ENGINEERING WHITE PAPER

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January 9, 2020

Construction of a Split System Cross Plot

When selecting DX evaporator coils and matching condensing units, it's important to calculate the balance point at which they operate. If the condensing unit has more capacity than the evaporator coil, the suction temperature will be low. Sometimes, this is the desired affect if you are looking for dehumidification, cold air and lots of latent capacity. Alternately, if the condensing unit is relatively smaller than the evaporator, the suction temperature will be higher. This could be useful when you want to avoid dehumidification such as a data center or telecom room.

First, some definitions:

- **Saturated Suction Temperature (SST):** The temperature of the refrigerant gas at the inlet to the compressors. The manufacturer's published condensing unit ratings are based on this temperature.
- **Saturated Evaporator Temperature (SET):** The temperature in the DX evaporator where the refrigerant liquid is changing state to a gas. In most manufacturer's coil selection software, this is referred to as "Suction Temperature", but since it differs slightly due to the pressure drop in the suction line between the evaporator and compressor, we'll refer to it as saturated evaporator temperature.
- **Suction Line Loss:** This is the pressure drop in the suction line and depends on the length of the refrigerant piping, vertical separation and number of elbows, fittings and accessories. Although pressure drop is usually measured in PSI, the suction line loss is typically given in degrees Fahrenheit. It is important to size the suction line such that this line loss is ≤ 2°F. For constructing a cross plot, you can assume a suction line loss of 1°F to 2°F for R-410a depending on relative separation of the condensing unit and coil.

As the SST increases, the condensing unit capacity increases. As the SET increases, the DX coil capacity decreases (think chilled water coil and how higher temperature water will decrease the capacity of the coil). Any combination of condensing unit and evaporator coil will have a balanced condition where the rate of evaporation and the mass flow rate through the compressors occurs at the same rate.

To construct a graph, you'll need at least two points of data at two suction temperatures for each component in the split system. In the example below, we're selecting a nominal 40 ton split system with a desired evaporator temperature between 42°F and 47°F. The suction line loss is assumed to be 1°F.

Tag	SET(°F)	SST (°F)	Condensing Unit (95°F)		DX Evaporator Coil (16,000 CFM at 76/63)		
			Model No.	THC (MBH)	Model No.	THC (MBH)	SHC (MBH)
AHU-1	47	46	RCS045D	521.2	5EJ1104B	3 90.7	332.2
	42	41		478.3		510.9	384.2

These two points allow construction of a graph in Excel. In the line graphs on page 2, the condensing unit capacity is shown with the blue line. The coil total and sensible capacities are indicated with the green and red lines respectively.

The balance point occurs at the intersection of the compressor capacity (blue line) and total evaporator capacity (green line). This establishes the balanced suction temperature and resulting sensible capacity of the coil. In the bottom graph, these intersection points are indicated by the purple circles and lines. The suction temperature at the compressor inlet is ~42°F and the saturated evaporator temperature will be ~43°F with a 1°F suction line loss.

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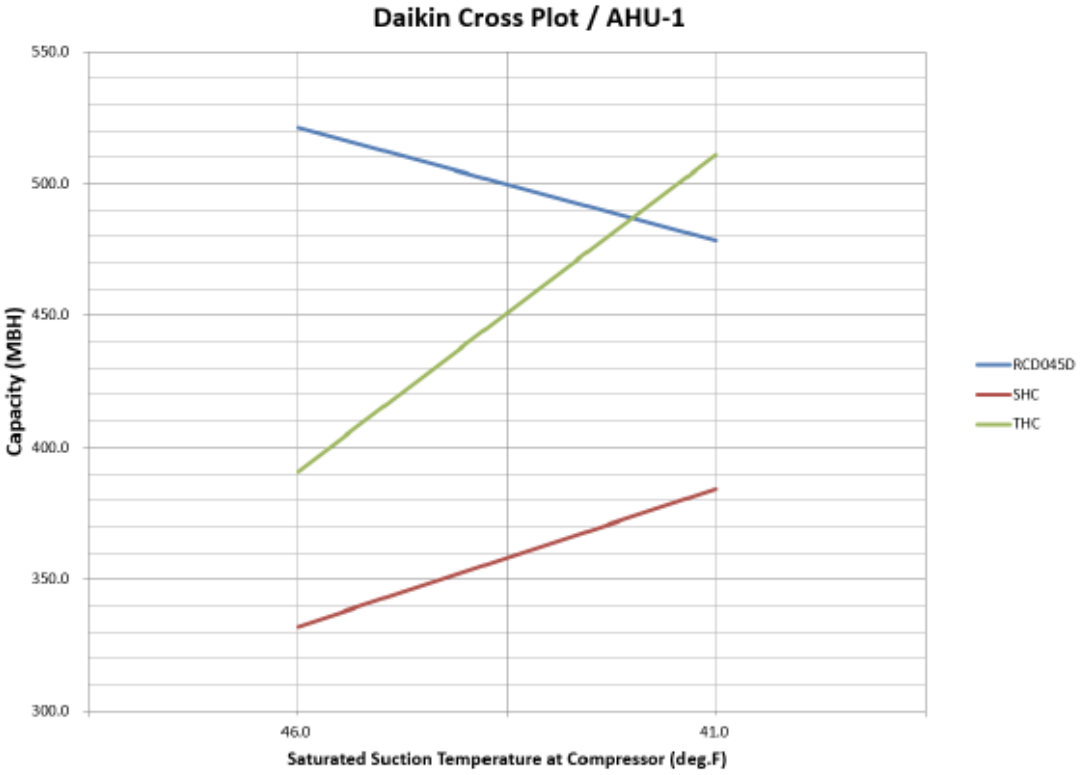

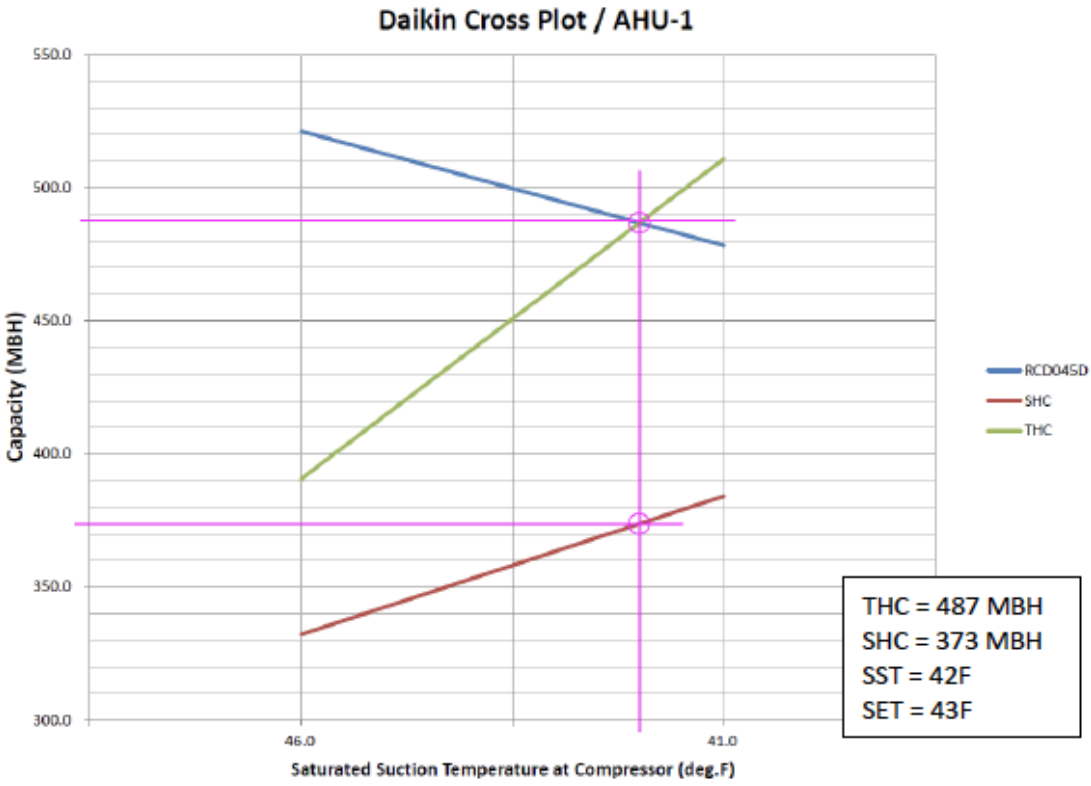

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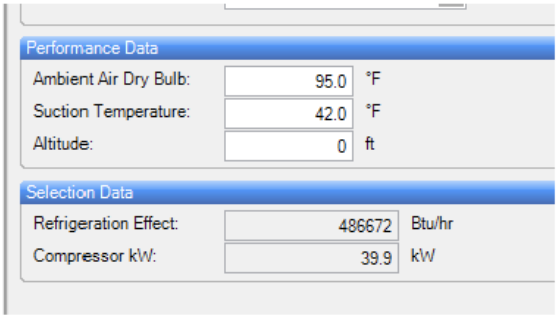
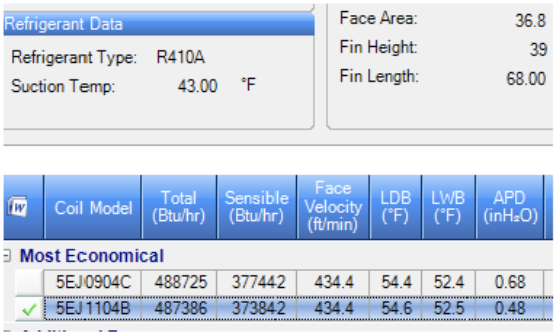
Quick Method:

A quick method of selecting equipment can be accomplished in the Daikin software. (Also, if you're using VRV condensing units, you'll need to use this "1-point" method as Daikin does not have VRV condensing unit capacities at multiple suction temperatures.)

For the example above, knowing we want ~480 MBH, we first select a condensing unit at the design ambient and adjust the suction temperature between 40 and 50 depending on what our target sensible heat factor is. For standard cooling, this will be between 42 and 45°F typically (similar to chilled water temperature in a hydronic system).



Then we add 1 or 2F suction line loss to the suction temperature from the condensing unit rating and select a DX coil that gives us close to the same total capacity as the condensing unit. In this example, a 4-row/11 FPI B-fin coil has a similar capacity at 43°F accounting for a 1°F loss in the suction line.



There is a cross plot spreadsheet on the H: drive in the Engineering folder. One spreadsheet has four data points and linear equations that accurately calculate the intersection (thanks Ryan Brown). The other is a simplified twopoint spreadsheet.

If there are any questions or concerns, please feel free to contact the engineering department.

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