

## Air Flow formulas

**CFM** = Duct area sq ft x Velocity  
(Mercury)

**Standard Air** = 70F @ 29.92" HG

**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

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

#### Fan Law #2

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

#### Formulas for problem solving

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

#### Fan Law #3

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

#### Formulas for problem solving

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

## Volume calculations:

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

$$CFM = \text{Room Volume} \times \frac{\text{AirChangesPerhour}}{60}$$

## Calculating Outside Air quantities:

$$\mathbf{OAT} = \frac{(\mathbf{MAT} \times 100) - (\% \mathbf{RA} \times \mathbf{RAT})}{\% \mathbf{OA}}$$

**O**=Outside **A**=Air **R**=Return **M**=Mixed  
**T**=Temperature

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

$$\mathbf{MAT} = \frac{(\% \mathbf{OA} \times \mathbf{OAT}) + (\% \mathbf{RA} \times \mathbf{RAT})}{100}$$

$$\mathbf{RAT} = \frac{(\mathbf{MAT} \times 100) - (\% \mathbf{OA} \times \mathbf{OAT})}{\% \mathbf{RA}}$$

### Velocity and Velocity with density correction:

For Standard Air (70F @ 29.92"):

For Other Than Standard Air:

$$V = 4005 \times \sqrt{VP}$$

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

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

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

### Airflow stations flow:

$$CFM = C_v \times \sqrt{\Delta P(\text{inches})H_2O}$$

$$C_v = \sqrt[3]{\frac{CFM}{\Delta P(\text{inches})H_2O}}$$

$$\Delta P(\text{inches})H_2O = \left( \frac{CFM}{C_v} \right)^2$$

### Air Thermal calculations:

$$sp.ht = 0.24$$

$$13.3 \text{ cu.ft.} = 1 \text{ lb.}$$

$$0.075 \text{ lbs.} = 1 \text{ cu.ft.}$$

$$.075 \text{ lbs.} \times 60 \text{ min.} = 4.5 \text{ lbs per hour}$$

$$4.5 \times 0.24 = 1.08$$

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

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

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

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

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

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

h = Enthalpy in BTU per Lb.

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

### **Fan calculations:**

Static fan efficiency:

$$FanBHP = \frac{CFM \times SP}{6356 \times SE}$$

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

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

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

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

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

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

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

d = Motor Sheave dia. (in.)

$$\text{Max. (min.) Fan sheave Dia.} = \frac{\text{ExistingFanSheaveDia.}}{\sqrt[3]{\frac{\text{Max.BHP}}{\text{ExistingEstimatedBHP}}}}$$

$$\text{Max. Motor sheave} = \text{Existing Motor sheave Dia.} \times \sqrt[3]{\frac{\text{Max.BHP}}{\text{ExistingEstimatedBHP}}}$$

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

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