CONCEPT OF CONTROL VOLUME

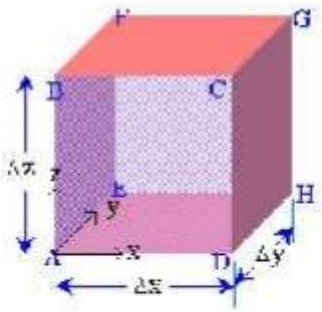
A specified large number of fluid and thermal devices have mass flow in and out of a system called as control volume.

1.CONTINUITY EQUATION

Concepts

The continuity equation is governed from the principle of conservation of mass.It states that the mass of fluid flowing through the pipe at the cross-section remains constants,if there is no fluid is added or removed from the pipe.

Let us make the mass balance for a fluid element as shown below: (an open-faced cube)



Let us denote the sides by with the following corresponding numbers:

x-direction		y-direction		z-direction	
ABFE	1	ABCD	3	AEHD	5
DCGH	2	EFGH	4	BFGC	6

$$\frac{\partial}{\partial x}(\rho v_x) + \frac{\partial}{\partial y}(\rho v_y) + \frac{\partial}{\partial z}(\rho v_z) = -\frac{\partial \rho}{\partial t}$$

This is the continuity equation for every point in a fluid flow whether steady or unsteady , compressible or incompressible.

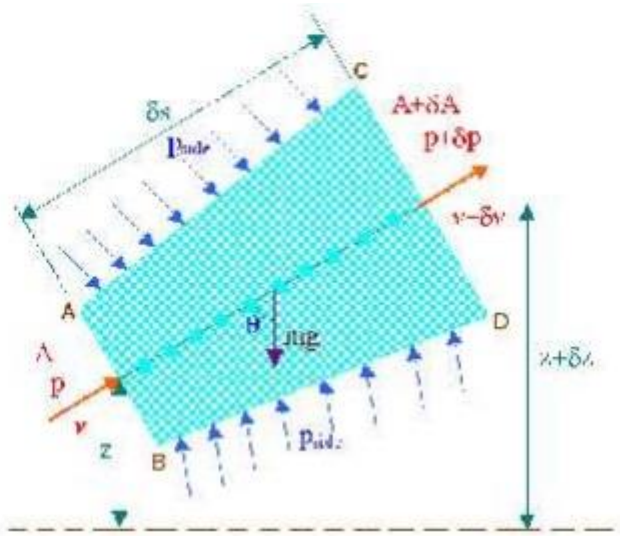
For steady, incompressible flow, the density ρ is constant and the equation simplifies to

$$\frac{\partial v_x}{\partial x} + \frac{\partial v_y}{\partial y} + \frac{\partial v_z}{\partial z} = 0$$

For two dimensional incompressible flow this will simplify still further to

$$\frac{\partial v_x}{\partial x} + \frac{\partial v_y}{\partial y} = 0$$

2 EULER'S EQUATION OF MOTION



$$\frac{1}{\rho}\frac{dp}{ds} + \frac{vdv}{ds} + g\frac{dz}{ds} = 0$$

$$\frac{dp}{\rho} + vdv + gdz = 0$$

This is known as Euler's equation, giving, in differential form the relationship between p, v, ρand elevation z, along a streamline for steady flow.

3 BERNOULLI EQUATION

Concepts

Bernoulli's Equation relates velocity, pressure and elevation changes of a fluid in motion. Itmay be stated as follows " In an ideal incompressible fluid when the flow is steady and

continuous the sum of pressure energy, kinetic energy and potential energy is constant along streamline"

$$\frac{p}{\rho g} + \frac{v^2}{2g} + z = \text{constant} \quad \text{--> 1}$$

This is the basic from of *Bernoulli equation* for steady incompressible inviscid flows. It may be written for any two points 1 and 2 on the same streamline as

$$\frac{p_1}{\rho_1 g} + \frac{v_1^2}{2g} + z_1 = \frac{p_2}{\rho_2 g} + \frac{v_2^2}{2g} + z_2 \quad \text{--> 2}$$

The contstant of Bernoulli equation, can be named as *total head (h_o)* has different values on different streamlines.

$$h_o = \frac{p}{\rho g} + \frac{v^2}{2g} + z \quad \text{--> 3}$$

The total head may be regarded as the sum of the *piezometric head* $h^* = p/\rho g + z$ and the *kinetic head* $v^2/2g$.