3.1 Continuity equation

Continuity equation represents the law of conservation of mass.

In general for unsteady flow the continuity equation is

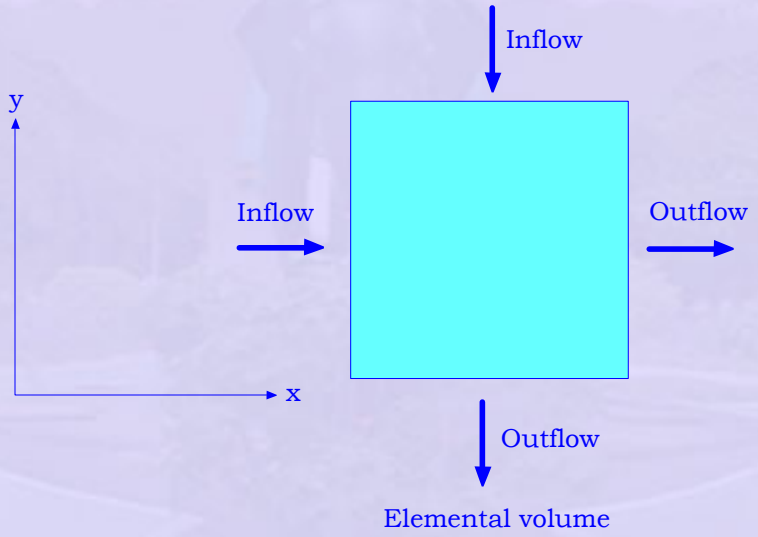
(Mass flow rate into the system) - (Mass flow rate out of the system) = Rate of change of storage.

For steady state condition

(Mass flow rate into the system) - (Mass flow rate out of the system) = 0.

Example: Inflow: The flow that is coming into a system or an elemental volume such as rainfall in y direction, flow entering into the river or a channel.

Outflow: The flow escaping from the system such as evaporation, seepage, water released from a system.



Generally, the mass balance is written in all the three directions namely x, y and z.

$$\frac{\partial \rho u}{\partial x}+\frac{\partial \rho v}{\partial x}+\frac{\partial \rho w}{\partial x}=0$$

in which

u, v and w are the velocity components in x, y, z directions respectively,

ρ is the mass density of the fluid. If the mass density is constant the above equation can be rewritten as

$$\frac{\partial u}{\partial x}+\frac{\partial v}{\partial x}+\frac{\partial w}{\partial x}=0$$

If *v=0, w=0 i.e.,* for one dimensional flow it reduces to

$$\frac{\partial \rho u}{\partial x}=0$$

$$\text{Mass density } \rho=\frac{\text{Mass}}{\text{Volume}}$$

$$\frac{\partial \rho u}{\partial x} * \text{elemental area} = \text{constant}$$

Integrating one gets

UA = constant

$\therefore$ Volume rate could be expressed as m^3/s. This is generally known as flow rate or discharge (Q) and expressed as cubic meter/second and is abbreviated as cumec (m^3/s).

$$Q = \text{Area} * \text{Velocity} = A\bar{V}$$