**FIDE-AKWUOBI ANTHONY CHIZALU**

**17/ENG06/037**

**MECHANICAL ENGINEERING**

**MEE 322**

**QUESTION 1a**

**Three conditions for a coutte flow are:**

1. The flow is uniform.
2. Pressure gradient is constant.
3. The flow is steady.

**Four (4) conditions that can be used to determine the nature of flow are given by Reynolds experiment as:**

1. The diameter of the pipe (m).
2. The density of the fluid passing through the pipe (kg/m3).
3. The viscosity of the fluid (Ns/m2).
4. The velocity of the flow (m/s).

**The differences between aerofoils and hydrofoils are:**

|  |  |
| --- | --- |
| AEROFOIL | HYDROFOIL |
| 1. The aerofoil is a lifting device mainly used in gaseous fluids (air in particular)
 | The hydrofoil is a lifting device mainly utilized in liquid fluids (water) |
| 1. The aerofoil is mainly used for lifting of airplanes and jets.
 | The hydrofoil is mainly used to overcome drag and make machines move with a higher velocity in water. |

**QUESTION 1b SOLUTION**

 µ= 0.9 centipoise= 0.9 x 10-2 poise = 0.9 x 10-3 Ns/m2

 U= 1m/s

 b= 10mm=0.01m

 dp= 60KN/m2

 dx= 60m

therefore the pressure difference gradient is = $\frac{∂p}{∂x}$ = $\frac{-60000}{60}$= -1 x 103 N/m3

1. Velocity distribution= u = $\frac{U\_{y}}{b}-\frac{1}{2μ}\left(\frac{∂p}{∂x}\right)\left(by-y^{2}\right)$

 u =100y + 5555.56y – 555555.56y2

 u = (5.65556 x 103 )y – (5.556x 105 ) y2

1. Discharge per unit width = q= $\frac{Ub}{2}-\frac{b^{3}}{12μ}\left(\frac{∂p}{∂x}\right)$

 q = 0.005 + 0.09259 = 0.09759 m3/s/m

1. Shear stress at upper plate is @y=b,

 τ = $\frac{μU}{b}-\frac{1}{2}\left(\frac{∂p}{∂x}\right)\left(b-2y\right)$

 = τ = $\frac{μU}{b}-\frac{1}{2}\left(\frac{∂p}{∂x}\right)\left(-b\right)$

 τ = 0.09-5 = - 4.91 N/m2

**QUESTION 2 SOLUTION**

Given: µ= 0.9Ns/m2 b= 10mm=0.01m

 ρ= 1260kg/m3 P1= 250KN/m2

 U= -1.5m/s P2= 80KN/m2

$\frac{∂p}{∂x}$ = $\frac{-(P.1-P.2)}{Δx}$

But P.1= P1 + ρgz (piezometric)

 = 250000 + (1260) \*(9.81) \*(1)

 = 262.36KN/m2

And P.2= P2 + ρgz (piezometric)

 = 80000 + (1260)\*(9.81)\*(0)

 = 80KN/m2

$$Δx$$

1m

1m

Because the two plates are aligned at an angle of 45 degrees, the above diagram can be used to calculate the change in x

By Pythagoras theorem,

$Δx$ = $\sqrt{1^{2}+1^{2}}$ = $\sqrt{2}$ m

Therefore,

 $\frac{∂p}{∂x}$ = $\frac{-(P.1-P.2)}{Δx}$ = $\frac{-\left(262⋅36-80\right)}{\sqrt{2}}$ = -128.948KN/m3

1. **Velocity distribution**= u = $\frac{U\_{y}}{b}-\frac{1}{2μ}\left(\frac{∂p}{∂x}\right)\left(by-y^{2}\right)$

 u = -150y + 716.38y – 71637.8$y^{2}$

 u = -(7.16378 x 104 )$y^{2}$ + 565.62y

1. **Shear distribution**= τ = $\frac{μU}{b}-\frac{1}{2}\left(\frac{∂p}{∂x}\right)\left(b-2y\right)$

 τ = -135 + 644.74 – 128948y

 τ = 509.74 – (1.289 x 105 )y

1. **Maximum flow velocity**

At maximum flow velocity, $\frac{∂u}{∂y}=0$

0= -(1.4328 x 105 )y + 565.62

y= 3.9476 x 10-3 m

umax= -(7.16378 x 104 )$(3.9476 x 10-3 )^{2}$ + 565.62(3.9476 x 10-3)

umax= 1.12 m/s

1. Shear stress at upper plate is @y=b

Therefore, τ = 509.74 – (1.289 x 105 )y

 τ = 509.74 – (1.289 x 105 )( 0.01)

 τ = -779.26 N/m2