Commonly Used HVAC Formulae and Conversions

Air Side

Q_{Total} = CFM x (h_i - h_f) x 4.5 Btuh

$Q_{Sensible}$ = CFM x (t_i - t_f) x 1.085 Btuh

Q_{Latent} = CFM x (Gr_i - Gr_f) x .068 Btuh

Humidification = CFM x (Gr_f-Gr_i) / 1,555 lbs/hr

CFM = l/s x 2.12

Air Pressure Drop (in. wg) = Pa / 249

Water Side

Q = USGPM x (t_i - t_f) x 500 Btuh

Q = USGPM x (t_i-t_f) x 450 Btuh (50% E.G.)

Q = USGPM x (t_i-t_f) / 24 Tons

USGPM = l/s x 15.85

Water Pressure Drop (ft. wg) = kPa x 0.335

1.0 PSI = 2.31 wg

7,000 Grains = 1.0 lb

Miscellaneous

1.0 Ton = 12 MBH = 12,000 Btuh
1.0 Therm = 100,000 Btuh = 100 MBH

COP = 3.516 / (kw / Ton)

EER = Tons x 12 / (Total kW input)

Btuh = Watt x 3.412

HP = kW x 1.3405

1 Boiler HP = 33.48 MBH

1 US Gallon = 8.33lbs

Latent heat of vaporization of steam in air (average) = 1,050 Btuh/lb

The Affinity Laws (Fan/Pump Laws)

$$\frac{rpm_2}{rpm_1} = \frac{Flow_2}{Flow_1}$$

$$\frac{\Delta P_2}{\Delta P_1} = \left(\frac{Flow_2}{Flow_1}\right)^2$$

$$\frac{mhp_2}{mhp_1} = \left(\frac{Flow_2}{Flow_1}\right)^3$$

$$\text{Pump BHP} = \frac{\text{USGPM} \times \text{Head (ft. wg)}}{3960 \times \text{Pump Efficiency}}$$

$$\text{Fan BHP} = \frac{\text{CFM} \times \text{S.P. (inches wg)}}{6356 \times \text{Static Efficiency}}$$

Air-Conditioning Formulas

1 Btu = amount of heat required to raise (or lower temperature of one pound of water 1^{o}F

1 ton refrigeration = 12,000 Btu/h = 200 Btu/min

1 watt = 3.412 Btu/h

1 horsepower = 2545 Btu/h

1 lb = 7000 grains

1 ft (head) = 0.433 psi

1 square foot EDR (equivalent direct radiation) = 240 Btu

1 boiler horsepower = 33,479 Btu/h

No. of air changes (N) =60 cfm/ft^3

Sensible heat (Btu/h) = 1.08 $Q\Delta t$

Where Δt = difference between entering and leaving dry-bulb temperature and Q = airflow rate in cubic feet per minute

Latent heat (Btu/h) = 0.68 $Q\Delta g$

Where Δg = difference in moisture content of entering and leaving air, grains per pound of dry air

Water quantity (gpm) required for heating and cooling = q/500 Δt_{water}

Where q = load in Btu/h

Chiller capacity (tons) = gpm (chilled water) x Δt (water)/24

For Air:

1 lb/h = 4.5 Q

1 ton = $Q\Delta h/2670$

$$\text{Fan hp} = \frac{\text{cfm x static pressure (in. w.g.)}}{\text{6356 x Efficiency}} \times \frac{\text{Density of air}}{\text{Density of standard air}}$$

Small fans 0.40 – 0.50 efficiency

Large fan 0.55 – 0.60 efficiency

For Water:

1 lb/h = 500 gpm

1 ton = (gpm) $\Delta t/24$

$$\text{Pump hp} = \frac{\text{gpm x ft head}}{\text{3960 x Efficiency}} \times \text{Specific Gravity}$$

Small pumps 0.40 – 0.60 efficiency

Large pumps 0.70 – 0.85 efficiency