

## 12.4: Fluid Flow

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**Definition:** (Ideal Fluid) An **ideal fluid** is one which is incompressible and has no internal friction (viscosity). Most liquids are pretty close to incompressible, and we can ignore their viscosity in most cases.

**Definition:** (Flow Lines)

A **flow line** is the path a particle takes. **Steady flow** is when flow lines don't change.

**Streamlines** are lines which are always tangent to the fluid velocity at every point

A collection of flow lines is called a **flow tube**

**Laminar flow** occurs when adjacent layers of fluid slide past each other.

**Turbulent flow** occurs when there is no steady-state pattern

**Theorem:** (The Continuity Equation) The continuity equation states that at two points in a tube, the following holds:

$$A_1 v_1 = A_2 v_2$$

**Proof:** In steady flow, the mass of a moving fluid can't change. Therefore, at a point, fluid is moving according to

$$ds = v dt$$

over a small time interval  $dt$ . Therefore, a cylinder with cross section  $A$  is moving

$$dV = A ds = A v dt$$

amount of fluid over that interval. Since the fluid's mass can't change and it is incompressible, its volume can't change either, so therefore,  $dV_1 = dV_2$ , and as such,

$$A_1 v_1 = A_2 v_2$$