Rack Oil regulation and System Oil Failures

Bryan Lord 2009

Oil failure alarms are usually more than just a compressor safety control failure or low oil pressure event. Unfortunately OFC alarms are just reset and the service call gets signed off without a follow-up. Oil failures can be caused by liquid slugging, flooded starts, compressor overload tripping or control circuit problems. Some commonly overlooked factors in a compressor alarm are attributed to oil return and rack oil supply systems. Rack oil control is the least understood part of the system. Oil failures often are caused by problems not related to oil issues.

- Oil separators, reservoirs and oil pots only act as storage containers.

- Oil pots, reservoirs and separators act as a time delay for when the system’s oil equilibrium changes.

- Oil pot level controls cannot accurately be adjusted while the compressor is running. To properly adjust the level, the oil returning through the suction must be eliminated by turning the compressor off and closing oil equalizer lines. Once the compressor is off and the oil level is lower than the desired level, you can fine tune the pot adjustment to allow the pot to fill up to the desired level.

- Oil Pots will compensate for differences between compressors on a common suction header due to variables in size, run time, and wear.

- New properly functioning reciprocating compressors will circulate 1% to 3% in oil per pound of refrigerant pumped every hour.

- Worn compressors can circulate up to 10% oil per pound of refrigerant pumped per hour.

- A new 15hp Discus (R404a, POE 32CF) running at 110f SLT / 15f SST circulates approximately 1,790lbs of refrigerant per hour. At a rate of 1% that equals 17.9lbs of oil per hour (2.3 gal of oil). At a rate of 3% that equals 53.7lbs of oil per hour (7 gal of oil per hour!). (Based on weight of 1us gal 32CF Nu-Calgon oil = 7.5lbs)

- 100hp R404a rack operating at -20f SST and 110f SCT will circulate 9310lbs of refrigerant per hour. At a 1% ratio that equals 93lbs of oil (12.4gal). At a 3% ratio that equals 279lbs (37gal).

- As a practical example, If you were running both a 15hp and 5hp compressor on a common suction header and without a oil separator for a one hour period. If we shut the 15hp down for 15 min during that hour, the 5hp will have over twice the oil returning as it would normally circulate. In effect it would take two hours for the 5hp to pump the excess oil return without an equalizer line. (Copeland recommends the use of an oil separator, oil level controls and equalization lines between compressors piped in parallel applications)

- Improper line sizing, insulation and improper install practices are not the only causes for oil logging. Underfeeding TXVs produce low velocity problems in coils and will log oil. Dirty evap coils/cases and burnt out fan motors can lead to oil logging as well.
• The check valve in the compressor between the crank case sump and the motor is in place to prevent oil from being forced out of the sump and into the motor when the compressor starts. But when a compressor has worn rings, it will blow-by into the crank and possibly close off the check valve, preventing oil return from the suction line to enter the sump. The Comp will now rely on the oil pot alone for supply. This can lead to a shortage of oil supply from the separator and other compressors on the rack. This problem can easily be misdiagnosed leading to oil failure controls, oil pots and oil pumps being replaced without due cause. For example if a compressor pressurizes the crank case with enough pressure to prevent flow from the oil pot, the compressor will run dry and shut down on oil failure. Once the compressor is off the crank will equalize with the suction pressure and the check valve will open. Oil in the motor end of the compressor will fill the sump and the mechanic will notice adequate levels in the sight glass upon arrival. (In extreme cases with an EQ line between oil pots, one compressor with excessive blow-by could pressurize the cranks of every compressor on the rack and producing multiple oil failures)

• Short cycling compressors can lead to oil failures. When compressors short cycle continually they can pump all of the oil out of the crank case. Without the compressor running for a sufficient time to stabilize the system, oil will not return to fill the crank case. Causing oil failures. (common cause is low charge and or improper LP control settings)

• POE oil has solvent tendencies due to its acid and alcohol base. POE will scrub pipes and fittings and carry the debris throughout the system. Most of the debris will collect in places like TXV screens and oil screens found in oil pots and compressor pickups. Commonly overlooked places are oil pot inlet screens, compressor oil pickup screen, oil failure control diff sensor, and in the bottom of oil separators. Thus plugging floats, outlets and/or Y1236 regulators.

• Oil filters on racks are designed to keep particle limits in oil below 3 microns or less. Compressor bearing life is cut in half when particle levels rise above this level. (1 micron is 1/300th the diameter of a human hair)

• Oil separator efficiency ratings are mostly sales pitches. Higher efficiency models will limit the amount of oil entering the system, but until a 100% efficient model is invented it is only a matter of time before oil accumulates in the same quantities and at the same locations as a less efficient separator. High efficiency separators in effect hide problems or delay the inevitable for a short time.

• Oil reservoirs hold the oil needed to pick up the slack in a fluctuating rack situation. It is impossible to size a reservoir to compensate for a system that is incorrectly piped. Sporlan states that ¾ gal of oil in a reservoir is more than enough for any sized system. (Exception to this is Scroll parallel applications)

• Oil pots are make-up-the-difference valves. They compensate for higher compressor oil pumping to return ratios.

• Oil level fluctuations are an indication of oil logging.

• Copeland Oil pumps under normal operation will deliver net oil pressures between 20 to 40psi net. Adequate lubrication will be maintained at pressures down to 10psi. An internal bypass valve will prevent net oil pressure from exceeding 60psi net.
• Liquid refrigerant will settle below refrigeration oil in a compressors sump. If the compressors oil pickup is below the actual oil level the net oil pressure will drop below the minimum oil failure pressure settings and cause oil failures (Commonly upon arrival mechanics will not see any signs of liquid in the compressor).

• Copeland Oil Failure control specs are rated at 120 seconds at < or = to 9psi. (+,- 2psi)

• Copeland 4D and 6D Discus compressors utilize **Electronic Motor Protectors**. This monitors internal winding temperatures, low line voltage to monitor and power outages. The module will open the compressor control circuit and prevent restart for a delay of 2min. Sensor resistance will vary from 30ohms (cold) to 20,000ohms (hot). Reset values after trip are between 2700-4500ohms. (Copeland had problems with modules made by Texas Instruments pre 2004. As a result they have a new module to replace the older styles in the event they fail. (The common failure is intermittent lockouts causing oil failures)

• Scroll Compressors used in parallel rack applications require a different design to Discus compressors. Copeland scrolls have an internal oil pump that does not have an external means of measurement. 7 ½ to 15hp scrolls have an oil capacity of 140oz as compared to 125oz in a 3D Discus. Although scrolls use much less oil. Copeland scrolls use Alco OMB level controls that feature low oil level lockout as the only oil protection (The amount of oil between ½ sight glass and empty sight glass is only 15oz.). TRAX OIL controls are no longer used on Copeland compressors due to the failures inherent to the design (It was very common for debris to get stuck in the mechanical float and prevent the oil fill solenoid from energizing).

• Alco OMB controls use a "Hall Effect" magnet to actuate the flow valve. Therefore they are susceptible to metallic particles in the oil. Clean oil is essential to keep the controls operating properly.
**Sporlan Oil Pot**

As of 2007 Sporlan has stopped supplying the OL1 and OL2 oil pots. The replacement is now the OL60 with a new adjustment chart. The OL1 oil pot has a max net oil of 30psi. The OL2 and OL60 can both handle 90psi Net. I have found that the OL60 oil pots don’t respond well with oil pressures below 20psi net. I have also noticed that the OL1 will start to over feed over 25psi net. Caution needs to be taken with replacing an older OL1 pot with a new OL60. Both pots are pre-adjusted 3 ½ turns in from the top but will give drastically different results.

**New Sporlan Pots (2007 to current)**

Adjustment

The oil level control is factory set 3-1/2 turns clockwise from the top stop. To set the oil level, remove the seal cap on top of the control. Turn the adjustment stem clockwise to lower and counter-clockwise to raise. The proper adjustment can be determined from Figure 6. The oil level is given in eights of an inch at various differential pressure conditions. Make adjustment (if necessary) prior to installing the control on the system.

Under no circumstance adjust beyond 10 turns down from the top stop or the control may be damaged. With care a person can feel the top and bottom stops. One of the symptoms of over-adjustment of the oil level control is a totally full sightglass.

Data obtained using POE lubricant at 75°F with a one inch sightglass.

If a sudden load increase or system defrost causes a large amount of oil to return through the suction line the control will not prevent the oil level from rising above the control point.

**Old Sporlan Pots (pre-2007)**
AC&R, Henry, Emerson, Alco Oil Pots

The only information I have come across for these oil regulators is from 1992. Emerson has recently purchased the design and changed the model numbers. The new model is a replacement for the S-9190 but I cannot get any info on any changes to the design or adjustment charts. I have found that 5 to 6 turns in from the top is approximately ½ sight glass.

Although the sales literature states that the “exclusive” design allows the oil pot to be adjusted without shutting the system down, you still cannot properly adjust this oil pot with the compressor running since oil returning via suction gas will make oil levels raise. Classic difference between Sales and Engineering.
## Recommended Oil Levels for Copelandetic Compressors

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### References

- RSES Bulletin: 110-140 *How to maximize supermarket compressor life* (June 2000)
- Sporlan Bulletin:110-10 *Oil Level control system* (January 2004)
- Sporlan Bulletin:110-10 *Oil Level control system* (September 1991)
- Sporlan Supermarket Refrigeration Troubleshooting Seminar (2005) Presented by:

  - Russ Barnthouse  Senior Supermarket Application Engineer
  - Pat Bundy       Senior Supermarket Application Engineer
  - Dave Demma      Senior Supermarket Application Engineer
  - Steve Maxson    Supermarket Specialist