Basic equations of fluid statics

Science, Physics



Basic equations of fluid statics ||||||||||||||||||| An equation representing pressure field P = P(x, y, z) within fluid at rest is derived in this section. Since the fluid is at rest, we can define the pressure field in terms of space dimensions (x, y and z) only. Consider a fluid element of rectangular parellopiped shape(Fig : L - 7. 1) within a large fluid region which is at rest. The forces acting on the element are body and surface forces. || Body force : The body force due to gravity is L -

7. 1 where is the volume of the element. Surface force : The pressure at the center of the element is assumed to be P (x, y, z). Using Taylor series expansion the pressure at point on the surface can be expressed as
L -7. 2 When , only the first two terms become significant. The above equation becomes
L - 7. 3 Similarly, pressures at the center of all the faces can be derived in terms of P (x, y, z) and its gradient. Note that surface areas of the faces are very small. The

center pressure of the face represents the average pressure on that face. The surface force acting on the element in the y-direction is

L -7. 4 Similarly the surface forces on the other two directions (x and z) will be The surface force which is the vectorical sum of the force scalar components L - 7. 5 The total force acting on the fluid is L - 7. 6 The total force per unit volume is For a static fluid, dF= 0.

gravity is expressed as , the components of Eq(L- 7. 8) in the x, y and z directions are The above equations are the basic equation for a fluid at rest. Simplifications of the Basic Equations If

L-7.7

If acceleration due to

Then.

the gravity is aligned with one of the co-ordinate axis, for example z- axis, then The component equations are reduced to L -7. 9 Under this assumption, the pressure P depends on z only. Therefore, total derivative can be used instead of the partial derivative.

L - 7. 10 | | | | | | | | | | | | | This simplification is valid under the following restrictions a. Static fluid b. Gravity is the only body force. c. The z-axis is vertical and upward. | | |