure control to open. Sometimes, the actual cause of the trip is obvious, for example when there is no oil showing in the crankcase sight glass. Often, however, the cause is not noticed and is more difficult to figure out, calling for detective work to keep the refrigeration system operating.

OIL PRESSURE CONTROL CHECK LIST

The following is a general listing of possible causes of oil failure trips.

- Low compressor oil level.
- The system refrigerant piping is not designed or sized properly.
- The system has not been properly adjusted and balanced.
- Lack of proper "winter-charge" of refrigerant. (Low refrigerant)
- Refrigerant migration.
- The system controls have not been properly set.
- Electrical problems.
- Compressor problems.



A typical oil pressure safety control.

Courtesy Penn Controls, Inc.

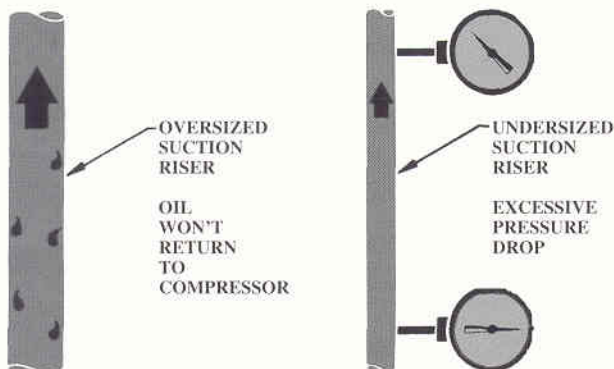
Continued on Page 2

OIL PRESSURE PROBLEMS *(Continued from Page 1)*

COMPRESSOR OIL LEVEL

What is the level of oil in the crankcase sight glass? You should be able to see the oil level in the sight glass. If you can't see the oil level, there is either too much oil in the compressor or not enough. In most compressors, the oil level in the sight glass should be between 1/4 and 1/2 sight glass. Too little oil in the compressor results in an obvious oil trip. Too much oil in the compressor can also cause oil trips. Excessive oil can cause enough turbulence in the crankcase to result in a low net oil pressure. In another twist of too much

The figure below shows the importance of proper suction line design.



oil in the sight glass, the high level of oil may be caused by liquid refrigerant in the crankcase. The liquid refrigerant could be mixed with the oil or collect beneath

the oil on the bottom of the crankcase. In either case, the refrigerant in the crankcase will cause the net oil pressure to be low. If there is too much oil in the crankcase, the excessive oil should be

drained to the proper level. If there is not enough oil in the crankcase, you must find the reason the oil has not returned to the compressor.

SYSTEM PIPING

If the oil does not properly return to the compressor, it could be due to the system piping and/or design. For oil return, the suction pipe is the most critical. The suction pipe should slope toward the compressor and should be sized for minimum pressure drop and proper refrigerant velocities. Minimum pressure drop and proper gas velocities can conflict with each other by their nature, so take care in selecting pipe sizes. If the pipe size selected is too large, the refrigerant velocity becomes insufficient to carry oil vertically up the pipe. Low refrigerant velocities will result in poor oil return to the compressor. The oil must pass freely through the entire system and reach a state of equilibrium to maintain stable oil levels in the compressor. *Heatcraft Inc. publishes refrigerant line sizing charts in several documents including the System Installation Manual.*

OIL TRAPS AND SUCTION RISERS

Equally important in the system piping design, is the use of traps in the suction line. A p-trap should be used at the base of any suction riser greater than three to four feet in length. A suction riser is any vertical line which has an upward refrigerant flow. In long suction risers, p-traps should be used for each 20 feet of vertical rise. In addition, it is good practice to install a p-trap at the outlet of the evaporator if the suction line rises above the bottom of the evaporator. This trap will insure that oil can flow freely out of the evaporator. The reason for the suction p-trap is to help the return of oil to the compressor. The refrigerant gas returning from the evaporator will contain drops of oil which can collect and mix in the turbulence of the trap. This turbulent action breaks up the larger drops of oil into smaller droplets carried up the riser pipe by the gas velocity.

HEATCRAFT TECH•TOPICS

Tech•Topics is published quarterly by and for the employees, suppliers, distributors and friends of Heatcraft Inc. It is produced by the Corporate Public Relations Department in cooperation with other company operating groups, staffs and strategic business units.

Contributing Writers: Steve Maxson, Steve Attri

Correspondence should be directed to:

Jane Scott, *Tech•Topics*
Public Relations Department, Lennox International Inc.
2100 Lake Park Blvd., Richardson, TX 75080

Be careful of piping installations where the pipe is being routed over, around, or under obstacles. This can inadvertently create unwanted traps in the return line that will collect oil. If possible, the refrigerant line should travel a direct and straight course between the evaporator and compressor.

NEW SYSTEMS

What if the system is new? Sometimes not enough oil is added to a new system to allow for the pipe, accumulators, separators, suction traps, evaporators and condensers. There is always a certain amount of oil in the system that will stay disbursed throughout the system after stabilization and during normal operation. Use extreme care in adding oil to a new system. Most compressors are shipped with enough oil to carry through systems up to 50 feet of piping without additional oil. Always check the system for possible problems before adding oil to the compressor. Barring leaks and other unforeseen problems, oil should never have to be added to a stabilized system.

SYSTEM BALANCE

A refrigeration system should be fine tuned after installation and start-up. Never assume the thermal expansion valve installed at the evaporator is factory preset. Each expansion valve has an adjustment stem for a definite purpose. That purpose is to fine tune the system for your particular conditions and application.

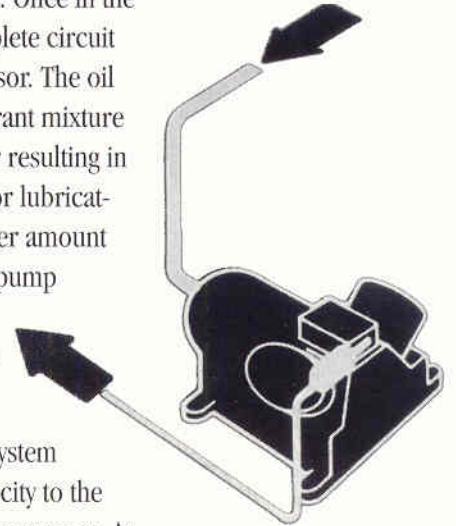
A system with too low superheat risks liquid refrigerant returning to the compressor. If the liquid refrigerant gets into the compressor crankcase, problems can develop rapidly. We have already discussed what liquid refrigerant in the crankcase can do in the section on Compressor Oil Level. If liquid refrigerant is inside the crankcase during an off cycle, it is difficult to decide the true level of oil. When the compressor restarts, the sudden drop in pressure in the crankcase will boil the refrigerant causing the oil/refrigerant

mixture to foam violently and forcing the oil out of the compressor and into the system. Once in the system, the oil must travel the complete circuit before it can return to the compressor. The oil pump will also force the oil/refrigerant mixture into the bearings of the compressor resulting in death to the compressor due to poor lubricating quality of the oil mixture. A larger amount of oil/refrigerant mixture in the oil pump usually results in low net oil pressures. This condition will cause the oil safety control to trip.

A condition that causes too high a system superheat will result in low gas velocity to the compressor, and often low suction pressures. As discussed in the section on System Piping, low gas velocities make it more difficult for the oil to be carried up the vertical suction risers. If this condition persists, the system could eventually become oil logged and the compressor will pump itself out of oil resulting in oil failure.

Heatcraft recommends a system superheat at the compressor of 30°F. This can vary depending upon local conditions and length of refrigerant pipe run. This superheat ensures the refrigerant gas returning to the compressor is "dry" and cool.

There are several problems which can prevent the user from achieving stable operating conditions. Fine tuning the system is vital to oil control. The distributor, and the nozzle inserted into the distributor, have become vital parts of the refrigeration system, adversely affecting operation if not sized correctly. Factors affecting these parts are: evaporator capacity, liquid refrigerant temperature, suction temperature, and refrigerant type. Usually, a standard nozzle is shipped with a particular evaporator sized for standard capacity of the coil, normal liquid refrigerant temperatures of 90° to 100°F and refrigerant type. If any of the conditions deviate from the standard, such as



Oil leaving the compressor should equal oil returning.

OIL PRESSURE PROBLEMS *(Continued from Page 3)*

mechanical subcooling the liquid refrigerant below 80°F, the distributor and the nozzle may not perform properly. When a problem exists, the system cannot maintain the required fixture temperature and/or the suction superheat is erratic and unstable. In the worst case, if the suction superheat is too low, it causes liquid floodback to the compressor. As mentioned previously, liquid refrigerant is not welcome at the compressor.

SEASONAL CHANGES

A significant number of oil control trips occur during the “swing” times of the year when the night temperatures are cold and the day temperatures are warm. Often the mechanic finds the compressor not operating during the day because of an oil control trip. When the cause of the oil failure is not readily apparent, the control is reset, the compressor operates normally, and everything looks good from the refrigeration perspective. What could have caused the oil failure? Several factors should be considered.

Inadequate refrigerant in systems designed to flood the condenser (for head pressure control) will cause low suction pressures. If the refrigerant charge is low, the expansion valve will not feed the evaporator properly, resulting in high superheat and low gas velocities. Low gas velocities result in poor oil return and can result in oil logging in the evaporator or other areas in the piping.

Low head pressure resulting from cold ambient can affect the thermal expansion valve. If the valve is not sized correctly or is not designed to operate under low differential pressure, it will not feed the evaporator. This condition results in high superheat, low suction pressure and low return gas velocity as discussed in the preceding paragraph.

During cold nights or winter months, outdoor compressors should have an operating crankcase heater. Crankcase heaters help keep the oil in the compressor from getting too cold during compressor off times. When refrigeration oil is cold, it

becomes very thick and viscous, making it difficult to move the oil through the special pressure sensing mechanism of electronic oil controls. The crankcase heaters also help prevent refrigerant migration.

MIGRATION

Migration occurs on cold nights because of pressure differences. Refrigerant will always move from warmer areas to colder areas. Therefore, when the compressor is off, refrigerant will migrate to the coldest part of the system. If the compressor is the coldest part of the system, then refrigerant will migrate into the crankcase of the compressor. When the compressor restarts, rapid expansion of the liquid refrigerant in the crankcase will cause the oil/refrigerant mixture to boil rapidly. (See the section on System Balance for liquid in the crankcase reactions.) Refrigerant migration may occur if the compressor crankcase heater is inoperative or inadequate or when the evaporator becomes warmer than the compressor during defrost.

Migration can be controlled with the use of a pump down solenoid. This requires a liquid solenoid valve be installed in the liquid line of the system. Whenever the system is defrosting or satisfied on temperature, the liquid solenoid valve should be closed. This will help reduce the potential for refrigerant migration to the compressor.

SYSTEM CONTROLS

It is important the controls in the refrigeration system be properly set. This would include low pressure controls, head pressure controls, condenser fan cycling controls, and any other type control that special systems and circumstances require. All valves which can change system pressures should also be included in this section. Check manufacturer specifications for proper settings of all valves and controls. Improper settings could result in oil pressure trips when least expected.

ELECTRICAL

Oil pressure trips can be caused by electrical problems. Any electrical problem that causes the motor windings inside the compressor to overheat can cause internal overloads in the compressor to open. On smaller model compressors (those without external control modules), this condition will result in an oil failure trip. The compressor is not operating and not producing oil pressure, yet the oil pressure control is still energized and monitoring the oil system. After the specified time out period for the control, the contacts will open and the oil safety control must be manually reset. Possible electrical problems include high voltage, low voltage, phase imbalance on three phase systems, and phase loss on three phase systems.

Where the electronic oil control is used, another type of electrical problem can cause an oil control trip: 'electrical noise'. Some electronic controls are sensitive to electrical line noise and can mis-read the electrical transients as an oil related problem. Electronic controls use line frequency for timing. An inordinate amount of electrical transients on the incoming lines can fool the electronic controls into counting this noise and trip. Some models of electronic controls now have protection against transient line noise, but this does not guarantee trips will not occur.

Another problem causing trips of an electronic oil failure control is a result of local electrical characteristics. In some locations there is one leg of power, with voltage to ground much higher than on the other legs of power. In this instance, care must be taken not to connect the system control circuit to this high leg of power.

COMPRESSOR PROBLEMS

There are several compressor problems which can cause the oil failure control to trip. Compressors with oil pumps are totally dependent upon the oil pump to provide the necessary pressure to lubricate the bearings and other moving parts

inside. If the oil pump itself is defective or worn excessively, there is usually no net oil pressure. On three phase equipment, the rotation of the pump can be reversed to see if it eliminates the problem. If the compressor is leaking oil pressure internally, there is usually some net oil pressure. Internal oil leaks can be a result of

excessive wear on bearings and load surfaces associated with the crank shaft. This problem is a symptom, not a cause, of poor lubrication. The lubrication problem should be corrected and the compressor replaced if this condition persists.

Smaller horsepower compressors (without external control modules) can trip on oil failure if the compressor does not start when electrical power is applied to the terminals. In this situation, the compressor contactor is energized and the oil safety control thinks the compressor is operating and producing oil pressure. If the compressor has a problem and cannot start, the oil control will trip after the time out period of the control. This situation can occur on three-phase equipment and on single-phase equipment.

Oil contamination (trash or other foreign matter) can cause a problem at the pick-up tube in the compressor crankcase. A fine mesh screen surrounding the pick-up tube in the crankcase can become clogged with debris under severe conditions. On models with electronic oil controls, there is also a screen in the special oil sensor of the control. Contamination can result in low net oil pressure and an oil failure trip.

In older compressors, oil failures can occur because of the pressurization of the crankcase

Reasons for Oil Not Returning at a Satisfactory Rate

- Low Refrigerant Velocity
- Short Cycling
- Low Load
- Traps
- Piping Errors

OIL PRESSURE PROBLEMS *(Continued from Page 5)*

due to blow-by from the pistons or piston rings. This can cause the oil return check-valve, located between the motor compartment and the crankcase, to close and not allow oil to return into the crankcase. When the crankcase is emptied of oil, the control trips and must be manually reset. By the time the mechanic gets to the job to reset the control, the crankcase has equalized, and the oil has drained from the motor compartment.

Short cycling occurs when the compressor pumps more oil than normal. Short cycling, caused by many conditions – low head pressures, low refrigerant charge, improper differential setting of the low pressure control, or leaking of the liquid solenoid valve – can cause the oil control to trip.

FINAL SAY

Today's refrigeration mechanic must be knowledgeable and not afraid to ask questions. To isolate the oil problem, sometimes asking the right question can uncover vital information.

- Does the operation of the facility differ at night, when no one is around – or at other various times during the work period?
- Can the evaporator fan motors be turned off without shutting off the compressor? (Are breakers which control the evaporator fans turned off at night?)
- Do the evaporator fan motors shut off when the fixture door is open?
- How long is the fixture door open during loading and unloading?
- Does the refrigerant load change drastically over certain periods?

This article has briefly covered some possible causes of oil failure in refrigeration equipment, but certainly not all. Service persons should always be alert to unique or unusual equipment problems, and to conditions causing oil failure problems.

HEATCRAFT
TECH•TOPICS

