Formulas and Tables

Fan Laws

The fan laws can be used to predict the performance of a tower with a non-standard motor.

$RPM_2 = RPM_1 (CFM_2) / (CFM_1)$

$Static\ Pressure_2 = Static\ Pressure_1 (CFM_2/CFM_1)^2$

$Horsepower_2 = Horsepower_1 (CFM_2 / CFM_1)^3$

DID YOU KNOW?

Cooling tower tons account for the heat of compression imposed by the chiller in addition to the building load. The heat of compression is typically assumed to be a 25% addition, or 3,000 BTUH per ton.

Formulas

Range = Entering Water Temperature - Leaving Water Temperature

Approach = Leaving Water Temperature - Ambient Wet-Bulb Temperature

Heat Rejected by a Cooling Tower:

BTUH = (Flow) X (Range) X 500 X (SG) X (SH)

Note: SG = SH = 1 for water

MBH = 1000 BTUH

Refrigeration Tons:

$$\textbf{Tons} = \frac{BTUH}{12{,}000}$$

Cooling Tower Tons:

$$\textbf{Tons} = \frac{BTUH}{15{,}000}$$

Basic Electrical:

E = I x R

P = I x E

Where: E = voltage (volts) I = current (amps)

R = resistance (ohms) P = power (watts)

AC Line Current in a Single Phase Supply

$$I = \frac{P}{E * PF * EFF}$$

Where:
I is the RMS line current in Amps
P is the average output power in Watts
E is the AC line voltage in Volts

AC Line Current in a Three Phase Supply

$$I = \frac{P}{(\sqrt{3}) * E * PF * EFF}$$

PF is the input power factor
EFF is the efficiency of the supply

Formulas and Tables

STEEL GAUGE THICKNESS AND WEIGHTS

Gauge	Inches	lbs/ft²
8	0.165	6.9
9	0.150	6.3
10	0.135	5.6
11	0.120	5.0
12	0.105	4.3
13	0.090	3.7
14	0.075	3.0
15	0.067	2.8
16	0.059	2.5

SPECIFIC HEAT AND SPECIFIC GRAVITY OF GLYCOL

	Ethylene Glycol		Propylene Glycol	
	SH	SG	SH	SG
10%	0.957	1.015	0.981	1.009
20%	0.924	1.030	0.960	1.019
30%	0.887	1.045	0.934	1.027
40%	0.849	1.058	0.904	1.034
50%	0.809	1.071	0.868	1.040

Temperature Conversions

Fahrenheit to Celsius: Temp ºC = 5/9 (Temp ºF - 32)

Celsius to Fahrenheit: Temp ºF = 9/5 (Temp ºC) + 32

For quick temperature conversion, see page J22.

Water Quality Guidelines

To control the cycles of concentration such that BAC water quality guidelines* are maintained, it will be necessary to "bleed" or "blow down" a small amount of recirculating water from the system. This "bleed" water is replenished with fresh make-up water, thereby limiting the build-up of impurities.

The required continuous bleed rate can be calculated using the following formula:

$$\text{Bleed Rate} = \frac{\text{Evaporation Rate}}{\text{Number of Cycles of Concentration - 1}}$$

Where:

Evaporation Rate = (Flow) x (Range) x 0.001

The evaporation rate can also be estimated as:

- 2 GPM per 1 million BTU/HR of heat rejection
- 3 GPM per 100 tons of refrigeration

Water Make-Up Rate = Bleed Rate + Evaporation Rate

Number of Cycles of Concentration

The degree to which dissolved solids and other impurities build up in the recirculating water may be defined as the cycles of concentration. Specifically, cycles of concentration is the ratio of the concentration of a dissolved solid (for example - chlorides, sulfates, etc.) in the recirculating water to the concentration of the same material in the make-up water.

NOTE: BAC water quality guidelines are available in the applicable Operation and Maintenance Manuals available at www.BaltimoreAircoil.com.