Experiment 6 - Effeciency of a square diffuser (200010094 - Manav Doshi)

Aim: To determine the pressure recovery of square curved diffusers of various geometries

Name - Manav Doshi
Roll No - 200100094

* Working and Calculations

→ Using S6 No 4

$$P_1 = (h_w \sin 45°) S_g \cdot (-1 \sin 45°)(1000 \times 10) 9.8 \times 10^{-3}$$
$$= -6.929 \text{ Pa}$$

$$U_{max} = \sqrt{\frac{2\Delta P}{\rho_{air}}} \cdot \sqrt{\frac{2 S_w h_w g}{\rho_{air}}} \cdot \sqrt{\frac{2 \times 1000 \times 10 \times 10^{-3} \times 9.8}{1.2}} = \boxed{12.78 \text{ m/s}}$$

$$V_1 = 0.8 U_{max} = \boxed{10.224 \text{ m/s}}$$

$$V_2 = \frac{A_1 V_1}{A_2} = \frac{40 \times 40}{40 \times 415} \times 10.224 = \boxed{0.985 \text{ m/s}}$$

$$Re = \frac{V_1 D}{\nu} = \frac{10.224 \times 40 \times 10^{-3}}{1.5 \times 10^{-5}} = \boxed{26082.03}$$

$$\eta_p = \frac{P_2 - P_1}{S\left(\frac{V_1^2 - V_2^2}{2}\right)} = \frac{6.929}{(1.2)\left(\frac{12.78^2 - 0.985^2}{2}\right)} = \boxed{0.11152}$$

→ Part 2 (Using so number 4)

$\Delta P = (h_w \sin 45^\circ) \times S_{wg}$

$= 18 \sin 45^\circ \times 1000 \times 9.8$

$= \boxed{124.733 \text{ Pa}}$

* Sources of error

→ Mispositioning pilot tube may give incorrect velocity readings

→ Angle of manometer may not be exactly 45° and may give ~~incorrect readings~~ errors

→ Parallax error while measuring height difference on the manometer.

* Questions and Answers

Q1) Factors are:

a) High Re - Turbulent flow has lesser boundary layer seperation than laminar flow

b) Roughness - Causes boundary layer tipping and makes the flow more turbulent

c) Rate of change of cross sectional area - Higher the rate, more the pressure drop ⇒ more separation

Q2) $\eta_p = \frac{(P_2 - P_1)}{S\left(\frac{v_2^2 - v_1^2}{2}\right)}$ As $A/A_2 \uparrow$ $\eta_p \uparrow$

With turbulent flow, flow separation is late and effective area $A_2^* \approx A_2$

& $\eta_p = \frac{v_2^2/2}{v_1^2/2}\left[\frac{1-(A/A_2^*)^2}{1-(A/A_2)^2}\right]$ as $A_2 \uparrow$ $\eta_p \uparrow$ ⇒ High Re ⇒ High A^* ⇒ High efficiency

Q3) i) Viscous loss
ii) Vibrational loss
iii) Loss due to flow reversal

Q4) Diffusers are used in centrifugal pumps for uniform and controlled flow

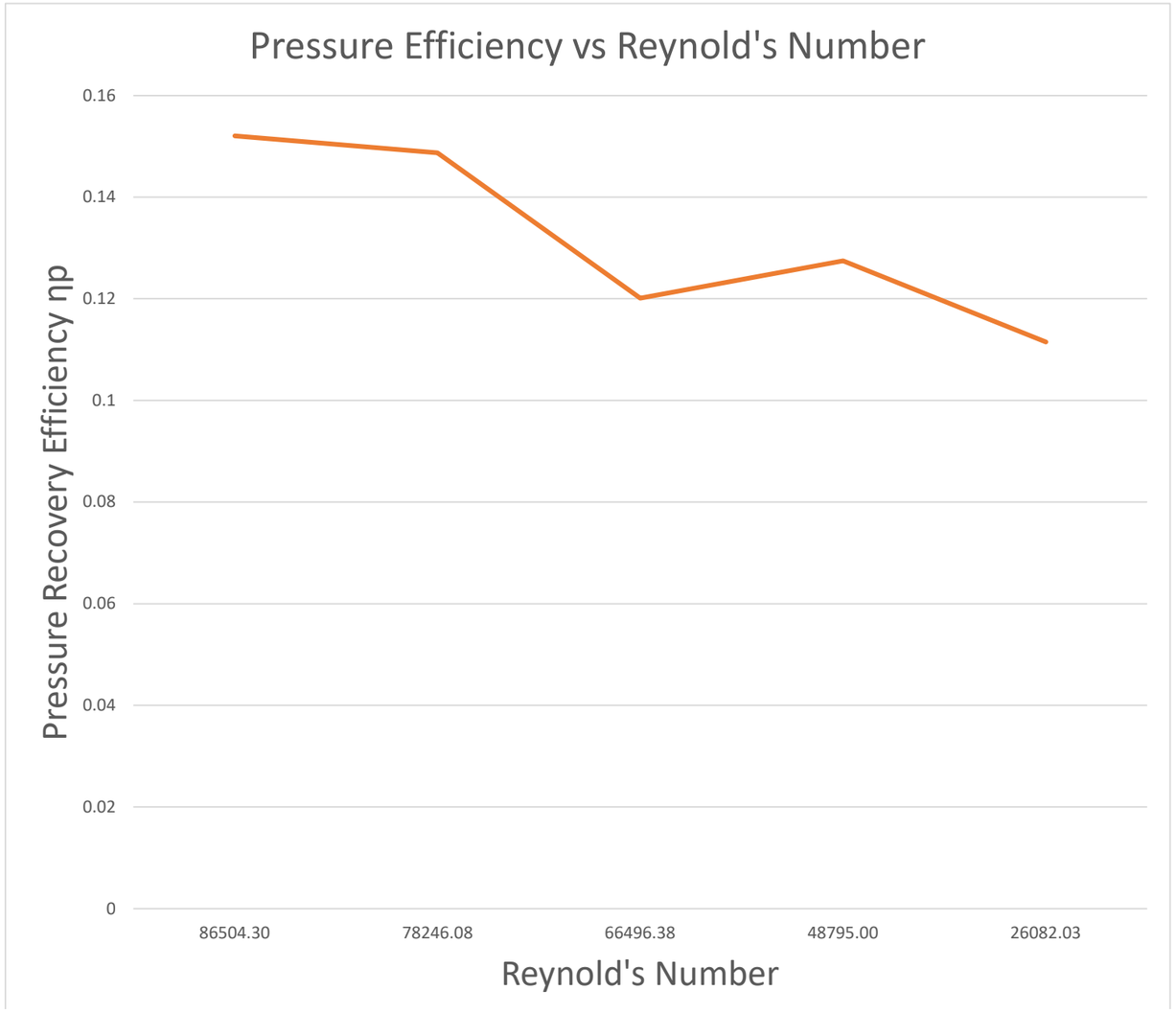
Q5) Factors are:
a) $A/A_2 \uparrow \quad \eta_p \uparrow$
b) Reynold's number $Re \uparrow \quad \eta_p \uparrow$
c) Roughness $\uparrow \quad \eta_p \uparrow$

Q6) The lower edge experiences pressure due to the weight while upper edge doesn't experience this. Due to this, flow separation occurs earlier in the bottom edge due to which pressure ~~distribution~~ distribution looks different for upper and lower edge.

Q7) We can use another liquid with low capillary action. We can also increase inclination of manometer, as it is a function of $\sin\theta$

* Conclusions
→ Our theory matches experimental data as we can see that η_p increases with Re. Increase in
→ We get $\eta_p < 1$, which is realistic.
→ Pressure tappings are different for the lower and upper edge.

Part 1									
Sr. No.	Pitot tube reading, h_p (mm of water)	Manometer reading, h_w (mm of water)	P_1 (Pa)	P_2 (Pa)	U_{max} (m/s)	V_1 (m/s)	V_2 (m/s)	*Re*	Pressure Recovery Efficiency η_p
0	110	-15	-103.9446968	0	42.387105	33.909684	3.26840327	86504.30	0.152074757
1	90	-12	-83.15575747	0	38.340579	30.6724632	2.956382	78246.08	0.148695318
2	65	-7	-48.50752519	0	32.5832268	26.0665814	2.51244158	66496.38	0.120100064
3	35	-4	-27.71858582	0	23.9095518	19.1276414	1.84362809	48795.00	0.12745313
4	10	-1	-6.929646456	0	12.780193	10.2241544	0.98546067	26082.03	0.111521488



	Part 2			
Sr no.		Pressure Tap No.	Manometer Reading (mm of water)	ΔP (Pa)
0	Upper Edge	1	12	83.15575747
1		2	14	97.01505038
2		3	17	117.8039897
3		4	18	124.7336362
4		5	18	124.7336362
5	Lower Edge	1	16	110.8743433
6		2	16	110.8743433
7		3	16	110.8743433
8		4	16	110.8743433
9		5	16	110.8743433