WHY DID THE COMRESSOR FAIL?

YOU MUST ALWAYS ASK ***YOURSELF*** THIS QUESTION. IF YOU DON'T FIND THE ANSWER YOU WILL PROBABLY BE CHANGING THE COMPRESSOR AGAIN. THE OLD COMPRESSOR HAS A STORY TO TELL. BY TAKING A LITTLE TIME WE MAY FIND THE ANSWER TO OUR QUESTION. LETS LOOK AT SOME STORIES.

Shorted to ground. A large percentage of shorts and/or grounds are caused by lack of lubrication. Pull the end bell off the compressor and look at the rotor and stator. Look at the windings and see what condition they are in. If we see a general burn, all windings burned, we need to check for low voltage, high voltage, voltage and/or current imbalanced or loss of motor cooling. If we see one or two phases burned and the others are not, then we probably had a single-phase condition, either primary single phase or secondary single phase. If we find half of the windings burned and the other half not, one contactor did not pull in and we overheated the other (part winding start). If we find two phases of half the winding burned, check for welded contact points keeping two legs energized in the off cycle. If you find a spot burn at the bottom of the compressor check the clearance between the rotor and stator. Check for up and down or side-to-side movement of the rotor.

If you have a compressor that is locked up, you need to look in the crankcase. Pull the side plate or bottom plate. Look for broken rods, galled bearings or seized pistons. You may also want to look at the valves by pulling the heads. Look for broken or discolored valves, blown head or valve plate gaskets, bent valve backers, loose, missing or broken valve bolts.

Is there any copper plating? Moisture and high temperatures result in acid followed by copper plating.

After installing a new compressor, you will want to use what you found on your inspection of the old compressor to check for system problems. Galled or worn bearings and wrist pins are signs of flooding. Broken valves and rods are signs of a flooded start or slugging from the system.

TAKE TIME TO CHECK THE SAFETIES.

Checking a compressor that is running:

The compressor is running but the oil leaves the compressor. This can be caused by worn pistons, worn rings, bad valves, flooding or worn bearings. The rear main bearing may be severely worn. When checking for flooding, look at the oil sight glass. Does the oil look foamy or clear and then turns foamy and back to clear? Are the heads too hot (sizzle when sprayed with water)? Is the crankcase too hot (105^{o} to 125^{o} F is normal)? Does the oil leave on start up and doesn't seem to come back? Check the suction pressure. Suction or head pressure may be too low to bring the oil back to the compressor. Has the compressor been running unloaded for an extended time? When a compressor is unloaded the gas velocity and line sizes are incorrect resulting in poor oil return. Is the crankcase pressure too high? Check the difference between the crankcase and the suction pressure. The crankcase pressure should be slightly lower than the suction on most hermetic reciprocating compressors. The Carrier/Carlyle O6E is one exception to this with a higher crankcase pressure but should not be more than 2 psig higher.

Does the compressor knock when it is running? Worn bearing, rods, wrist pins, broken rods or valves might be the cause. To check for a worn wrist pin, bring the piston to the top of its stroke and start back down. Now push down on the piston, there should be no movement. This condition is common if the compressor has run with a broken discharge valve. To check for high crankcase pressure, put a gauge on the crankcase fitting and one on the suction of the compressor. While the compressor is running, begin to close the suction service valve. Watch the crankcase pressure. When it stops dropping that is the lowest the suction pressure can be and still have the oil returned to the crankcase. Check the superheat. What do you want it to be? If it's 12^{o} or less it's considered wet and you will at times during system changes bring back some liquid. At the very least you will be washing the lubrication off the upper cylinders and reduce the life of the compressor. Brainerd requires a minimum of 15^{o} to insure a dry vapor, and recommends 20^{o} at the compressor. This is system superheat not evaporator superheat. The suction pressure should be taken at the compressor suction service valve and the temperature taken within 18 inches of this valve. Brainerd's recommendations are for true superheat, not your readings. True superheat is your readings adjusted according to the ambient temperature and how well the temperature probe was insulated. You can expect an error of two to five degrees if the best possible field procedures with a well-insulated temperature probe are followed. This error will most likely be on the unsafe side. Keep in mind that superheated refrigerant in not needed in the evaporator; many evaporators are flooded, but superheat is what protects the compressor. Liquids will not compress, when you try, parts break.

The following information is quoted directly from Copeland's Application Engineering Manual AE-104-R1 page 17-9. It eliminates confusion on WHERE to measure and HOW MUCH superheat you should have.

> "A minimum of 15^{o} F superheat at the compressor must be maintained at all times to insure the return of dry gas to the compressor suction chamber, and a minimum of 20^{o} F. of superheat is recommended. Note that this is not superheat at the expansion valve, but should be calculated from the pressure measured at the suction service valve and the temperature measured 18" from the compressor on the bottom of a horizontal run of the suction tubing. Lower superheat can result in liquid refrigerant flooding back to the compressor during variations on evaporator feed with possible compressor damage as a result. Excessively wet refrigerant vapor continually returning to the compressor can reduce the lubricating qualities of the oil and greatly increase compressor wear, as well as resulting in a loss of capacity."

Does the compressor vibrate excessively when running? Common causes are broken valves, blown gaskets, broken rods or crankshaft, and oil trapping, as well as a high oil level and system flooding. Fan cycle switches or defective capacity control valves can cause the TXV to flood the compressor.

Check the discharge temperature within twelve inches of the compressor discharge service valve, 200^{o} F is ok, above 200^{o} is in the danger zone for air conditioning applications. Heat pumps and refrigeration applications may be higher. Valve temperatures are 50^{o} to 75^{o} above discharge temperature. Oil will break down at 350^{o} F. In systems with refrigerant cooled compressors the compressor is the last thing to get cooling and the first thing to loose it. A low discharge temperature indicates flooding. Discharge temperature should have reached 160^{o} F

within one minute of operation. Feel the compressor body. Is it cold up around the heads? It shouldn't be. Check the oil pressure, this can be critical. You cannot always tell when a compressor is not being lubricated. Check the oil failure switch for proper operation and settings. When checking voltage, be aware of the voltage difference between legs. Two percent is the maximum allowed voltage imbalance. The maximum allowable current imbalance is ten percent. Most current imbalance is due to voltage imbalance Winding temperatures increase rapidly with any current imbalance. A five percent imbalance will result is a twenty five percent increase in winding temperature. This increase is above its normal winding temperature.

If your suction pressure is about the same as your discharge then you could have a broken crankshaft, broken valves or a leaking pressure relief valve. The compressor may run smooth if the crankshaft is broken. A compressor valve check can be done by pumping the compressor down. If it will not pump down, or pumps down slowly, one or more suction valves may be bad. If the compressor pumps down and off but the pressure on the suction side rises rapidly, one or more discharge valves are bad, the pressure relief valve is leaking, or you have a blown gasket. If the compressor is going off on the oil pressure control you may have a broken oil pump shaft or an oil pressure-regulating valve that is stuck. Most low oil pressure problems are a result of worn bearings causing a loss in pressure around the bearing surfaces. Other causes for low oil pressure are high temperature and oil dilution. A broken oil pump shaft results in zero or no oil pressure and maybe a result of a bearing failure allowing the compressor crankshaft to bounce and snap the oil pump shaft.

There is a wide range of air conditioning and refrigeration system designs, refrigerants and configurations. They are far too numerous for me to list all the conditions and causes of compressor failures. The statements made here are by no means meant to be a comprehensive list of faults and remedies. We wish only to impress upon the readers the importance of determining a cause for the compressor failure before installing a replacement and leaving the job half done. Keep in mind that few compressors you replace actually wore out due to age. When you're called to fix a system with a bad compressor, try to remember that the bad compressor is most likely a result. Most of us have seen compressors that have been running for thirty or forty years but most of what we change have less than ten years running time. Most failures fall into just a few categories. Loss of lubrication is probably number one and many things can cause this, most are system faults rather than compressor defects. Any system fault will eventually show up in the compressor. When doing an inspection, remember that what you find, are, for the most part, a result and a clue to the cause of the compressor failure, not the cause itself. The above example of a shorted to ground motor winding is not uncommon. Was this a result of a system fault? If so, it's not the cause of failure. If you do not have time to inspect the compressor do you have time to replace it?

All manufacturers agree that replacement compressors fail at a rate several times higher than original equipment compressors. It is the service technician's responsibility to determine not only the reason the unit isn't cooling, "compressor is shorted to ground", but also what caused it to fail and to correct any system faults. ***Why did the compressor fail?***