FLUID STATISTICS

Fluid statics is the branch of fluid mechanics that studies incompressible fluids at rest. It encompasses the study of the conditions under which fluids are at rest in stable equilibrium as opposed to fluid dynamics, the study of fluids in motion

Prelude to Fluid Statics

What exactly is a fluid? Can we understand fluids with the laws already presented, or will new laws emerge from their study? The physical characteristics of static or stationary fluids and some of the laws that govern their behavior are the topics of this chapter.

What Is a Fluid?

A fluid is a state of matter that yields to sideways or shearing forces. Liquids and gases are both fluids. Fluid statics is the physics of stationary fluids.

Density

Density, as you will see, is an important characteristic of substances. It is crucial, for example, in determining whether an object sinks or floats in a fluid. Density is the mass per unit volume of a substance or object.

Pressure

Pressure is the force per unit perpendicular area over which the force is applied. In equation form, pressure is defined as F=PA. The SI unit of pressure is pascal and 1\, Pa = 1 \space N/m^2.

Variation of Pressure with Depth in a Fluid

Pressure is the weight of the fluid mg divided by the area A supporting it (the area of the bottom of the container): P = \dfrac{mg}{A}. \nonumber Pressure due to the weight of a liquid is given by P = h\rho g, \nonumber where P is the pressure, h is the height of the liquid, \rho is the density of the liquid, and g is the acceleration due to the gravity.

Pascal's Principle

Pressure is force per unit area. A change in pressure applied to an enclosed fluid is transmitted undiminished to all portions of the fluid and to the walls of its container. A hydraulic system is an enclosed fluid system used to exert forces. Since atoms in a fluid are free to move about in an enclosed fluid, they transmit the pressure to all parts of the fluid and to the walls of the container. Remarkably, the pressure is transmitted undiminished. This phenomenon is called Pascal's principle.

Gauge Pressure, Absolute Pressure, and Pressure Measurement

Gauge pressure is the pressure relative to atmospheric pressure. Absolute pressure is the sum of gauge pressure and atmospheric pressure. Aneroid gauge measures pressure using a bellows-and-spring arrangement connected to the pointer of a calibrated scale. Open-tube manometers have U-shaped tubes and one end is always open. It is used to measure pressure. A mercury barometer is a device that measures atmospheric pressure.

Archimedes' Principle

Buoyant force is the net upward force on any object in any fluid. If the buoyant force is greater than the object's weight, the object will rise to the surface and float. If the buoyant force is less than the object's weight, the object will sink. If the buoyant force equals the object's weight, the object will remain suspended at that depth. The buoyant force is always present whether the object floats, sinks, or is suspended in a fluid. Archimedes' principle states that the buoyant force on an

Cohesion and Adhesion in Liquids – Surface Tension and Capillary Action

Attractive forces between molecules of the same type are called cohesive forces. Attractive forces between molecules of different types are called adhesive forces. Cohesive forces between molecules cause the surface of a liquid to contract to the smallest possible surface area. This general effect is called surface tension. Capillary action is the tendency of a fluid to be raised or suppressed in a narrow tube, or capillary tube which is due to relative strengths of cohesive and adhesive forces.

Pressures in the Body

Measuring blood pressure is among the most common of all medical examinations. The pressures in various parts of the body can be measured and often provide valuable medical indicators. The shape of the eye is maintained by fluid pressure, called intraocular pressure. When the circulation of fluid in the eye is blocked, it can lead to a buildup in pressure, a condition called glaucoma. Some of the other pressures in the body are spinal and skull pressures, bladder pressure, pressures in the skeleton

Kinematics of Fluids

knematics is one of the branches of fluid mechanics in which we study the different parameters of the fluid flows without their causing parameters. Fluid kinematics analyzes the fluid particle's motion without analyzing the motion-causing forces.

Kinematics:

In the field of mechanics, kinematics refers to describing the motion of an object without being concerned with the forces that cause the object to be in motion (such as gravity or friction). Therefore, kinematics is specifically concerned with measurements such as the velocity or displacement of an object.

Fluid kinematics is a branch of mechanics that is concerned with the movement/motion of fluids (such as water). Just like the general field of kinematics, fluid kinematics is concerned primarily with the movement of a fluid, not the forces that cause the movement of the fluid. For example, fluid kinematics would be concerned with measuring the velocity of a fluid traveling through a metal pipe. It should be noted that fluid kinematics can also be applied to materials that are not necessarily fluids, but have fluid-like properties, such as the grains of sand flowing through an hour glass.

Fluid flow

Fluid Flow is a part of fluid mechanics and deals with fluid dynamics. It involves the motion of a fluid subjected to unbalanced forces. This motion continues as long as unbalanced forces are applied.

Types of Fluids

Ideal fluid

A fluid is said to be ideal when it cannot be compressed and the viscosity doesn't fall in the category of an ideal fluid. It is an imaginary fluid which doesn't exist in reality.

Real fluid

All the fluids are real as all the fluids possess viscosity.

Newtonian fluid

When the fluid obeys Newton's law of viscosity, it is known as a Newtonian fluid.

Non-Newtonian fluid

When the fluid doesn't obey Newton's law of viscosity, it is known as Non-Newtonian fluid.

Ideal plastic fluid

When the shear stress is proportional to the velocity gradient and shear stress is more than the yield value, it is known as ideal plastic fluid.

Incompressible fluid

When the density of the fluid doesn't change with the application of external force, it is known as an incompressible fluid.

Compressible fluid

When the density of the fluid changes with the application of external force, it is known as compressible fluid.