جامعة تكريت

كلية الهندسة قسم الميكانيك

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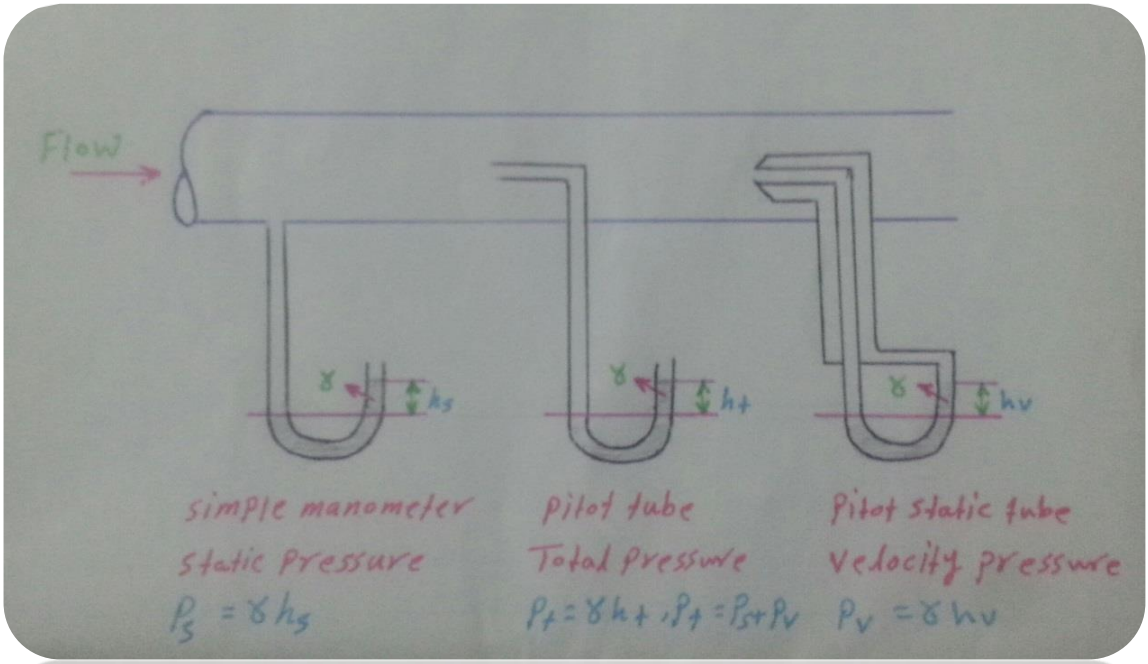
Fan Performance

From fluid lectures Remember that ↓



1-$Q \Rightarrow$ $flow\ rate\ (\frac{m^3}{s})$

2-$Fan\ Total\ pressure\ \ FTP\ \ (\frac{N}{m^2})$

3-$Fan\ Velocity\ pressure\ \ FVP\ \ (\frac{N}{m^2})$

4-*Fan Static pressure* FSP $(\frac{N}{m^2})$

$FTP = FSP + FVP$

5-*Power* P $(Watt)$

6-*Air Power* AP

7-*Mechanical effeciency* $\eta_m \cong \frac{Output\ \text{Power P}}{Input\ \text{Power P}}$

8-*Static effeciency.* $\eta_s \cong \frac{P_s}{P_t}$

9-*Inlet Fan area* A_i

10-*Outlet Fan area* A_o

11-*Impeller Revelution Per Minut* $RPM.$ (N)

12-*Impeller Diameter* (D)

13-ΔP *Duct Presuure Drop* (Pa)

Note that *P Pressure (Pa)*

& P *Power Watt (W)*

Fan Data Calculations

1- $V_o = \frac{Q}{A_o}$ $(\frac{m}{s})$

2- $FVP = \frac{1}{2} * \rho_{air} * V^2 \quad \Rightarrow V = V_o$

3- *Air densit* $\rho_{air} = 1.2 * \frac{P_a + P_s}{101325} * \frac{273+20}{273+t}$

$t = Air\ temperature\ \ C$

$P_a = Barrometric\ pressure \quad (Pa)$

$P_s = Static\ air\ pressure \quad (Pa)$

4- $Duct\ work - System\ resistance = c = \frac{\Delta P}{Q^2}$

5- $Electrical\ input\ Power\ \ P_i\ in\ (W)$

$$P_i = Q * FTP * \frac{10^{-3}}{PF} * \frac{1}{imp\%} * \frac{1}{motor\%} * R$$

$Q \Rightarrow \ \ flow\ rate\ (\frac{m^3}{s})$

$FTP \Rightarrow in\ (Pa)$

$PF \Rightarrow Power\ Factor(0.5 - 0.7)$

$imp\% \Rightarrow Fan\ impller\ effeciency.\%$

$motor\% \Rightarrow Fan\ motor\ effeciency.\%$

$R \Rightarrow overal\ motor\ drive\ Power$

$R = 1 + Fan\ Power\ ratio\ at\ zero\ air\ flow$

$i.e: general\ only\ a\ static\ pressure\ within\ its\ casing$

$R = 1 + 0.4 = 1.4$

6- $Phase\ current \quad I \ \ (A)$

$$I = \frac{Input\ Power\ (kW) * 1000}{\sqrt{3} * V} \quad When \quad V = voltage$$

7- $Air\ Power \ \ (AP) = Q * FTP$

8- $Mechanical\ effeciency. \eta_m = \frac{Q*FTP}{P_i}$

9- $Static\ effeciency. \eta_s = \frac{Q*FSP}{P_i}$

***Example*: For a fan has the following data**

Q=5.6 m^3/s PF=0.7 , FTP=ΔP=350 Pa , %imp= 85% , R=1+0.4 = 1.4 , %motor =95 %

Find the Power P_i and the $current\ (I)$ for Single phase and 3 phase & *Fan power at zero air flow*?

Solution

$$P_i = Q * FTP * \frac{10^{-3}}{PF} * \frac{1}{imp\%} * \frac{1}{motor\%} * R$$

$$P_i = 5.6 * 350 * \frac{0.001}{0.7} \frac{1}{0.85} \frac{1}{0.95} * 1.4$$

P_i *= 4.8544 kVA*

Single phase

$$I = \frac{Input\ power\ (Pi)*1000}{V} = \frac{4.8544*1000}{220} = 22.065\ A$$

3 phase

$$I = 3\ phase = \frac{Pi}{\sqrt{3}*V} = \frac{4.8544*1000}{\sqrt{3}*415} = 6.753\ A$$

*Fan power at zero air flow = 0.4 * Pi = 0.4 * 4.8544*

= 1.94 kVA