**ASSIGNMENT 2**

1. $μ=0.9 Poise=0.09Ns/m^{2}$

$$ρ=0.9×1000kg/m^{3}$$

$$D=120mm=0.12m$$

$$l=12m$$

$$A=\frac{πD^{2}}{4}=0.0113m^{2}$$

$$Weight of oil,w=785N$$

$$w=\frac{mg}{g\_{c}}$$

$$where m=mass of oil; g\_{c}=1kgm/Ns^{2} and g=9.81m/s^{2}$$

$$m=\frac{wg\_{c}}{g}$$

$$m=\frac{785×1}{9.81}$$

$$m=80.02kg$$

If 80.02kg of oil was collected in 25 seconds, therefore mass flowrate, $\dot{m} will be$

$$\dot{m}=\frac{80.02}{25}=3.2008kg/s$$

$$\dot{m}=ρAV$$

$$V=\frac{\dot{m}}{ρA}$$

$$V=\frac{3.2008}{900×0.0113}=0.3147m/s$$

1. $ Re=\frac{ρVD}{μ}$

$$Re=\frac{900×0.314×0.12}{0.09}=376.8$$

Re < 2000, therefore the flow is laminar

Using Hagen-Pouseille equation: $P\_{1}-P\_{2}=\frac{32μul}{D^{2}}$; u=V

b) $ P\_{1}-P\_{2}=\frac{32×0.09×0.314×12}{0.12^{2}}=753.6N/m^{2}$

$$h\_{f}=\frac{P\_{1}-P\_{2}}{ρg}=\frac{753.6}{900×9.81}=0.085m of oil$$

2. $ν=0.015 stokes=1.5×10^{-6}m^{2}/s$

$$ρ=1000kg/m^{3}$$

$$ν=\frac{μ}{ρ}$$

$$μ=ν×ρ=1.5×10^{-6}×1000=1.5×10^{-3}$$

$$Q=8.5 lit/sec=8.5×10^{-3}m^{3}/s$$

$$D=60mm=0.06m$$

$$l=850m$$

$$A=\frac{πD^{2}}{4}=0.00283m^{2}$$

$$V=\frac{Q}{A}=\frac{8.5×10^{-3}}{0.00283}=3.0035m^{2}$$

$$Re=\frac{ρVD}{μ}$$

 c) $Re=\frac{1000×3.0035×0.06}{1.5×10^{-3}}=120,000$

 Re > 4000, therefore the flow is turbulent

$$F=\frac{0.0791}{Re^{0.25}}=\frac{0.0791}{120000^{0.25}}=4.25×10^{-3}$$

1. $ h\_{f}=\frac{4Flv^{2}}{2gD}=\frac{4×4.25×10^{-3}×850×3.0035^{2}}{2×9.81×0.06}=110.73m of water$
2. $τ\_{0}=\frac{Fv^{2}ρ}{2}=\frac{4.25×10^{-3}×3.0035^{2}×1000}{2}=19.17N/m^{2}$

**ASSIGNMENT 3**

1. $μ=0.9Ns/m^{2}$

$$ρ=1260kg/m^{3}$$

$$D=10mm=0.01m$$

$$l=65m$$

$$Q=\frac{180lit}{min}=\frac{180}{1000×60}=0.003m^{3}/s$$

$$A=\frac{πD^{2}}{4}=7.854×10^{-5}m^{2}$$

$$V=\frac{Q}{A}=\frac{3×10^{-3}}{7.854×10^{-5}}=38.2m/s$$

1. $Re=\frac{ρVD}{μ}$

$$Re=\frac{1260×38.2×0.01}{0.9}=534.8$$

Re < 2000, therefore the flow is laminar

b) $ P\_{1}-P\_{2}=\frac{128μQl}{πD^{4}}$

$$P\_{1}-P\_{2}=\frac{128×0.9×0.003×65}{π×0.01^{4}}=715051328.3N/m^{2}$$

$$h\_{f}=\frac{P\_{1}-P\_{2}}{ρg}=\frac{715051328.3}{1260×9.81}=57849.2m of glycerine$$

2. $μ=800 centipoise=0.8Ns/m^{2}$

$$-\frac{δP}{δx}=\frac{2000×10^{3}}{95}$$

$$\frac{δP}{δx}=-\frac{2000×10^{3}}{95}$$

$$ρ=0.85×1000kg/m^{3}$$

$$D=65mm=0.065m$$

$$R=\frac{D}{2}=\frac{0.065}{2}=0.0325$$

$$l=95m$$

$$∆P=2000KN/m^{3}$$

$$A=\frac{πD^{2}}{4}=0.00332m^{2}$$

1. Rate of flow of oil, Q = A$\overbar{u}$

$$\overbar{u}=-\frac{1}{8μ}\frac{δP}{δx}R^{2}$$

$$\overbar{u}=\left(-\frac{1}{8×0.8}\right)\left(-\frac{2000×10^{3}}{95}\right)\left(0.0325\right)^{2}$$

$$\overbar{u}=3.47m/s$$

$$Q=0.00332×3.47$$

$$Q=0.0115m^{3}/s$$

Nature of flow

$$Re=\frac{ρuD}{μ}$$

$$Re=\frac{850×3.47×0.065}{0.8}=239.6$$

Re < 2000, therefore the flow is laminar

1. Centre line velocity, $u\_{max}=2\overbar{u}$

= 2$ ×3.47$

$$u\_{max}=\frac{6.94m}{s}$$

1. Total frictional drag, $F\_{D}=τ\_{0}πDl$

$$τ\_{0}=-\frac{δPr}{2δx}$$

$$τ\_{0}=\frac{2000×10^{3}×0.0325}{2×95}$$

$$τ\_{0}=342.105N/m^{2}$$

$$F\_{D}=342.105×3.142×0.065×95$$

$$F\_{D}=6.637KN$$

1. Power required to maintain the flow, $P=F\_{D}.\overbar{u}$

$$P=6.637×3.47$$

$$P=23.03KW$$

1. Velocity gradient at the pipe wall

$τ\_{0}=μ\frac{δu}{δy}$, @ y = 0

$$\frac{δu}{δy}=\frac{τ\_{0}}{μ}$$

$$\frac{δu}{δy}=\frac{342.105}{0.8}$$

$$\frac{δu}{δy}=427.631s^{-1}$$

1. Velocity at 60 mm from the wall, $u=$ $-\frac{1}{4μ}\frac{δP}{δx}\left(R^{2}-r^{2}\right)$

$$y=0.06m$$

$$y=R-r$$

$$0.06=0.0325-r$$

$$-0.0275=r$$

$$u=\left(-\frac{1}{4×0.8}\right)\left(-\frac{2000×10^{3}}{60}\right)\left(0.0325^{2}—(-0.0275)^{2}\right)$$

$$u=3.125m/s$$

1. Shear stress at 60 mm from the wall

$$\frac{τ\_{mm}}{r}=\frac{τ\_{0}}{R}$$

$$\frac{τ\_{mm}}{r}=\frac{τ\_{0}}{R}$$

$$τ\_{mm}=\frac{342.105×-0.0275}{0.0325}$$

$$τ\_{mm}=-289.47N/m^{2}$$