Dt. 22/02/2022

[120BM0014]

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TRANSPORT PROCESS

Q2) ~~$xy = 3 - 3z$~~

~~$v = 1 + ky$~~

~~$u = 9 - 3x$~~

Q3)

Local Acceleration	Convective Acceleration
1) It is the change in velocity with respect to time in a fluid flow.	1) It is the velocity at a point multiplied with the velocity gradient at that point within the fluid flow.
2) This results when the flow is unsteady.	2) This results when the flow is non-uniform
3) $\boxed{a_L = \frac{\partial V}{\partial t}}$	3) $\boxed{a_s = V\frac{\partial V}{\partial s}}$

Q4) Stream line – A streamline is one that is drawn is tangential to the velocity vector every point in the flow at a given instant and helps in understanding flows.

$$\frac{du}{u} = \frac{dv}{v} = \frac{dw}{w}$$

Stress form

$$\nabla \cdot u = \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} = 0$$

The 3 - axes

$$\cancel{\rho \frac{Du}{Dt} = \rho g_x - \frac{\partial p}{\partial x} \ldots}$$

$$\rho\left(\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} + w\frac{\partial u}{\partial z}\right) = -\frac{\partial p}{\partial x} + \rho g_x + \mu\left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2}\right)$$

for x-axis

y-axis – replacing $\frac{\partial u}{\partial t}$ & $\frac{\partial^2 u}{\partial x^2}$ by $\frac{\partial v}{\partial t}$ & $\frac{\partial^2 v}{\partial x^2}$

z-axis – $\frac{\partial u}{\partial t} \rightarrow \frac{\partial w}{\partial t}$ $\quad \rho g_x \rightarrow \rho g_z$

$\frac{\partial^2 u}{\partial x^2} \rightarrow \frac{\partial^2 w}{\partial x^2}$

Q7) Stream func^n $(\psi) = 4x^2 - y^3$

$u = -\frac{d\psi}{dy}$

$= 3y^2$

So, at $(2, 3)$

$$\boxed{u = 3(3)^2 = 27 \text{ m/s}}$$

ϕ = velocity potencial

$u = -\frac{\partial \phi}{\partial x}$

$\cancel{27 = -\frac{d\phi}{dx}}$

$\cancel{\int 27\,dx = -\int d\phi}$

$\cancel{\Rightarrow 27x + c = -\phi}$

$\cancel{\Rightarrow \phi = -(27x + c)}$

$u = -\partial\phi/\partial x$

$-\int 3y^2\,\partial x = \int \partial\phi \Rightarrow \boxed{\phi = -(3xy^2 + c)}$

Pathline – It is the line traced by a given particle. This is generated by injecting a dye into the fluid and following its path by photography or other means.

Streakline – This concentrates on fluid particles that have gone through a fixed station or a point. At some instant of time the position of all these particles are marked a line is drawn.

So, the streamline, pathline & streakline coincide when the flow is steady. As during steady flow all the flow parameters do not change with time.

Q5) Navier-Stokes equation, is a partial differential equation that describes the flow of incompressible fluid. This is a generalized equation of Euler.

$$\boxed{\frac{\partial u}{\partial t} + u \cdot \nabla u = -\frac{\nabla P}{\rho} + \nu \nabla^2 \mu}$$

This equation also expresses conservation of momentum and mass.

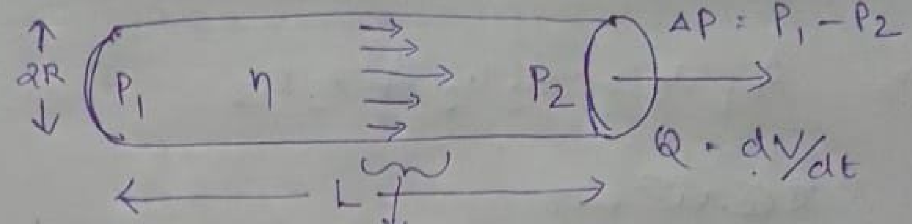
Continuity Equation

$$\boxed{\nabla \cdot \vec{V} = 0}$$

Partial Equation

$$\boxed{\underbrace{\rho \frac{DV}{Dt}}_{\text{change in velocity}} = \underbrace{-\nabla P}_{\text{pressure flow}} + \underbrace{\mu \nabla^2 V}_{\text{viscosity factor}} + \underbrace{\rho g}_{\text{represents external forces.}}}$$

So, the flow through the catheter.

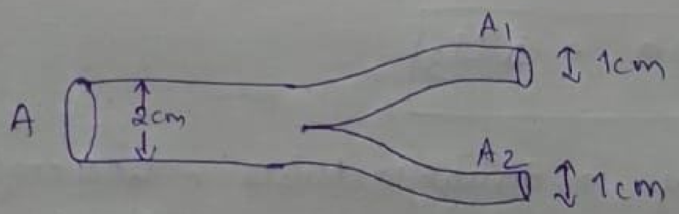


η = viscosity

This flow depends on factors like : pressure gradient, length of tube, the radius & viscosity.

Q6) Average velocity = 1 m/s
diameter = 2cm or 0.02 m

Two new vessels = 1 cm or 0.01 m diameter each.



So, discharge in (parent vessel) = area × velocity

$= \pi (0.01)^2 \times 1 \text{ m/s}$

$= 3.14 \times 10^{-4} \times 1 \text{ m}^3/\text{s}$

$\boxed{= 3.14 \times 10^{-4} \text{ m}^3/\text{s}}$

Q2)

$u = 9 - 3x$
$v = 1 + 6y$
$w = 3 - 3z$

For, incompressible liquid, we have the condition,

$$\frac{\partial (u)}{\partial x} + \frac{\partial (v)}{\partial y} + \frac{\partial (w)}{\partial z} = 0$$

LHS

So, $\frac{\partial (9-3x)}{\partial x} + \frac{\partial (1+6y)}{\partial y} + \frac{\partial (3-3z)}{\partial z}$

$= -3 + 6 - 3$

$= 0$ (RHS)

So, we can find that it satisfies the equation as LHS = RHS. So, the velocity represents incompressible flow.

Q1) The Poiseuille formula is,

$$\boxed{Q = \frac{\pi \Delta P r^4}{8 \eta l}}$$

As the diameter is same in the daughter tubes,

so, $A_1 u_1 = A_2 u_2 + A_3 u_3$

$$\pi (1)^2 \times 100 = \pi (0.5)^2 u_2 + \pi (0.5)^2 u_3$$

$$\Rightarrow 100\cancel{\pi} = \cancel{\pi} (0.5)^2 (u_2 + u_3)$$

$$\Rightarrow \frac{\cancel{100}^{4} \times 100}{\cancel{5 \times 5}} = u_2 + u_3$$

$$\Rightarrow 400 = u_2 + u_3$$

As, both tubes are identical, we can assume $u_2 = u_3$

So, $u_2 + u_2 = 400$

$$\Rightarrow \boxed{u_2 = 200 = u_3}$$

Average velocity in daughter tubes = 200 cm/s

= 2 m/s