By: Grant Laidlaw

Welcome to the Solutions page

Many people ask for assistance in the understanding of theoretical and practical aspects of the industry. I will endeavour to enlighten

John sent in this: Hi Grant, I am interviewing technicians for a position and was wondering if you could give us an idea as to what type of questions we could ask? We are an air conditioning and refrigeration company dealing in commercial applications. Thanks

Hi John. I looked at your question in the last issue and as I mentioned previously and I think this gives me a good opportunity to share some of the answers I receive to some basic questions. You could use the same questions to evaluate candidates. I would expect any qualified person to have little difficulty in answering.

As before let us expand your question to include trade test applicants.

In my position I conduct many interviews as part of the pre trade test assessment process for trade testing. The people coming for the interviews therefore consider themselves as trade test ready. As you will see the response is poor. Of course this indicates that people have not been trained and do not receive the necessary scope of experience at workplaces. Nevertheless there is an expectation that after - say around five years, people should be able to pass a trade test. Really!, well then, lets look at the answers.

So: Question

This is a more advanced aspect but considering we are talking to people who are qualified or about to qualify as refrigeration artisans, one would expect that the person would understand how an oil pressure safety switch operates.

On larger systems we might encounter an oil pressure safety switch. This switch is connected to the control circuit of the system that if for some reason the oil pressure drops to below an acceptable level the compressor is stopped to prevent damage. As the oil pump is often situated on the end of the crankshaft and therefore is driven by the compressor, when the compressor turns off the oil pressure will drop.
Question 1: As there is no oil pressure when the compressor is not running, the oil pressure safety switch should prevent the compressor from starting. How do we overcome this issue?
Question 2: Why are there two connections to the switch (Pipes entering top and bottom)?

Common Answer: Very few will even attempt this one. Most will state the obvious, its there for protection (just as the name says).
The oil pressure safety switch

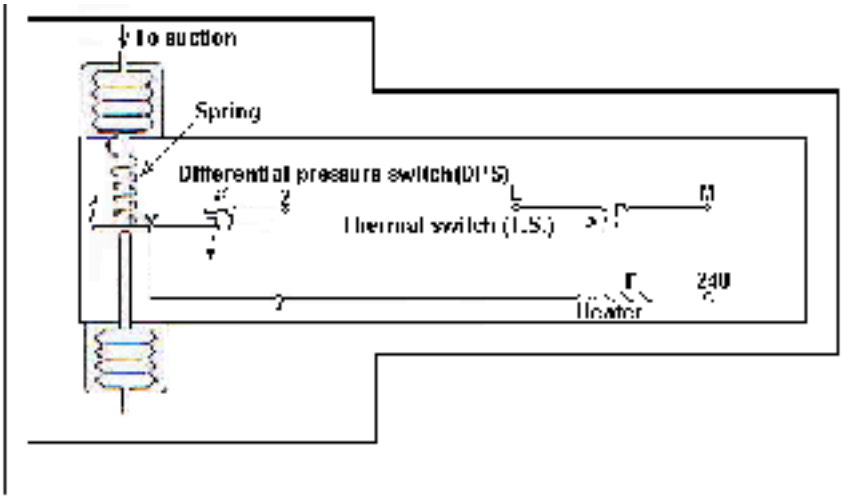
Let me enlighten:
Refrigeration compressors equipped with positive lubrication systems, are normally fitted with oil pressure failure switches. It doesn't matter if the compressor is of the centrifugal, rotary or reciprocating type, as long as it has an oil pump and positive lubrication, an oil pressure switch will usually be fitted.

Purpose of the oil pressure switch

The oil pressure switch is there to stop the compressor if the net oil pressure becomes too low for the compressor's safe operation. Net oil pressure is the difference between the oil pressure and the oil pump's discharge port and the suction pressure in the compressor's low-pressure side (the crankcase). Each compressor manufacturer specifies the minimum acceptable net oil pressure for each particular compressor in his range and it is best to find out what that pressure is, in order to set the oil pressure switch, rather than work to rules of thumb.

Principle of operation

Oil pressure switches are a combination of two separate switches. They are a differential pressure switch and a thermal switch.
You will see that both the suction pressure and the pressure of a spring force, the contacts of the differential pressure switch (DPS) closed. When the DPS contacts are closed, the heater below the thermal switch (TS) will be energised. After a predetermined time, usually between 90 and 120 seconds, the contacts of TS will open if the heater remains energised. The compressor's contactor is controlled by TS.

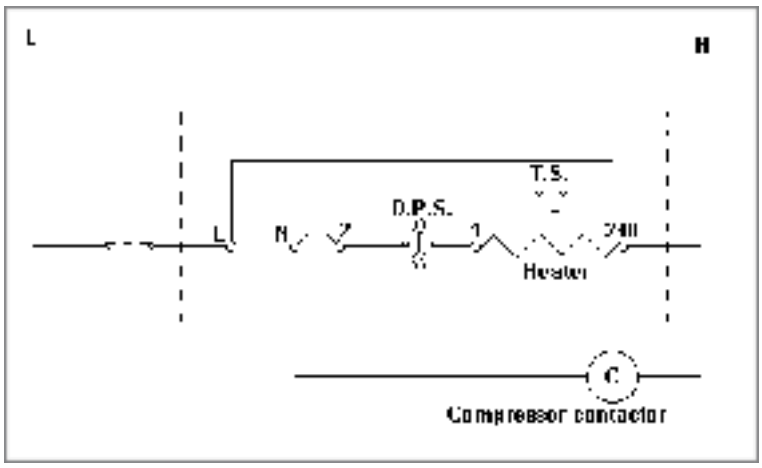


Oil pressure switch operation

Oil pressure switch wiring

In the diagram below, the compressor contactor C is energised by the other system controls (HP/LP, thermostat, etc.) being closed and putting control power on to terminal L. The power flows from L and M via the normally closed TS and out to the contactor's coil. The contactor closes and, assuming the main circuit is energised, the compressor starts up.

From terminal M the power also travels through the closed DPS contacts, through the heater element to neutral. The heater, of course, starts to warm up.
The compressor has up to 120 seconds, from the moment it starts, to build up enough oil pressure to open the DPS and switch off the heater. If the oil pressure does not build up, the TS will open and stop the compressor. The heater will also be turned off. The thermal switch must be manually reset.
When connecting an oil pressure switch into the control circuit, be sure there are no other switches connected between terminal 240 and neutral, or between terminal M and the compressor contactor. If there are, the oil pressure switch will malfunction.
It is of prime importance that all safety switches and control switches are placed between terminal L and the live supply.



Oil pressure switch connections

Testing the oil pressure switch

If the switch is connected as per figure, testing it becomes a very easy task. Follow the simple procedure below:

1. Switch off the main circuit to the compressor motor.
2. Leave the control circuit on and start the rest of the plant normally with cooling being called for.
3. The compressor contactor should fall out within 120 seconds.
4. If after 120 seconds the contactor is still energised, there is a problem, which must be found and rectified. The heater element may be open circuit or there may be some other open circuit anywhere between terminal 2 and the neutral connection.

It is recommended that testing the oil pressure switch becomes a regular part of your routine maintenance checks. It could save you a compressor.

Question

We have a compressor mounted higher than the evaporator, we know that refrigerant oil moves through the system, how do we ensure that the oil returns to the compressor and does not get trapped in the evaporator?

Common Answers:

- Around 30% of candidates know what a “P” trap is used for.

Oil Trapped Suction Lines

Carefully selected and well-balanced equipment can give continual trouble because of carelessly installed refrigerant piping. There is much more to the problem than merely conducting the liquid refrigerant to the evaporator, and the refrigerant gas back to the condensing unit. For example, oil is one of the complicating factors in a refrigerant piping system. The very design of the reciprocating compressor results in mixture oil with refrigerant.

Because the compressor must be lubricated, the refrigerant gas comes in intimate contact with lubricating oil on the cylinder walls of the machine. Some of this oil is carried into the discharge line by the refrigerant and on to the condenser and receiver. To ensure that the compressor does not run short of oil, the piping system must be designed to carry this oil with the refrigerant on through the evaporator and back to the compressor. The lines must be properly pitched and oil traps must be provided where necessary.

In a liquid state, fortunately, refrigerants mix readily with oil. Therefore, it is comparatively easy to carry oil with liquid refrigerant. But in a gaseous state, most refrigerants are notoriously poor carriers of oil.

Oil under pressure in hot gas discharge lines, turns into a mist. The gaseous refrigerant and the oil mist will not mix. The oil will usually collect on the walls of the piping and then drain to low points in the system. This oil reduces the size of the gas passageway, causing a restriction, which in turn necessitates a lower cut-out setting in order to obtain proper temperatures.

The problem then, in designing and installing refrigerant piping, is to recognise that the piping must not only carry the refrigerant satisfactorily, but it must also handle the oil that is brought into the piping system by the refrigerant, returning the oil to the compressor continually as fast as it is carried into the piping system.

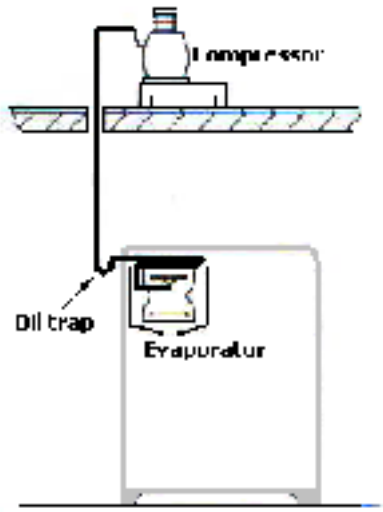
In installations where the suction line run is vertically down or at a downward slope to the condensing unit the problem of returning oil to the compressor will not arise. However, in cases where the lowest point in the suction line is below the suction line crank case inlet, provision must be made for the satisfactory returning of the oil to the crankcase. A 150 mm U- shaped bend in the suction line, as illustrated in figures can be used to provide proper oil return (P Traps). When this method is used, the suction line should be sloped to a point close to the condensing unit, and at this point the U-shaped bend should be made. The suction line then goes to the suction valve on the compressor .

When condensing units are located above the top of the refrigerator, the U-shaped trap should be made in the suction line outside the fixture and the suction line from the evaporator should slope to the oil trap. The suction line then runs vertically to the manifold or suction valve connection.
In operation, the U-shaped trap fills with oil. The evaporator pressure, aided by the suction of the compressor, forces the oil from the trap into the crankcase.

Position of oil trap

In designing the trap, the horizontal dimensions should be kept as short as possible. This should be done to prevent the trapping of excessive amounts of oil. Should the trap be too large horizontally, there is a definite possibility that the compressor crankcase will be robbed of oil.

Question



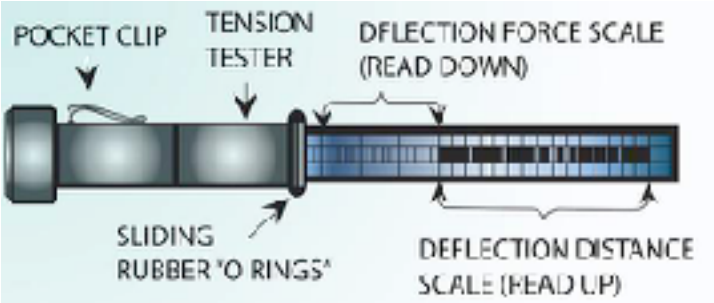
How does one go about tensioning a V belt?

Common Answers: You feel it - and my favourite: its like a guitar string, pull it, if it goes boing boing - its ok!
Around 10% of candidates do have an idea.

Let me elaborate:

A general method used, is to grasp one of the 'V" belts between the finger and thumb midway along its span. If by using some effort it can be twisted between a ¼ and ½ twist, the tension should be sufficient for average requirements. But let us be honest this cannot be accurate. My effort will not be that same as your effort.

The most and accurate method of tensioning “V” belts recommended by all manufacturers is the Belt Tension Indicator. This is a gauge which indicates the force required to deflect a belt 16mm per meter of the span (centre distance) of the belt.



Tensioning gauge

The correct tensioning of “V” belts is of the utmost importance, for the following reasons:

1. To achieve the optimum performance, the belt must be given the correct initial tension:
   a) If the 'V' belt tension is too low, the belt is likely to slip, resulting in abnormal belt wear.
   b) If the 'V' belt tension is too high, the belt life will be drastically reduced due to abnormal stretching and wear. Damage to the components of the drive, e.g. bearings, can fail prematurely due to the abnormal loads created by over-tensioning.
2. Before tensioning ensure that the slack on all the belts is on the same side of the pulleys. If the belts are tensioned with slack portions in different positions, excessive strain will be imposed on the belts when they attempt to settle in a common position on the pulleys.
3. During the first 48 hours of operation, the belt tension should be checked regularly and the belts re-tensioned.
4. With multiple belt drives, each belt must absorb an equal proportion of the total load and must therefore be equally tensioned.

I have explained the tensioning procedure in a previous issue.
(It is interesting to note that it is possible to tension high performance belts by plucking and measuring resultant frequency, typically used in the motor / motorcycle industry)

John that should be enough to get you going and serve as a heads up to trade tested candidates. I have received lots of comment on these questions / answers. We all agree, refrigeration really is a scarce skill! Also let me also reiterate: I did not exaggerate any of the answers, this is reality.

Thank you for all your questions. Send your problems (and sometimes your creative solutions) to acra@netactive.co.za with “Solutions Page” in the subject line. You may include pictures.

References:
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