Air Flow formulas

CFM = Duct area sq ft x Velocity

Standard Air= 70F @ 29.92" HG (Mercury)

1 cubic foot of standard air = 0.075 pounds

13.3 cubic feet of standard air = 1 pound

FAN LAWS:

Remember RPM is interchangeable for CFM

Note: *new* is the same as **1** and *old* is the same as **2**

Fan Law #1

$$\left(\frac{CFM_{new}}{CFM_{old}}\right) = \left(\frac{RPM_{new}}{RPM_{old}}\right)$$

Formulas for problem solving

$$\textbf{CFM}_{new} = CFM_{old} \times \left(\frac{RPM_{new}}{RPM_{old}}\right) \qquad \textbf{RPM}_{new} = RPM_{old} \times \left(\frac{CFM_{new}}{CFM_{old}}\right)$$

Fan Law #2

$$\left(\frac{CFM_{new}}{CFM_{old}}\right)^2 = \frac{SP_{new}}{SP_{old}} \text{ Or } \left(\frac{CFM_{new}}{CFM_{old}}\right) = \sqrt{\frac{SP_{new}}{SP_{old}}}$$

Formulas for problem solving

$$\textbf{CFM}_{new} = CFM_{old} \times \sqrt{\frac{SP_{new}}{SP_{old}}} \qquad \textbf{SP}_{new} = \left(\frac{CFM_{new}}{CFM_{old}}\right)^2$$

Fan Law #3

$$\left(\frac{CFM_{new}}{CFM_{old}}\right)^3 = \frac{BHP_{new}}{BHP_{old}} \text{ or } \frac{CFM_{new}}{CFM_{old}} = \sqrt[3]{\frac{BHP_{new}}{BHP_{old}}}$$

Formulas for problem solving

$$\textbf{CFM}_{new} = CFM_{old} \times \sqrt[3]{\frac{BHP_{new}}{BHP_{old}}} \qquad \textbf{BHP}_{new} = BHP_{old} \times \left(\frac{CFM_{new}}{CFM_{old}}\right)^3$$

Volume calculations:

Air Changes Per Hour = $\frac{CFM x 60}{Cubicfeet}$

CFM = Room Volume x $\frac{AirChanges_{perhour}}{60}$

Calculating Outside Air quantities:

OAT = $\frac{(MATx100)-(\%RAxRAT)}{\%OA}$ **O**=Outside **A**=Air **R**=Return **M**=Mixed **T**=Temperature

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

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

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

Velocity and Velocity with density correction:

For Standard Air (70F @ 29.92"):

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

$$Den = 0.075 \times \frac{530}{460+T} \times \frac{BAR}{29.92}$$

For Other Than Standard Air:

$$V = 1096.7 \times \sqrt{\frac{VP}{Den}}$$

Airflow stations flow:

$$CFM = C_V \times \sqrt{\Delta P(inches)H2o} \qquad Cv = \sqrt[3]{\frac{CFM}{\Delta P(inches)H2o}}$$

$$\Delta P(inches)H2o = \left(\frac{CFM}{Cv}\right)^2$$

Air Thermal calculations:

sp.ht = 0.24
13.3 cu.ft. = 1 lb.
0.075 lbs. = 1 cu.ft.
.075 lbs. x 60 min. = 4.5 lbs per hour
4.5 x 0.24 = 1.08

$$BTUH = M \times sp.ht. \times \Delta T$$

M = Mass Flow Rate in Lbs. per Hour. sp.ht. = Specific Heat in BTU/Lb. per Degree F.

$$CFM = \frac{BTUH(Sensible)}{1.08 \times \Delta T(DryBulb)}$$

$$BTUH = CFM \times 1.08 \times \Delta T \times \frac{Den}{0.075}$$

$$\Delta T = \frac{BTUH}{1.08 \times CFM}$$

$$BTUH(Total) = CFM \times \Delta h \times 4.5 \times \frac{Den}{0.075}$$

h = Enthalpy in BTU per Lb.

$$\frac{BTUH}{1000} = MBH$$

Fan calculations:

Static fan efficiency: $$FanBHP = \frac{CFM \times SP}{6356 \times SE}$$

$$FanTipSpeedFPM = RPM \times \frac{Circ.(in.)}{12}$$

$$Circ.(in.) = \frac{Ts(FPM) \times 12}{RPM}$$

$$RPM = \frac{Ts(FPM) \times 12}{Circ.(in.)}$$

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

$$FanRPM = MotorRPM \times \frac{d}{D}$$

$$MotorRPM = FanRPM \times \frac{D}{d}$$

BL = Belt Length (in.) C = Distance between shaft centers (in.) D = Fan sheave dia. (in.)
d = Motor Sheave dia. (in.)

Max. (min.) Fan sheave Dia. = $$\frac{ExsistingFanSheaveDia.}{\sqrt[3]{\frac{Max.BHP}{ExsistingEstimatedBHP}}}$$

Max. Motor sheave **= Existing Motor sheave Dia. X** $$\sqrt[3]{\frac{Max.BHP}{ExsistingEstimatedBHP}}$$

New **Motor** Sheave size **Diameter new =** Dia.$_{old}$ x $\left(\frac{RPM_{new}}{RPM_{old}}\right)$

New **Fan** Sheave size **Diameter new** = Dia.$_{old}$ x $\left(\frac{RPM_{old}}{RPM_{new}}\right)$