How can you tell when a system is low on refrigerant? Running down the list below will determine whether that’s the case. Consider this scenario: A service technician installs gauges and thermostors on an R-134a, its condenser, medium temperature refrigeration system, incorporating a liquid high-side receiver and a thermostatic expansion valve (TXV) as the metering device. Both measured and calculated values are listed in Table 1, along with a detailed system analysis.

**ANALYSIS**

**Compressor discharge:** This temperature is very high compared to normal system operations. The 195°F discharge temperature is caused by the evaporator and compressor running high superheat along with high compression ratios. When undercharged, do not expect the TXV to control superheat. The TXV may be seeing a combination of vapor and liquid at its inlet, so the evaporator will be starved of refrigerant and running high superheat. The compressor will then see high superheat and, with high compression stroke, will superheat the refrigerant even more.

Compression ratios will also be elevated, giving the system a higher than normal heat load. However, compression ratios will give the system very low volumetric efficiencies and cause unwanted inefficiencies with low refrigerant flow rates. The compressor will then have to compress much lower pressure vapors coming from the suction line to the condensing pressure. This requires a greater compression range and a higher compression ratio.

The greater compression range from the lower evaporator pressure to the condensing pressure is what causes compression work and generates added heat of compression. This increased heat may be seen by the high compressor discharge temperature, however, because of the lower flow rates from the lower volumetric efficiencies, a somewhat low load is seen by the compressor. This low load is what keeps the discharge temperature from getting too hot. In conclusion, higher compression ratios and higher superheats are what cause the discharge temperature to be somewhat high. Remember, the discharge line sees all of the superheat coming to the compressor, the motor heat generated, and the heat of compression.

The limit for any discharge temperature measured 3 inches from the compressor on the discharge line is 225°F. The back of the discharge valve is usually 50° to 75° hotter than the discharge line, which would make the back of the discharge valve about 230° to 300°. This could vaporize oil around the cylinders and cause excessive wear. At 350°, oil will break down, and overheating of the compressor will soon occur. Compressor overheating is one of today’s most serious field problems, so try to keep your discharge temperatures below 225°F for longer compressor life.

**High evaporator superheats:** Since the evaporator is starved of refrigerant, there will be high evaporator superheats. In turn, this will lead to high compressor superheats. The receiver will not get enough liquid refrigerant from the condenser because of the shortage of refrigerant in the system, and this will starve the evaporator heat loads increase, and as evaporator heat loads decrease, condenser splits will decrease.

**Low condenser superheating:** The compressor will see very hot vapors from the high superheat range checks, the gases entering the compressor will be extremely expanded and have a low density. The compression ratio will be high from the low receiver because a capillary tube system can run high superheating simply from a restriction in the capillary tube or liquid line. The excess refrigerant will accumulate in the condenser, causing high superheating and high head pressures. If a TXV receiver system is restricted in the liquid line, most of the refrigerant will accumulate in the receiver, with a bit in the condenser. This will cause low superheating and low head pressure.

**Low compressor amps:** High superheats will cause compressor inlet vapors from the suction line to be extremely expanded, decreasing their ability to absorb low-density vapors entering the compressor will mean low refrigerant flow rates through the compressor. This will cause a low amp draw because the compressor will not have to work as hard compressing the low-density vapors. Low refrigerant flow will also cause refrigerant-cooled compressors to overheat.

**Low evaporator pressure:** Low evaporator pressure is caused by a starved compressor. The compressor will try to draw refrigerant into its cylinders, but there is not enough to satisfy it, so the entire low side of the system will experience low pressure.

**Low condensing pressure:** Because the evaporator and compressor are being starved of refrigerant, the condenser will also be starved. Starving the condenser will reduce the heat load on the condenser because it will not see as much refrigerant to reject any heat. With not as much heat to reject — thus reject from the compressor — the condenser will be at a lower temperature. This lower temperature will cause a lower than normal suction pressure because of the pressure/temperature relationship at saturation. The temperature difference between the condensing temperature and the ambient temperature is called the conditioner’s delta T or split. The service industry often refers to this as the condenser split, and it can be calculated as follows:

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\text{condensing temperature} - \text{ambient temperature} = \text{condenser delta T (split)}
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As the condenser sees less and less heat from the compressor, because of being starved from the undercharge of refrigerant, the condenser split will decrease. No matter what the ambient temperature is, the condenser split — that is, the difference between the condensing temperature and the ambient — will remain the same if the load remains the same on the evaporator. However, condenser split will change if the heat load on the evaporator changes. As evaporator heat loads increase, the condenser split will increase, and as evaporator heat loads decrease, condenser splits will decrease.

**SUMMARY**

In summary, here are the seven symptoms or telltale signs of a system low on refrigerant: 1. Medium to high discharge temperatures; 2. High evaporator superheat; 3. High compressor superheat; 4. Low condenser subcooling; 5. Low compressor amps; 6. Low evaporator temperatures and pressures; and 7. Low condensing temperatures and pressures.