17/ENG05/003
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Solution.

1a) Shear Stress
The Velocity
The flowrate

ii.) The Density
1. The fluid viscosity
2. Density
3. Mean flow Velocity
4. Pipe's Diameter

iii.) Aerofoil | Hydrofoil.

Aerofoil	Hydrofoil
- This is used when the fluid is gaseous.	This is used when the fluid is water
- lift forces are due to the angle of the attack.	Lift force is due to d pressure on the bottom of the foil
- The foils are bigger than foils on a hydrofoil boat	The foils on a hydrofoil beat are smaller than the foils on an aeroplane

2.) Viscosity of liquid - $\mu = 0.9$ Centipoise $= 0.009 = 0.0009$

$b = 10mm = 0.01m$

Velocity $u = 1m/s$

$$\left(\frac{-\partial p}{\partial x}\right) = \frac{60 \times 10^3}{60}$$

$$= 10^5 N/m^2/m.$$

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(i.) $u = \frac{u}{b} + \frac{1}{2\mu}\left(-\frac{\partial p}{\partial x}\right)(by - y^2)$

$= \frac{11}{0.001} + \frac{1}{2\times 0.0009}(10^3)(0.01\times y - y^2)$

$= y(11000 + 5555.55 - 555555.55y)$

$u = y(5655.55 - 555555.55y)$

ii.) Discharge / unit width

$q = \int_0^{b} u\,dy$

$= \int_0^{0.01} \left(5655.55\frac{y^2}{2} - 555555.55\frac{y^3}{3}\right)_0^{0.01}$

$= \left[5655.55\times\frac{0.01^2}{2} - 555555.55\times\frac{0.1^3}{3}\right]$

$= 0.2827775 - 0.185185$

$= 0.0975 m^3/s$

iii.) Shear Stress

$= \mu\times\left(\frac{\partial u}{\partial y}\right) = \mu\frac{\partial}{\partial y}(5655.55y - 555555.55y^2)$

$= 0.0009(5655.55 - 111111.11y)$

Therefore the top plate $= 0.01m$

$\tau_0 = 0.0009(5655.55 - 111111.1\times 0.01)$

$= -4.9N/m^2$

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Question 2. Solution.

$\mu = 0.9 Ns/m^2$

$\rho = 1260$; specific gravity $= \frac{1260}{1000} = 1.26$

$b = 10mm = 0.01m$

$U = 1.5 m/s$

$P = 250 kN/m^2$; $P_2 = 80 kN/m^2$

(a) $h_1 - h_2 = \left(\frac{P_1}{w} + z_1\right) - \left(\frac{P_2}{w} + z_2\right)$

$= \left(\frac{250 \times 10^3}{1.26 \times 9810} + 1\right) - \left(\frac{80 \times 10^3}{1.26 \times 9810}\right) + 0$

$= 21.225 - 6.47$

$= 14.755m$ $\sqrt{2}m$ or $1.414m$

$\frac{\partial h}{\partial x} = -\frac{14.755}{1.414} = -10.435$

$\frac{\partial P}{\partial x} = w\frac{\partial h}{\partial x} = (1.26 \times 9810) \times (-10.435)$

$= -128983 N/m^2$

$u = \frac{U}{b} \cdot y - \frac{1}{2\mu} \cdot \left(\frac{\partial p}{\partial x}\right)(by - y^2)$

$= \frac{1.5}{0.01} y - \frac{1}{2 \times 0.9} \times (-128.483 \times 10^3)(0.01y - y^2)$

$= -150y + 716.57y - 71657y^2$

$566.57y - 71657y^2$

$= 566.57y - 7.165\times10^{-4}\, y^2$

Shear stress distribution is given as

$$\tau = \mu \times \frac{V}{b} - \frac{1}{2}\cdot\frac{\partial p}{\partial x}(b - 2y)$$

$$= 0.9 \times \left(\frac{-1.5}{0.01}\right) - \frac{1}{2} \times (-128983)(0.01 - 2y)$$

$$= -135 + 644.92 - 128983y$$

$$= 509.92 - 128983y$$

$$= 509.92 - 1.289\times10^{5}\, y$$

B) Maximum Flow Velocity, Umax:

Maximum velocity $\frac{du}{dy} = 0$

$$\frac{d}{dy}(566.57y - 71657y^2) = 0$$

$$566.57 - 143314y = 0$$

$$y = \frac{566.57}{143314} = 3.95\times10^{-3}\,m$$

$$U_{max} = 566.57(3.95\times10^{-3}) - 71657(3.95\times10^{-3})^2$$

$$= 2.238 - 1.118$$

$$= 1.12\,m/s$$

c) The shear stress at the upper plate;

$$(\tau)_{0.01} = 509.92 - 128983\times0.01 =$$

$$= -780\,N/m^2.$$

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