AIRFLOW FORMULAS & FAN LAWS

$CFM = A \text{ X } V$

$CFM = Ak \text{ X } V$

$\frac{CFM}{V} = A$

$\frac{CFM}{A} = V$

TP = SP + VP

TP – SP = VP

TP – VP = SP

$VP = \left(\frac{V}{4005}\right)^2$

$V = 4005 \text{ X } \sqrt[2]{VP}$

$V = 1096.7 \text{ x } \sqrt[2]{\frac{VP}{Den}}$

$Den = .075 \text{ x } \left(\frac{530}{460 + T}\right) \text{ x } \left(\frac{BAR}{29.92}\right)$

$Fan_{SP} = Discharge_{SP} - Inlet_{TP}$

FAN LAW #1 – FLOW vs. SPEED

Note: RPM, FPM, CFM, GPM, Frequency (Hz), and Dia. (Sheave/Impeller) are all interchangeable.

$\frac{RPM_2}{RPM_1} = \frac{CFM_2}{CFM_1}$

$RPM_2 = RPM_1 \text{ x } \left(\frac{CFM_2}{CFM_1}\right)$

$CFM_2 = CFM_1 \text{ x } \left(\frac{RPM_2}{RPM_1}\right)$

FAN LAW #2 – FLOW vs. PRESSURE (*SP*, ΔP, & $Density$)

$\frac{SP_2}{SP_1} = \left(\frac{CFM_2}{CFM_1}\right)^2$

$SP_2 = SP_1 \text{ x} \left(\frac{CFM_2}{CFM_1}\right)^2$

$CFM_2 = CFM_1 \text{ x } \sqrt{\frac{SP_2}{SP_1}}$

FAN LAW #3 – FLOW vs. ENERGY (*BHP & Amps*)

$\frac{BHP_2}{BHP_1} = \left(\frac{CFM_2}{CFM_1}\right)^3$

$BHP_2 = BHP_1 \text{ x} \left(\frac{CFM_2}{CFM_1}\right)^3$

$CFM_2 = CFM_1 \text{ x } \sqrt[3]{\frac{BHP_2}{BHP_1}}$

STATIC EFFCIENCY:

$FanBHP = \frac{CFM \text{ x } SP}{6356 \text{ x } SE}$

$FanSE = \frac{CFM \text{ x } SP}{6356 \text{ x } BHP}$

AIR CHANGES:

$ACH = \frac{CFM \text{ x } 60}{Room\ Volume}$

$CFM = Room\ Volume \text{ x} \left(\frac{ACH}{60}\right)$

PERCENT OF AIR: *(T=Temp, A=Air, M=Mixed, R=Return, O=Outside) *Used when there is at least a 20°ΔT between RA & OA. **CO_2 PPM can be substituted for Temperature.*

$\%OA = \frac{(RAT - MAT)}{(RAT - OAT)} \text{ x } 100$

$MAT = \frac{(\%OAxOAT) + (\%RAxRAT)}{100}$

$OAT = \frac{(MATx100) - (\%RAxRAT)}{\%OA}$

$RAT = \frac{(MATx100) - (\%OAxOAT)}{\%RA}$

FAN TIP SPEED:

$$\text{Circ. (in.)} = \frac{\text{TS(FPM)x12}}{\text{RPM}} \qquad \text{TS(FPM)} = \text{RPM x}\frac{\text{Circ. (in.)}}{12} \qquad \text{RPM} = \frac{\text{TS(FPM)x12}}{\text{Circ. (in.)}}$$

AIRFLOW STATIONS:

$$\text{CFM} = \text{C}_\text{v} \text{ x } \sqrt[2]{\Delta P_{(\text{in.})\text{H}_2\text{0}}} \qquad \text{C}_\text{v} = \frac{\text{CFM}}{\sqrt[2]{\Delta P_{(\text{in.})\text{H}_2\text{0}}}} \qquad \Delta P_{(\text{in.})\text{H}_2\text{0}} = \left(\frac{\text{CFM}}{\text{C}_\text{v}}\right)^2$$

BELTS & SHEAVES:

BL=Belt Length C=Centerline distance between shafts D=Fan Sheave dia. d=Motor Sheave dia.

$$\text{BL} = 2\text{C} + \left(1.57\text{x}(\text{D}+\text{d})\right) + \frac{(\text{D}-\text{d})^2}{4\text{C}}$$

$$\text{FanRPM} = \text{MotorRPM x} \left(\frac{\text{d}}{\text{D}}\right)$$

$$\text{MotorRPM} = \text{FanRPM x} \left(\frac{\text{D}}{\text{d}}\right)$$

New Motor Sheave: $\text{dia}_2 = \text{dia}_1 \left(\frac{\text{RPM}_2}{\text{RPM}_1}\right)$

New Fan Sheave: $\text{Dia}_2 = \text{Dia}_1 \left(\frac{\text{RPM}_1}{\text{RPM}_2}\right)$

$$\text{Fan}_{\text{Sp}} = \text{Discharge}_{\text{Sp}} - \text{Inlet}_{\text{Tp}}$$

$$\text{MotorRPM x Motor dia.} = \text{FanRPM x Fan dia.}$$

$$\text{Min Fan Sheave Dia.} = \frac{\text{Current Fan Sheave Dia.}}{\sqrt[3]{\frac{\text{Max BHP}}{\text{Current Est. BHP}}}} \qquad \frac{\text{RPM Fan}}{\text{RPM Motor}} = \frac{\text{Pitch d. Motor}}{\text{Pitch D. Fan}}$$

$$\text{Max Motor Sheave dia.} = \text{Current Motor Sheave dia. x} \sqrt[3]{\frac{\text{MAX BHP}}{\text{Current EST. BHP}}}$$

HEAT TRANSFER

AIR: *(h=Enthalpy in BTU per lb.)*

$$\text{BTUH (Sensible)} = \text{CFM x 1.08 x } \Delta\text{T} \qquad \text{BTUH (Total)} = \text{CFM x } \Delta\text{h x 4.5}$$

$$\text{BTUH (Sensible)} = \text{CFMx 1.08 x } \Delta\text{T x} \left(\frac{\text{Den}}{.075}\right) \qquad \text{BTUH (Total)} = \text{CFM x } \Delta\text{h x 4.5 x} \left(\frac{\text{Den}}{.075}\right)$$

$$\Delta\text{T} = \frac{\text{BTUH(Sensible)}}{\text{1.08 x CFM}} \qquad \Delta\text{T} = \frac{\text{BTUH(Total)}}{\text{4.5 x CFM}}$$

$$\text{CFM} = \frac{\text{BTUH(Sensible)}}{\text{1.08 x } \Delta\text{T (Dry Bulb)}} \qquad \text{CFM} = \frac{\text{BTUH(Total}}{4.5\text{x}\Delta\text{h}}$$

Latent Heat Transfer = .069 x CFM x Δgr

$$\text{Heat Loss in BTUH} = \text{Area x } \Delta\text{T x} \left(\frac{1}{\text{R}_{\text{Total}}}\right)$$