

## FORMULA SHEET

- 1) 1 ton = 12,000 BTU/hr = 12,000 BTUH = 12 MBH
- 2) For fresh water applications<sup>1</sup>: Tons =  $GPM * (\Delta T) / 24$
- 3) C.O.P. =  $3.517 / (I kW / ton)$ , EER =  $12 / (I kW / ton)$
- 4) For Hermetic Rotary Chillers:  
Condenser Heat Rejection (tons) = (Cooler Tons) + ((Motor I kW) / 3.517)
- 5) Pump kW = ((feet of head) \* GPM) / (5310 \* (pump efficiency))

- 6) Power Factor = A/B, where:

$$A = 1000 * (\text{Motor I kW})$$

$$B = \sqrt{(3) * (\text{motor voltage}) * RLA}$$

1 Therm = 100,000 BTU

- 7) Waterside

(Fresh Water)

$$BTU = 500 * GPM * \Delta T$$

$$Tons = \frac{(GPM * \Delta T)}{24}$$

(Brines)

$$500 * GPM * \Delta T * Sp.Gr * Cp$$

$$(GPM * \Delta T * Sp.Gr * Cp) / 24$$

- 8) Airside

a.  $BTU_S = CFM * 1.08 * \Delta T$

b.  $BTU_L = CFM * 0.69 * \Delta Gr$

c.  $BTU_T = CFM * 4.45 * \Delta H$

12)  $W = \sqrt{(3) * I * V}$   
1 ft<sup>3</sup> = 7.481 gallons

13)  $KW = (\Delta T * 1.08 * CFM) / (3414)$

1 KW = 3414.4 BTU

Heat Gain through Fan

$$\frac{BHP * 2545}{\text{Motor Eff.}} = \text{BtuH}$$

- 15) Heating

32 BTU per ft<sup>2</sup>

9) 2.31 x PSI = FT

10)  $BTU = (ft^2 / 400) * 12$

16)  $T_{mix} = \frac{(T_{RA} * CFM_{RA}) + (T_{OA} * CFM_{OA})}{CFM_{Total}}$

11) 8.32 lb H<sub>2</sub>O / gallon

17) 1 HP = 0.746 kw

<sup>1</sup>Note: This formula is a close approximation, and it is applicable to any heat exchanger (cooler or condenser) using fresh water as the heat transfer fluid.

## QUICK REFERENCE FIGURES

### TYPICAL KW/TON VALUES (FULL LOAD)

<u>Electric Chillers</u>	<u>New</u>	<u>Existing</u>
Air Cooled	1.1 - 1.2	1.25 - 1.3
Water Cooled Screw	.6 - 7.5	.75 - .9
Water Cooled Recip	.80 - 1.0	1.1 - 1.15
Water Cooled Centrifugal	.53 - .6	.75 - .95

---

<u>Absorption Chillers</u>	.01 - .03 kw/ton
----------------------------	------------------

<u>Cooling Towers</u>	
Electric Chillers	.06 - .08 kw/ton
Absorption Chillers	.08 - 1.1 kw/ton

<u>Condenser Water Pump</u>	
Electric Chillers	.04 - .08 kw/ton
Absorption Chillers	.04 - .08 kw/ton

---

### TYPICAL CHILLER \$/TON FIRST COST

<u>TONS</u>	<u>200</u>	<u>500</u>	<u>700</u>	<u>1000</u>	<u>1500</u>
Centrif \$/ton	210-260	170-190	160-175	155-170	150-160
Single Effect Abs	1.7	1.6	1.55	1.55	1.60
Double Effect Abs	2.6	2.4	2.4	2.4	2.4
Direct Fired Abs	2.9	2.8	2.7	2.7	-

---

### COOLING TOWER SIZING / FIRST COST FACTORS

	<u>ARI</u>	<u>Rejection</u>	<u>Cost \$/</u>
	<u>GPM/Ton</u>	<u>BTUH</u>	<u>Cooling Ton</u>
Electric Chiller	3.0	15,000	\$35 - \$45
Single Effect Absorption	3.6	29,000	\$45 - \$60
Double Effect Absorption	4.0	22,000	\$40 - \$55
Gas Direct Fired Absorption	4.5	22,500	\$40 - \$55

---

### TYPICAL INSTALLED COST \* \$/TON CHILLERS

<u>TONS</u>	<u>200</u>	<u>500</u>	<u>700</u>	<u>1000</u>	<u>1500</u>
Electric Centrifugal	730	530	480	440	420
Absorption	930	700	640	600	580
Air Cooled	650	-	-	-	-

\* Includes cooling tower, condenser water pump and piping

---

### TYPICAL ANNUAL MAINTENANCE COST \* \$/TON CHILLERS

<u>TONS</u>	<u>200</u>	<u>500</u>	<u>700</u>	<u>1000</u>	<u>1500</u>
Electric Centrifugal	25	18	18	15	15
Absorption	36	24	24	22	22

Note: Double effect is higher than single effect

\* Includes cooling tower, condenser water pump, chemicals