Pressure

Consider first a small piece of solid surface of area, dA, in contact with a fluid. Then the pressure, p, on that element of surface is the component of fluid-induced force acting normal to the surface divided by the area, dA. A simple way to visualize this is as the time-averaged effect of the collisions of the molecules of the fluid with that surface element. Indeed, by Newtons Law, the pressure is the sum of the normal impulses imposed on the wall by the molecular collisions per unit time and per unit surface area. Alternatively this can be evaluated as the net flux of momentum through and normal to the surface per unit area. For more on the *flux of momentum* the reader is advised to consult that webpage.

The pressure therefore has units of force per unit area, M/LT^2 or N/m^2 or kg/ms^2. A pressure of $1kg/ms^2$ is also called a pascal, $1Pa$. It is useful to remember that atmospheric pressure on the surface of the earth is approximately equal to 10^5Pa or $100kPa$ or $0.1MPa$. The above defines pressure at a solid bounding surface. This definition can be extended to any point within the body of the fluid as follows. Consider a small, imaginary piece of surface of area, dA, at any point within the fluid. Then the pressure on that imaginary surface can be defined as the net flux of fluid momentum through and normal to the surface per unit area. In a crude way it can be visualized as the normal force per unit area acting on a solid surface that might be placed in the body of the fluid (though one would have to assume in this thought experiment that the imaginary surface did not alter the characteristic motions of the molecules). In general as defined above, the pressure at any point in a fluid could differ depending on the orientation of the surface area, dA, since the molecular motions may be non-isotropic, that is to say not the same in all directions at the point under consideration. Under these circumstances we define a *normal stress* vector that is a function of both direction and location within the fluid. However, in a simple fluid at rest the random molecular motions are commonly isotropic and therefore the net flux of momentum at a point in the fluid is the same in all directions. Under such circumstances the pressure is independent of the direction at a given location and is then simply a scalar function of position within the fluid. How the pressure varies from point to point within a fluid is the subject of fluid statics.