COMPRESSOR RATINGS: A PRACTICAL GUIDE

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When I select a compressor what values should I use?
The new refrigerants have glide; how does this affect the compressor selection?

If you've struggled with sizing refrigeration compressors for 400 series refrigerants with glide, you should use **midpoint values** and the **net refrigeration effect** to calculate the correct capacity, and to correctly match the capacity to the fixture loads.

The discussion that follows provides detail to support these assertions.

MIDPOINT RATINGS

Many of the new refrigerants with lower global-warming-potential (GWP) values are zeotropes. With zeotropes, the refrigerant has a temperature range in the evaporator that is colder than the dewpoint temperature. This means that the average coil temperature (midpoint) is a few degrees colder than the outlet temperature (dewpoint).

For example, at a pressure of 52 psig the refrigerant R-448A has a dewpoint of 26.0°F but the average temperature of the evaporator is 20.8°F (Table 1).

The **bubble** temperature is when the refrigerant first starts to boil.

The **dewpoint** is the temperature of the refrigerant when the last drop of liquid refrigerant boils off.

Table 1: Table of evaporator temperatures for R-448A.

PRESSURE (PSIG)	TEMPERATURE (°F)		
	AVERAGE	BUBBLE	DEW
46.0	16.0	10.8	21.2
49.0	18.4	13.2	23.7
52.0	20.8	15.6	26.0

It is acceptable to size a compressor using the dewpoint temperature, but you must use the correct dewpoint temperature for a given evaporator (midpoint) temperature.

The example that follows describes how to size a compressor for a system using R-448A and an evaporator temperature of 20°F. If dewpoint temperature is used, Emerson's selection software will give a net refrigeration effect of 52,000 Btuh (Figure 1).

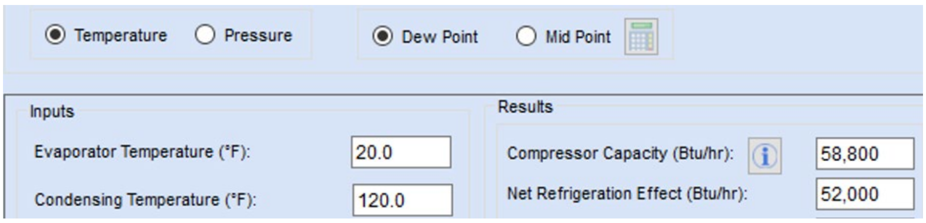


Figure 1: Compressor capacity using dewpoint temperature

This capacity value is incorrect, because 20°F is not the correct dewpoint temperature for an evaporator temperature of 20°F.

The Emerson software clearly provides the proper values (Figure 2).

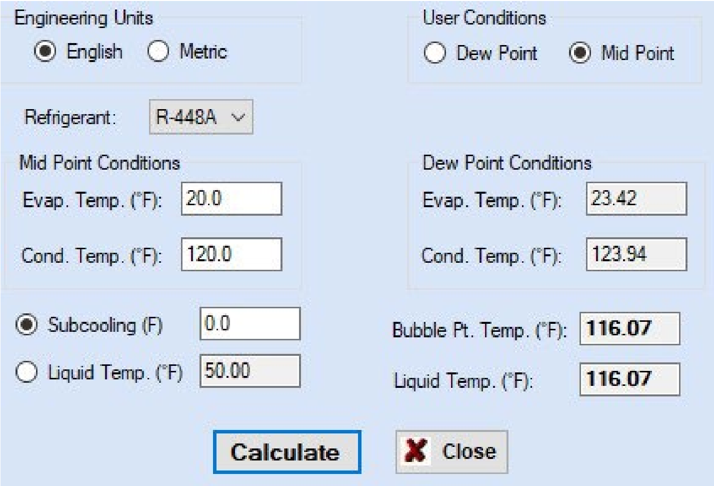


*Figure 2: Dewpoint calculation**

**Compressor calculations provided by Copeland/Emerson Product Selection software.*

For an overall evaporator temperature of 20°F, and an average condensing temperature of 120°F, the actual dewpoint conditions are 23.42°F for the evaporator and 123.94°F for the condensing temperature.

A pressure-enthalpy diagram is helpful in showing these values graphically (Figure 3).

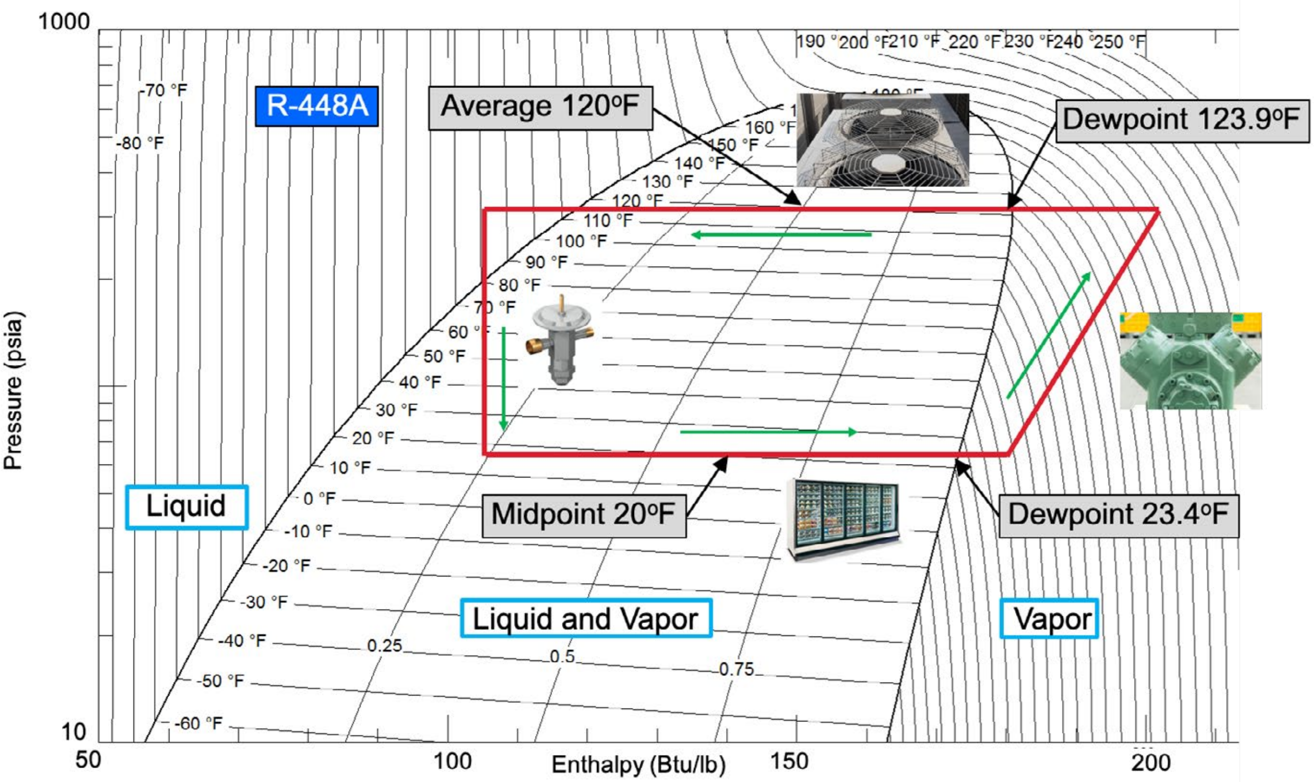


Figure 3: Pressure-Enthalpy Diagram, R-448A

This diagram shows that using the dewpoint value is acceptable, but you should use the correct value of 23.4°F. This naturally will give a higher capacity since a higher suction temperature (and resulting pressure) results in a more efficient compressor.

Recalculating with these values results in almost 6% higher compressor capacity (54,800 Btuh vs 52,000) (Figure 4).

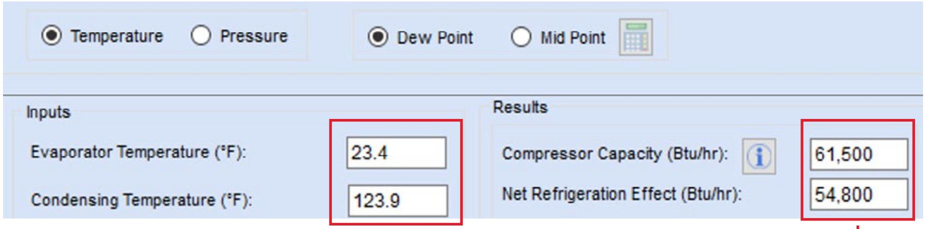


Figure 4: Capacity using correct dewpoint temperature for 20°F evaporator

Is it easier to enter evaporator and condensing temperatures and choose midpoint. (Figure 5). Yes!

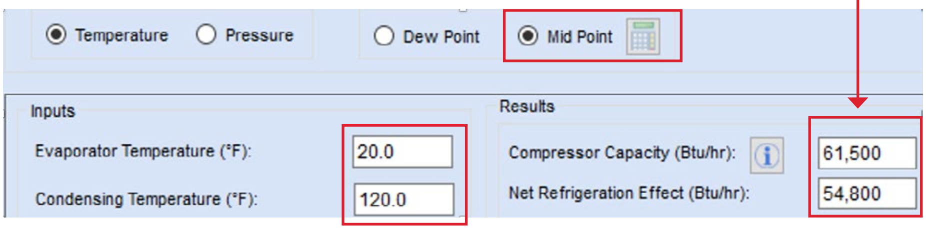


Figure 5: Capacity using midpoint

The results are exactly the same!

Summary

When seeking the correct capacity for zeotropic refrigerants, it is critical to use the midpoint temperature in compressor software, because it gives the true impact of the cooling benefit for lower GWP refrigerants with glide. When selecting condensing units, it is typically not possible to do this, which leads to incorrect capacity ratings.

NOTE:

Be vigilant of tabulated capacities from condensing unit manufacturers, which may be using the dewpoint temperature as the evaporator temperature instead of the midpoint. This will falsely result in a lower capacity than the refrigerant actually delivers.

NET REFRIGERATION EFFECT

We are accustomed to having compressor capacities described as a single number such as “12,000 Btuh”.

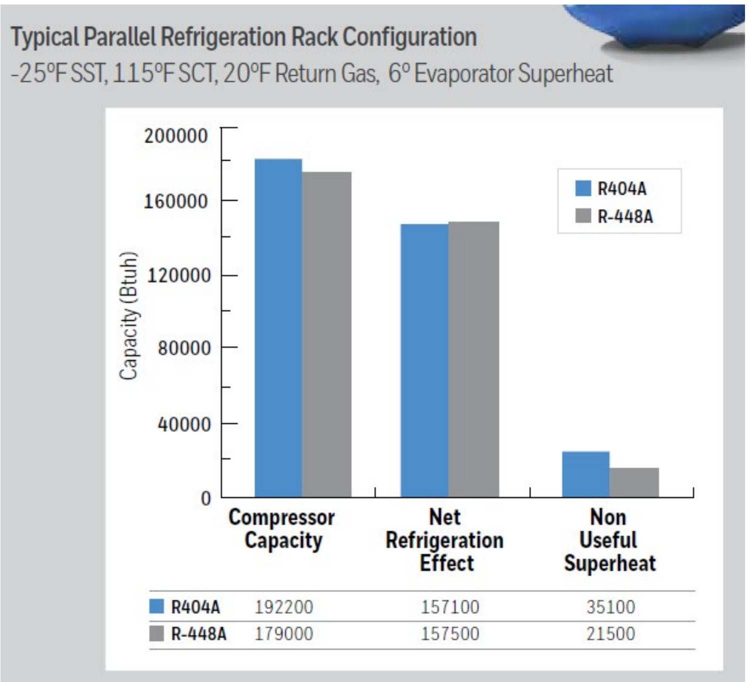
These ratings typically comprise the total compressor capacity **including the heat transfer in the suction line** (commonly referred to as “non-useful” superheat because it does not provide any useful cooling for the refrigeration load).

This means that the given capacity rating of the compressor is greater than the cooling that **actually occurs** in the evaporator. This can lead to undersized equipment. and is part of the reason designers historically added safety factors when sizing compressors this way.

Compressor manufacturers now provide a value for **net refrigeration effect** in addition to the **compressor capacity**. Net refrigeration effect is defined as “the actual work done in the evaporator.” You should compare this value to the published fixture refrigeration loads when sizing compressors.

Using net refrigeration effect is important because many of the new lower GWP refrigerants have characteristics that minimize the non-useful superheat. In other words, a larger percentage of the compressor’s refrigeration work is done in the evaporator vs the suction line. This difference can be as high as 10%.

Using net refrigeration effect when sizing compressors will provide the true refrigeration capacities of these new blended refrigerants and allow for a fair comparison with legacy refrigerants (Figure 6).



	Compressor Capacity	Net Refrigeration Effect	Non Useful Superheat
R404A	192200	157100	35100
R-448A	179000	157500	21500

Figure 6: Comparison of capactiies of R-404A vs R-448A

The reason for this difference in capacities can be seen graphically in a pressure-enthalpy diagram. When you compare R-404A to R-448A you can see that, due to the shape of the ph diagram, R-448A will deliver more cooling in the evaporator (Figures 7).

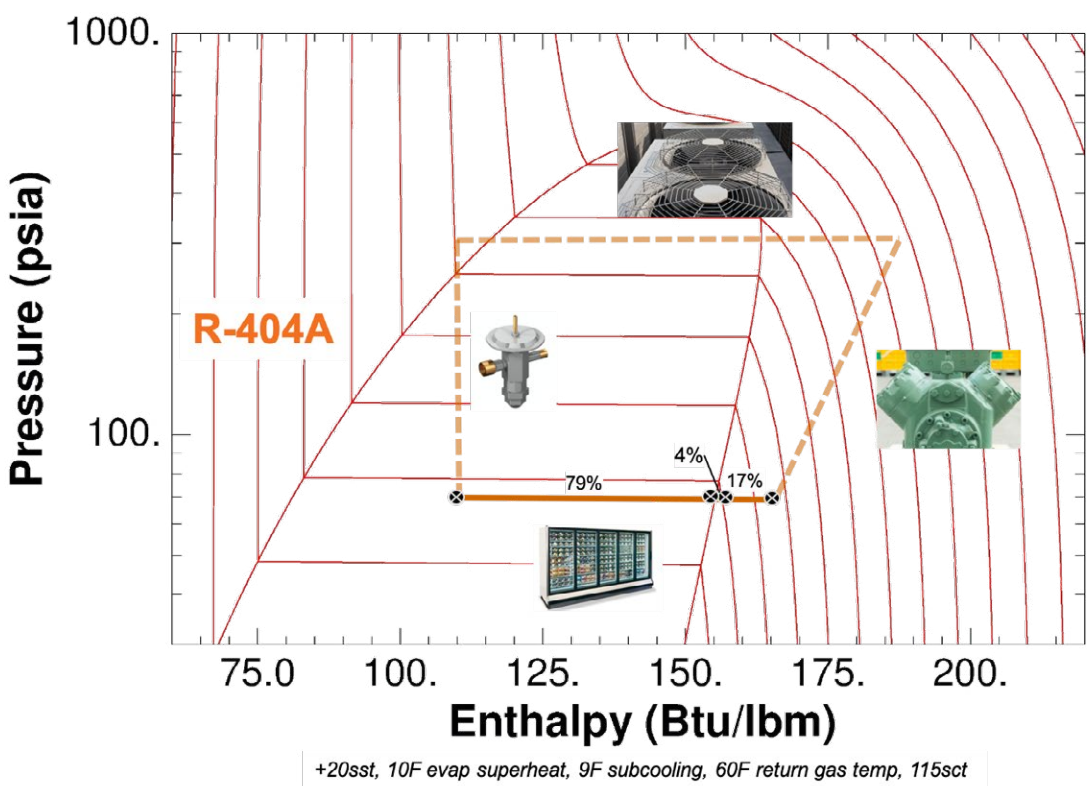


Figure 6: R-404A Net Refrigeration Effect

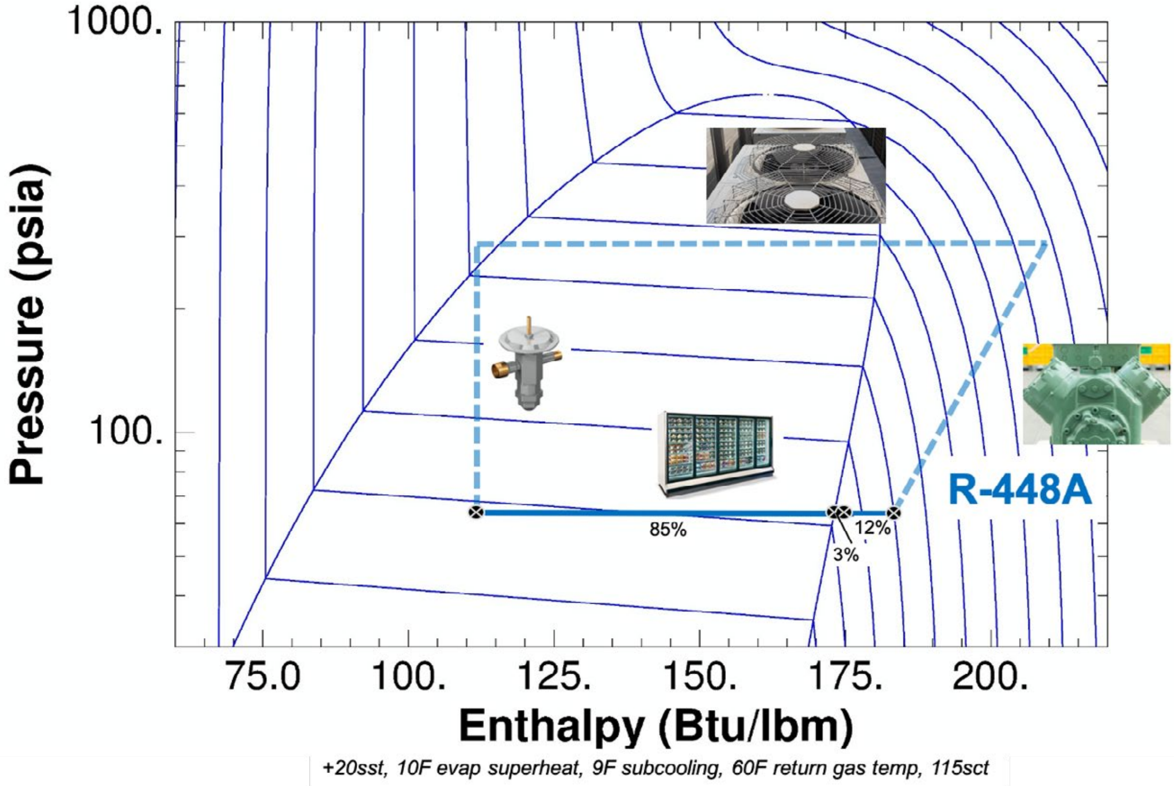


Figure 7: R-448A Net Refrigeration Effect

- R-448A will deliver more Btu per pound of refrigerant due to the shape of the diagram
- R-448A will deliver a higher percentage of useful work for each pound of refrigerant

NOTE:
Be vigilant of tabulated capacities from manufacturers, which may be using the compressor capacity vs. the net refrigeration effect. This will falsely result in a higher capacity than the refrigerant actually delivers to the refrigeration load.

CONCLUSION

When sizing compressors using refrigerants with glide (zeotropic), it is important to use midpoint and net refrigeration effect to correctly size the compressor to match the refrigeration load.

The relative effect of these charges are given in Table 2.

	DEW AND COMP. CAPACITY	DEW WITH NET EFFECT	MIDPOINT WITH COMP. CAPACITY	MIDPOINT WITH NET EFFECT
R-404A	26000	21700	26100	21800
R-448A	24500	21600	25400	22600
	✗	✗	✗	✓

Table 2: Effects of midpoint and net refrigeration effect on capacity

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