

## 06. USEFUL FORMULAS & FAN LAWS

### USEFUL FORMULAS

- AIR VELOCITY:  $V = \frac{Q}{A}$
- TOTAL PRESSURE:  $P_t = P_s + P_v$
- VELOCITY PRESSURE:  $P_v = \left(\frac{V}{4.04}\right)^2$  For Metric,  $P_v = \left(\frac{V}{4009}\right)^2$  For FPS
- FAN OUTPUT POWER:  $H_o = \frac{P_t \times Q \times 9.81}{1000}$  For Metric,  $H_o = \frac{P_t \times Q}{6360}$  For FPS
- FAN OUTPUT POWER (STATIC):  $H_{o_s} = \frac{P_s \times Q \times 9.81}{1000}$  For Metric,  
 $H_{o_s} = \frac{P_s \times Q}{6360}$  For FPS
- TOTAL EFFICIENCY:  $\eta_t = \frac{H_o}{H_i} \times 100$
- STATIC EFFICIENCY:  $\eta_s = \frac{H_{o_s}}{H_i} \times 100$
- TIP SPEED:  $T_s = \frac{\pi \times D \times N}{60}$  For Metric,  $T_s = \pi \times D \times N$  For FPS
- NET FREE AREA:  $A = \frac{\pi}{4} (D^2 - d^2)$
- SOLIDITY RATIO =  $\frac{\text{SUM OF FAN BLADE TIP CHORDS}}{\pi \times D}$

**BASIC FAN LAWS**

• ***Effect Of Fan Speed***

1. FAN AIR FLOW RATE VARIES DIRECTLY WITH FAN SPEED RATIO:

$$Q_2 = Q_1 \times \left( \frac{N_2}{N_1} \right)$$

2. FAN PRESSURE VARIES WITH THE SQUARE OF FAN SPEED RATIO:

$$P_2 = P_1 \times \left( \frac{N_2}{N_1} \right)^2$$

3. FAN INPUT POWER VARIES WITH CUBE OF FAN SPEED RATIO:

$$H_2 = H_1 \times \left( \frac{N_2}{N_1} \right)^3$$

• ***Effect Of Air Speed***

1. AIR FLOW RATE REMAINS THE SAME WITH A CHANGE IN AIR DENSITY.

2. PRESSURE VARIES IN PROPORTION TO THE AIR DENSITY:

$$P_2 = P_1 \times \left( \frac{\rho_2}{\rho_1} \right)$$

3. FAN INPUT POWER VARIES IN PROPORTION TO THE AIR DENSITY:

$$H_2 = H_1 \times \left( \frac{\rho_2}{\rho_1} \right)$$