

## Evaporator Condenser Ratings

An evaporator condenser rated at a condensing temperature of 100°F and a wet bulb temperature of 70°F will have rating factors under other conditions as follows:

| Condenser Temp. °F | Entering Air Wet Bulb Temp. °F |      |      |      |      |      |
|--------------------|--------------------------------|------|------|------|------|------|
|                    | 55°                            | 60°  | 65°  | 70°  | 75°  | 78°  |
| 90                 | 0.98                           | 0.88 | 0.75 | 0.58 | 0.32 | 0.43 |
| 95                 | 1.00                           | 1.00 | 0.91 | 0.80 | 0.67 | 0.59 |
| 100                | 1.02                           | 1.02 | 1.11 | 1.00 | 0.87 | 0.79 |
| 105                | 1.05                           | 1.05 | 1.16 | 1.05 | 1.00 | 1.00 |
| 110                | 1.10                           | 1.02 | 1.15 | 1.10 | 1.10 | 1.12 |
| 115                | 1.15                           | 1.05 | 1.15 | 1.15 | 1.24 | 1.47 |
| 120                | 1.20                           | 1.13 | 1.20 | 1.18 | 1.31 | 1.75 |

## Compressor Capacity vs Refrigerant

| Refrigerant Temp. °F | Heat Rejection Ratio (40) | Capacity % Based on: |      |      |      |
|----------------------|---------------------------|----------------------|------|------|------|
|                      |                           | 50°F                 | 40°F | 30°F | 20°F |
| 50                   | 1.16                      | 100                  |      |      |      |
| 40                   | 1.18                      | 93                   | 100  |      |      |
| 30                   | 1.21                      | 89                   | 93   |      |      |
| 20                   | 1.25                      | 86                   | 87   | 100  |      |
| 10                   | 1.30                      | 85                   | 84   | 90   |      |
| 0                    | 1.45                      | 86                   | 83   | 84   | 100  |
| -10                  | 1.53                      | 78                   | 74   | 80   | 78   |
| -20                  | 1.64                      | 73                   | 70   | 75   | 81   |
| -30                  | 1.77                      | 65                   | 68   | 77   | 82   |
| -40                  | 1.92                      | 50                   | 52   | 68   | 78   |

††† For sealed compressors.

The capacity of a typical compressor is reduced as the evaporating temperature is reduced because of increased specific volume (cu ft/lb) of the refrigerant and lower compressor volumetric efficiency. The average 1 hp compressor will have a capacity of nearly 12,000-btu/hr per ton, at 40°F refrigerant temperature, 100°F condensing temperature. A 10° rise/fall in condensing temperature will reduce/increase capacity about 6%.

## Proper System Charging

### Subcooling Charging Method - TXV (Expansion Valve)

Subcooling is defined as: The temperature of a liquid refrigerant when it is cooled below its condensing temperature. Subcooling takes place in the condenser and is determined by subtracting the liquid line temperature (as read on a thermometer strapped on the liquid line) from the saturation temperature (gauge temperature - the temperature that corresponds to the pressure read on the high side of the gauge).

- Locate the unit required subcooling from the name plate or product literature. (Typically 8-12°F).
- Measure liquid line temperature - convert to pressure.
- Subtract the required subcooling (1) from the converted temperature (2). This is the required liquid line temperature.
- Measure the liquid line temperature. If the measured temperature does not equal the required liquid line temperature:
  - Add refrigerant to lower the temperature.
  - Remove refrigerant to raise the temperature.
  - Allow a tolerance of +/- 3°F.

### Superheat Charging Chart - Cooling - Non TXV (Expansion Valve)

Superheat is defined as: The temperature of vapor refrigerant above its saturation point (evaporation) temperature. Superheat occurs in the evaporator and is determined by subtracting the saturation temperature (the temperature that corresponds to the pressure read on the low-side gauge) from the suction line temperature (as read on a thermometer strapped on the suction line).

## Cooling Tower Ratings

| Temperatures °F |            |          |                 |
|-----------------|------------|----------|-----------------|
| Hot Water       | Cold Water | Wet Bulb | Capacity Factor |
| 90              | 60         | 70       | 0.85            |
| 92              | 62         | 70       | 1.00            |
| 95              | 65         | 70       | 1.24            |
| 98              | 68         | 72       | 0.74            |
| 92              | 62         | 72       | 0.88            |
| 95              | 65         | 72       | 1.12            |
| 98              | 68         | 74       | 1.00            |
| 95              | 65         | 76       | 0.88            |
| 98              | 68         | 78       | 0.75            |
| 98              | 68         | 80       | 0.63            |

Hot water - Cold Water = Range

Cold Water - Hot Water = Approach

The Capacity factor is a multiplier by which the capacity at any common assumed condition may be found if the rating at some other point is known. Factors are based on heat rejection ratio of 1.25 (15,000 btu/hr per ton) and gpm/ton flow rate.

Example: at 95-85-80, the capacity is 0.63/0.85 or 0.75 that of the rating of 90-80-70.

Capacity is reduced as the flow rate per ton is increased. If the refrigerant temperature is below 40°F, the heat rejection will be greater than 15,000 btu/hr per ton. Evaporation will cause increasing deposits of solids and fouling of the condenser tubes unless water is bled off. A bleed of 1% of the circulation rate will result in concentrations of twice the original solids (two concentrations), and 0.5% bleed will result in three concentrations.

## Horsepower Per Ton

At 100°F condensing temperature vapor enters the compressor at 65°F

| Refrig. Temp. °F | 60   | 70   | 80   | -20  | -40  |
|------------------|------|------|------|------|------|
| Practical Avg.   | 0.87 | 1.20 | 1.70 | 2.40 | 3.20 |

| Required Superheat<br>Condenser Entering Air - Dry Bulb |    |    |    |    |    |    |    |    |    |    |     |     |
|---------------------------------------------------------|----|----|----|----|----|----|----|----|----|----|-----|-----|
| Indoor Air - Wet Bulb                                   | °F | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 | 105 |
|                                                         | 50 | 9  | 7  | 6  | 6  | 6  | 6  | 6  | 6  | 6  | 6   | 6   |
|                                                         | 52 | 12 | 10 | 8  | 8  | 8  | 8  | 8  | 8  | 8  | 8   | 8   |
|                                                         | 54 | 14 | 12 | 10 | 9  | 8  | 8  | 8  | 8  | 8  | 8   | 8   |
|                                                         | 56 | 17 | 15 | 13 | 10 | 9  | 8  | 8  | 8  | 8  | 8   | 8   |
|                                                         | 58 | 19 | 18 | 16 | 13 | 11 | 9  | 8  | 8  | 8  | 8   | 8   |
|                                                         | 60 | 23 | 21 | 19 | 16 | 13 | 11 | 9  | 8  | 8  | 8   | 8   |
|                                                         | 62 | 26 | 24 | 23 | 19 | 15 | 12 | 10 | 9  | 8  | 8   | 8   |
|                                                         | 64 | 29 | 27 | 24 | 21 | 18 | 15 | 13 | 11 | 9  | 8   | 8   |
|                                                         | 66 | 32 | 30 | 27 | 24 | 21 | 18 | 15 | 13 | 10 | 9   | 8   |
|                                                         | 68 | 35 | 33 | 30 | 27 | 24 | 21 | 19 | 16 | 14 | 12  | 10  |
|                                                         | 70 | 37 | 35 | 33 | 30 | 28 | 25 | 22 | 20 | 18 | 15  | 13  |
|                                                         | 72 | 40 | 38 | 36 | 33 | 31 | 28 | 25 | 24 | 22 | 20  | 17  |
|                                                         | 74 | 42 | 40 | 38 | 36 | 34 | 31 | 30 | 27 | 25 | 23  | 22  |
|                                                         | 76 | 45 | 43 | 41 | 39 | 37 | 35 | 33 | 31 | 29 | 27  | 26  |

- Measure the outdoor air (dry bulb) temperature, and indoor wet bulb temperature.
- Find the required superheat from the chart.
- Measure the suction line pressure - convert pressure to temperature.
- Add the required superheat (2) to the converted temperature (3). This is the required suction line temperature.
- Measure the suction line temperature. If the suction line temperature does not equal the required suction line temperature (4):
  - Add refrigerant to lower the suction line temperature.
  - Remove refrigerant to raise the suction line temperature.
  - Allow a tolerance of +/- 3°F.

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