**ASSIGNMENT**

1a.

i) Conditions for Couette flow are:

Velocity is defined by $u=-\frac{1}{2μ}\left(\frac{δP}{δx}\right)(by-y^{2})$

Flow rate is defined by $q=-\frac{1}{2μ}\left(\frac{δP}{δx}\right)(\frac{b^{3}}{6})$

Shear stress is defined by $τ=-\frac{1}{2}\left(\frac{δP}{δx}\right)(b-2y)$

ii) Four conditions that can be used to determine the nature of flow are:

Pipe diameter

Velocity of the flow

Viscosity of the fluid

Density of the fluid

iii)

|  |  |
| --- | --- |
| **Aerofoil** | **Hydrofoil** |
| The working fluid is air or gas  | The working fluid is water |
| Operates at lower speeds | Operates at higher speeds |
| Forces experienced on aerofoils are much lesser than those on aerofoil | Forces experienced on hydrofoils are 800 times greater than that on aerofoils |
| Aerofoils do not experience cavitations. | Hydrofoils can be subject to cavitations. |
| Aerofoils are used on wingtips of aircraft | Hydrofoils are used on rudders of boats. |

1b.

b = 10mm = 0.01m

$u\_{max }$ = 1m/s

 $μ$ = 0.9 centipoise = $9×10^{-5}Ns/m^{2}$

i) q = $\frac{2}{3}×$ $u\_{max }×$ b = $\frac{2}{3}×1×0.01=0.0067m/s$

$$q=-\frac{b^{3}}{12μ}\left(\frac{δP}{δx}\right)$$

 0.0067 = $-\frac{0.01^{3}}{12 × 9 × 10^{-5}Ns/m^{2}}\left(\frac{δP}{δx}\right)$

 $\frac{δP}{δx}= -$7.236

ii) $τ=-\frac{1}{2}\left(\frac{δP}{δx}\right)(b-2y)$

 $ τ=-\frac{1}{2}\left(-7.236\right)(0.01-2y)$

 @y = 0,

 $τ=-\frac{1}{2}\left(-7.236\right)(0.01)$

 $τ=3.618×10^{-2}N/m^{2}$

iii) $u=-\frac{1}{2μ}\left(\frac{δP}{δx}\right)\left(by-y^{2}\right)$

 $ u=-\frac{1}{2 × 9 × 10^{-5}Ns/m^{2}}\left(-7.236\right)(0.01y-y^{2})$

 $u=402y-40200y^{2})$

2

a) (i) Velocity distribution: $u=566.4y-7.164 ×10^{-4}y^{2}$

 (ii) Shear stress distribution $ τ= 509.76-1.289 ×10^{5}y$

b) umax (maximum velocity) = 1.12 m/s, $τ @ y=3.9530 ×10^{-3} m=0.218 N/m^{2}$

c) Shear stress at the upper plate: $τ \left(upper plate \right)$= - 0.78 N/m2