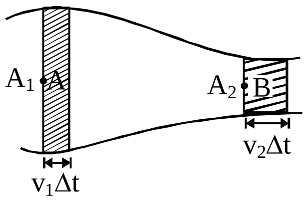
Equation of Continuity

The equation of continuity is derived from the principle of conservation of mass.



A non-viscous liquid in streamline flow passes through a tube *AB* of varying cross section. Let the cross sectional area of the pipe at points *A* and *B* be a_1 and a_2 respectively. Let the liquid enter with normal velocity v_1 at *A* and leave with velocity v_2 at *B*. Let ρ_1 and ρ_2 be the densities of the liquid at point *A* and *B* respectively.

Mass of the liquid entering per second at *A* = Mass of the liquid leaving per second at *B*

$a_1 v_1 \rho_1 = a_2 v_2 \rho_2$ and $A_1 v_1 = A_2 v_2$

[If the liquid is incompressible $\rho_2 = \rho_1$]or $av =$ constant or $a \propto \frac{1}{v}$

This expression is called the equation of continuity for the steady flow of an incompressible and non-viscous liquid.

(1) The velocity of flow is independent of the liquid (assuming the liquid to be non-viscous)

(2) The velocity of flow will increase if cross-section decreases and vice-versa. That is why :

(a) In hilly region, where the river is narrow and shallow (*i.e.*, small cross-section) the water current will be faster, while in plains where the river is wide and deep (*i.e.*, large cross-section) the current will be slower, and so deep water will appear to be still.

(b) When water falls from a tap, the velocity of falling water under the action of gravity will increase with distance from the tap (*i.e*, $v_2 > v_1$). So in accordance with continuity equation the cross section of the water stream will decrease (*i.e.*, $A_2 < A_1$), *i.e.*, the falling stream of water becomes narrower.