EXAM REVIEW

Lecture 15

28 OCT 13

1.

TEXT

9.19 – Calc Force on a Bend

$$\underset{\text{steady}}{\cancel{\frac{dP}{dt}}} + \frac{\overset{\rho =}{\rho_1} A_1 \cos\theta_1 \langle V \rangle_1^2}{\beta_1} \hat{r}^{(1)}$$

$$+ \frac{\overset{\rho =}{\rho_2} A_2 \cos\theta_2 \langle V \rangle_2^2}{\beta_2} \hat{r}^{(2)}$$

$$= \left[-PA\hat{n}\right]_1 + \left[-PA\hat{n}\right]_2 + \begin{pmatrix} R_1 \\ R_2 \\ R_3 \end{pmatrix}_{123} + M_{cv}\underline{g}$$

$Q \downarrow \quad \pi R_1^2 = A_1$

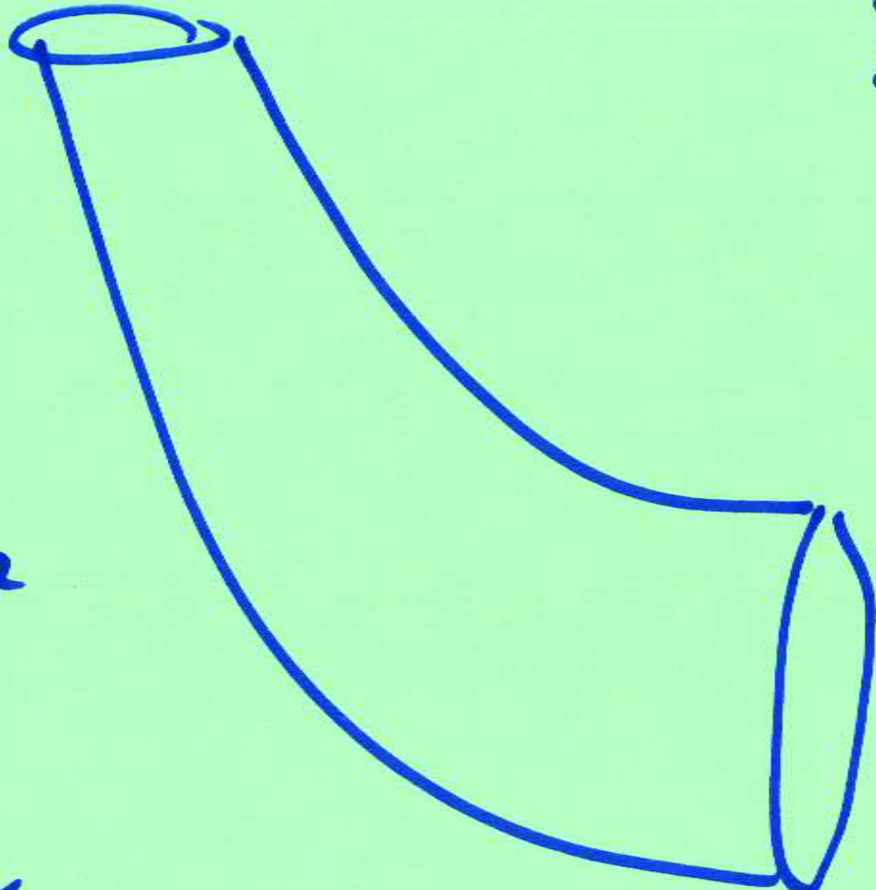
3

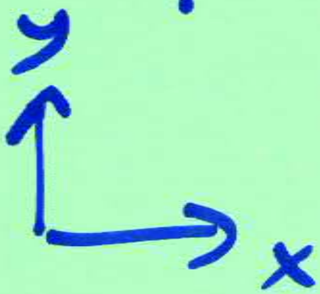
"1"

$\underline{g} = \begin{pmatrix} 0 \\ -1 \\ 0 \end{pmatrix}_{xyz}$

$\hat{v}_{(1)} = \begin{pmatrix} 0 \\ -1 \\ 0 \end{pmatrix}$

$(\hat{n} \cdot \hat{v})^{(2)} = \cos\theta_2$
$= -1$





$Q \rightarrow$

$\pi R_2^2 = A_2$

"2"

$\hat{n}_{(1)} = \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix}_{xyz}$

$\hat{n}_{(2)} = \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}_{xyz}$

$\hat{v}_{(2)} = \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}_{xyz}$

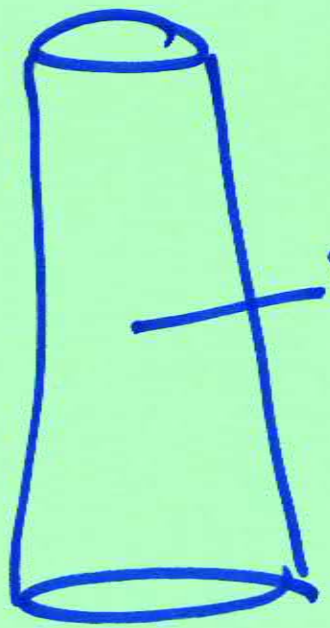
$\hat{n} \cdot \hat{v} = 1$

$\langle v \rangle_1 = \dfrac{Q}{\pi R_1^2}$ $\langle v \rangle_2 = \dfrac{Q}{\pi R_2^2}$

$\beta_1 = \beta_2 = \beta$ (turbulent)

$M_{cv} = ?$

estimate V by (assuming straight pipe)



$V\rho = M_{cv}$

ΔP?

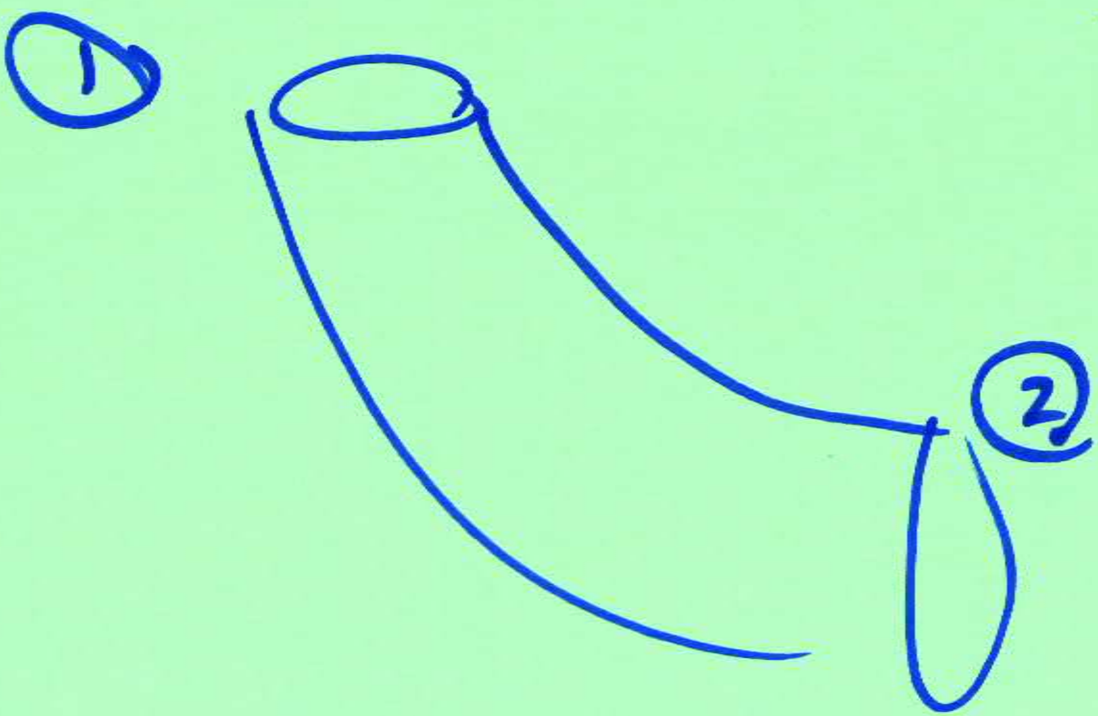
USE: $\underline{\text{MEB}}$

$$\Delta P = P_2 - P_1 \quad \left(\frac{Q}{\pi R_2^2}\right)^2 - \left(\frac{Q}{\pi R_1^2}\right)^2$$

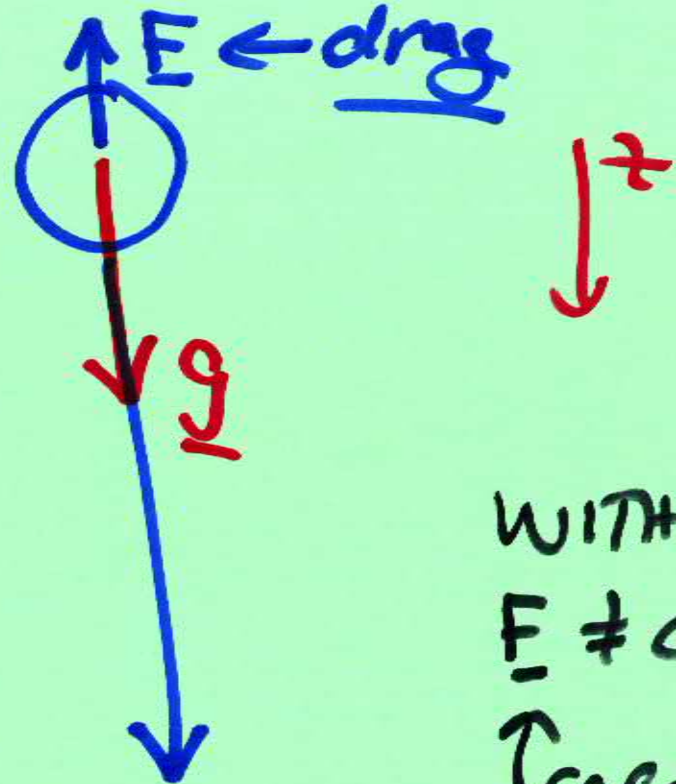
$$\frac{\Delta P}{\rho} + \frac{\Delta V^2}{2\alpha} + g\Delta z + F = \cancel{\frac{W_{s,on}}{\dot{m}}}$$

3"?

use K_f 90° bend



PROBLEM 8.19



WITHOUT DRAG:

$$\sum \underline{F} = m\underline{a}$$

$$\cancel{m_{sp}}\underline{g} = \cancel{m_{sp}}\frac{d\underline{v}}{dt}$$

$$\frac{d\underline{v}}{dt} = g$$

$$\frac{dv_z}{dt} = g$$

$$V = gt + C_1 \rightarrow \begin{cases} t = 0 \\ V = 0 \end{cases}$$

$$\boxed{V = gt}$$

WITH DRAG:

$\underline{F} \neq 0$

↑ calc from C_D; use Euler's Method

← see wikipedia

pages added 2NOV13 FAM

WITH DRAG:

$$\sum \underline{F} = m\underline{a}$$

$$m\underline{g} - \underline{F} = m \frac{d\underline{V}}{dt}$$

drag

$$\frac{dV_z}{dt} = g - \frac{F_z}{m}$$

depends on Re + hence v_z

We have previously related drag F_z with velocity

$$F_z = \frac{\rho v_z^2 A_p C_D}{2}$$

from $C_D(Re)$ correlation

solve the 1st order differential eqn.

Solution method:

$$\frac{dV_z}{dt} = g - \frac{\rho V_z^2 A_p C_d\left(\frac{\rho V_z d}{\mu}\right)}{2}$$

* see also Example 8.8 p643

Use Euler's Method
(see Wikipedia page)

i

1 $t = 0$ $V_{z(1)} = 0.00001$ miles/hr (small)

2 $t = \Delta t$ $V_{z(2)} = V_{z(1)} + \Delta t * \frac{dV_z}{dt}$ ← evaluated w/ $V_{z(1)}$

3 $t = 2\Delta t$ $V_{z(3)} = V_{z(2)} + \Delta t * \frac{dV_z}{dt}$ ← evaluated w/ $V_{z(2)}$

4 ⋮

⋮ etc.