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REVIEW NOTES FOR THE CERTIFICATION EXAM

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The illustration below is found in the handbook for preparing to take the RETA CIRO examination. Unless you have taken the exam, or have read the handbook you will never have seen this screen before you have taken the CIRO exam. This screen is from an imaginary system, but is showing values that would be found on any compressor manufacturer's screen or combination of screens.

We made it this way to be sure that no one has an advantage of familiarity with a particular brand or layout.

If you look at all the different data labels and values you'll see it tells you much information about how the system is operating. There are other bits of information present such as the type of oil cooling system and the actual condition of the refrigerant exiting the condenser.

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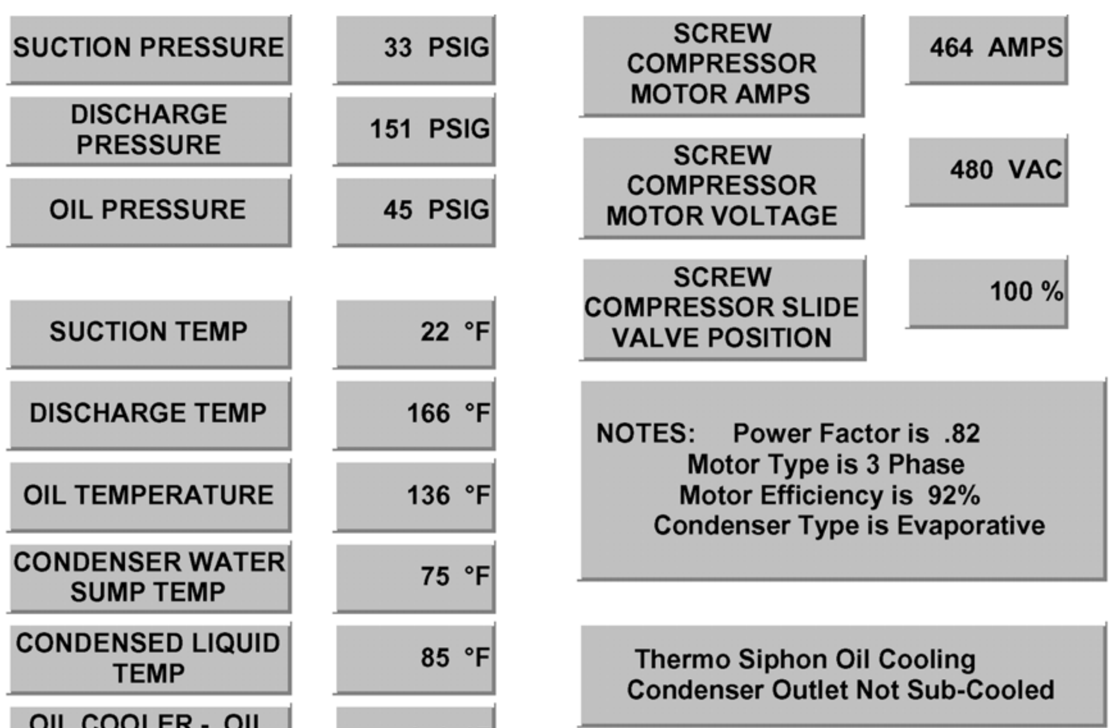

RETA Figure TS-5
500 Hp Screw Compressor - Normal Conditions - NH3

SUCTION PRESSURE	33 PSIG
DISCHARGE PRESSURE	151 PSIG
OIL PRESSURE	45 PSIG
SUCTION TEMP	22 °F
DISCHARGE TEMP	166 °F
OIL TEMPERATURE	136 °F
CONDENSER WATER SUMP TEMP	75 °F
CONDENSED LIQUID TEMP	85 °F
OIL COOLER - OIL INLET TEMP	156 °F
OIL COOLER - REFRIGERANT OUTLET TEMP	86 °F

SCREW COMPRESSOR MOTOR AMPS	464 AMPS
SCREW COMPRESSOR MOTOR VOLTAGE	480 VAC
SCREW COMPRESSOR SLIDE VALVE POSITION	100 %

NOTES: Power Factor is .82
Motor Type is 3 Phase
Motor Efficiency is 92%
Condenser Type is Evaporative

Thermo Siphon Oil Cooling
Condenser Outlet Not Sub-Cooled

RETA Figure TS-5
500 Hp Screw Compressor - Normal Conditions - NH_3

It would be very easy to make up about 20 to 25 questions based on this screen information. When talking to persons who have just taken the exam, I hear that they have a difficult time working a question out from this type of screen because of the amount of information available. To have trouble answering a question from this data, it is most likely because you are over-analyzing.

Let me explain:

This screen is basically telling you that there are 13 transducers hooked up and reporting information about the compressor package and system. If I were to ask you what is the superheat in the refrigerant at the compressor inlet, would you need to review all 13 data points to develop the answer? No, you would not. So let us ask this question: What is the superheat of the refrigerant **leaving** the compressor package?

If you do not really understand what information is needed to determine what the condition of refrigerant is, you will struggle with this question. Chapter 1 of IR-1 explains the condition of refrigerants when pressure and temperature are known.

So lets challenge the question.

1. The question is asking about superheat. The definition of a superheated gas is that the temperature of the gas molecules is higher than what it would be if the gas were saturated. In other words the point on the graph where the temperature and pressure intersect is not on the saturation line of the graph. The rule is that a gas can be either saturated or superheated.
2. Think about what you need to know to answer the question. You need temperature and pressure. There are 10 transducers that report temperature or pressure. The field is narrowing down a little bit.
3. This is where you want to really stop and read the question. What is it asking for? Superheat – of the refrigerant exiting the compressor. You still need temperature and pressure, but now you can narrow the options down some more.
   - The question is about the discharge gas – you find the value for the pressure at discharge: 151 psig.
   - We are still dealing with discharge gas – what is the temperature of that gas? 166°F.
   - Now you are done with the information on the screen. Out of 13 transducers available you only needed two. The next step is to look at the temperature / pressure (saturation) table in your RETA IR-1 or IR-2 book. If you are taking the exam, we give it to you to use.
4. The question is asking about superheat, so the anwer will be in degrees, not pounds of force.
5. Looking at the saturation table, you will find that a saturated refrigerant at 151 psig should be 85°F. But the temperature is 166°F. So what is the superheat? The superheat is the difference of what the refrigerant temperature would be if saturated and the actual temperature you read from the thermometer. 166 minus 85 = 81. The superheat is 81°F.

So you got the answer using only 2 of 13 transducers. The examination is more than "can you do the math," it is also about "do you understand what information is needed to analyze the running health of your system?"

So why should I care about the superheat at the discharge of the compressor? It has to do with oil temperature. **What is the breakdown point of your oil?** Our problem illustration is of a screw compressor, but how hot do you think it really gets at the cylinder wall and the tip of the compression and oil rings on your reciprocating compressor? It has to be very close to theoretical discharge temperature. Superheat climbing without a change in suction and discharge pressures indicates something is wrong.

Let's take another look at the illustration. No manufacturer's screen has a "note" plate built into it. The technical operating specifications of the package would tell you some of the information we put on the note plates. We have put those note plates in to help you visualize the system that is depicted in this example. This RETA Figure TS-5 system is a 500 horsepower screw compressor that has a thermosiphon oil cooling system and the refrigerant condenses in an evaporative condenser. It tells you that the power factor of the motor is 0.82 (at this moment in time - power factor does move around depending on the load seen on the motor) and that the motor is 3 phase, 480 volts. The efficiency of the motor is 92%.

When you take the RETA CIRO Exam you are provided a page with formulas. In the early years you were expected to memorize formulas such as Q=M x Cp x (T1 – T2). In 2002 the Certification committee decided that it was more important that you would be able to work the formulas than to have them all memorized.

Using the information from the screen, lets see how much horsepower is being required by the motor driving the compressor. The formula for horsepower is:

$$\frac{V \times A \times pf \times eff \times 1.73}{746}$$

The *V* stands for Voltage:
480 per the label plate

The *A* stands for Amperage:
464 per the label plate

The *pf* stands for Power Factor
which is 0.82.

The *eff* stands for motor efficiency
which is 92% or 0.92

The 1.73 is the square root of 3,
representing the effect of
the three phases of power.

The 746 is how many watts are
in one horsepower.

When you plug in all the numbers and do the math you end up with 389.6 as the result. We'll round up to 390 horsepower as the answer. The compressor needs only 390 horsepower to do the work it is doing now. Early in my career I had a hard time understanding why a 500 horsepower motor only developed 390 horsepower to get a job done. In my case it was a single stage ice making system operating at 0 psig suction and 181 psig discharge. It just didn't seem right to me. Then my supervisor, Ron, brought out the manufacturer's compressor information sheet and the ratings table. He patiently explained that the horsepower required to get the job done depended on how many pounds of refrigerant was being compressed with each compression stroke and to what discharge pressure we had to compress to.

The lower the pressure of a gas, the further apart the molecules, which means that there is less refrigerant weight per cubic foot as you go lower in pressure. So when you trap a volume of gas in the inlet of a compressor, the lower the pressure, the less mass is trapped for the compression stroke. I was fortunate to be able to work for a supervisor like Ron who could explain things to me.

In our example we compressed to 151 psig.from 33 psig. If we had something going wrong at the condenser we might have to compress up to 200 psig. That extra work would show up on the ampmeter as a higher value. The extra work will also show up on the electric bill.

When you take the exam, you'll encounter several of these screen shot illustrations. Some will show "normal" conditions and others will be "abnormal" conditions. In general the values are based on "real world" conditions that you might see showing up on your own information screens. Analyzing power use is part of an operator's job and knowing what conditions affect the use of power and being sure to catch the situation where something is starting to run out of whack makes you more valuable as an operator. Good luck preparing to take your exam.

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