FIELD: ENGINEERING-CIVIL ENGINEERING

## 1. FLUID STATICS.

Fluid statics is the part of fluid mechanics that deals with fluids when there is no relative motion between the fluid particles, the pressure can be transmitted by statics.

Similarly, In Archimedes point of view, it can be explained that a buoyant object is the same as the displaced liquids weight.

According to Pascals principle

The fluid can either be gaseous or liquid.

- ❖ Hydrostatics: When the fluid is a liquid.
- ❖ Aerostatics: When the fluid is a gas.

CHARACTERISTICS OF FLUID STATICS.

- Compressibility:

It is a measure of the relative volume change of a solid or a fluid in response to a pressure change. For a given mass of fluid, an increase in pressure will cause a decrease in volume.

- Pressure:

A measurement of the force per unit area that acts on an object in a fluid or an enclosed containers surface. The acceleration of this pressure is due to gravity or by forces that are outside the enclosed container.

- Buoyancy:

It is an upward force exerted by a fluid on an immersed object in a gravity field.

In fluids, pressure increases with depth. Hence when an object is immersed in a fluid, the pressure exerted on the bottom surface is higher than the pressure exerted on its top surface.

- Viscosity:

It is the measure of a fluid's resistance to flow. It describes the internal friction of moving fluid. A fluid with large viscosity resists motion because its molecular makeup gives it a lot of internal friction.

- Surface tension:

It is the tendency of liquid surface at rest to shrink into the minimum surface area possible.

It is what allows objects with a higher density than water such as razor blades and insects to float on a water surface without becoming even partly submerged. Surface tension of a liquid depends on temperature, intermolecular forces, pressure and viscosity.

DEALING FACTORS OF FLUID STATISTICS.

- ✓ Mass Density.

I. It refers to the volume of an object: depends on the weight of individual atoms or molecules which build an object. Solids are 2o times larger than liquids, whereas the gases are equal with water density

- ✓ Intensity of pressure.

I. It is the force exerted on a unit area. The intensity of pressure at any point in a liquid is directly proportional to the depth of the liquid from the surface.

II. The pressure intensity at a point in a fluid is the same in all directions only when the fluid has no relative motion between adjacent fluid layers.

- ✓ Friction between fluid molecules.

I. Fluid friction is a force that restricts the movement either within itself or for another medium moving through the liquid.

II. Due to the movement of the molecules inside the fluid, internal friction occurs and how the fluid interacts with the matter, external conflict occurs.

In fluid statics there is no relative motion between adjacent fluid layers and thus there are no shear(tangential) stresses in the fluid trying to deform it.

The only stress dealt with in fluid statics is the normal stress which is the pressure and the variation of pressure is due only to weight of the fluid.

In this fluid, there is relative motion between adjacent or neighbouring fluid layers.

No shear force present force as the fluid particles do not move respect to one another.

The velocity gradient is equal to zero.

$$\text{Velocity gradient} = \frac{\text{change of velocity between two adjacent layers}}{\text{Distance between two layers}}$$

$$= \frac{du}{dy} = 0$$

Significance of fluid statics in gravity fields.

- ➢ The design of many engineering systems such as water dams and liquid storage tanks requires the determination of the forces acting to the surfaces using fluid statics. Which remains the same

Conclusion: Depending on pressure measurement, fluid statics refers to the calculation of pressure at any point which remains the same.

On the othe4 hand it describes the pressure at the vessel wall which is perpendicular. It explains the mathematical measurement of substance.

At greater depths, a fluid exerts more pressure.

## 2. KINEMATICS OF FLUID.

Fluid kinematics is the study of fluid motion without taking into account the forces that cause it.

The study of kinematics is often refereed to as the geometry of motion.

Types of fluid flow;

Laminar/turbulent flows:

| Laminar flow | Turbulent flow |
|---|---|
| It is the flow in which the adjacent layers do not cross each other and move along well-defined path. | It is the flow in which adjacent layers cross each other and do not move along well-defined path. |

Steady/unsteady flow:

| Steady flow | Unsteady flow |
|---|---|
| It is the flow in which characteristics of fluid like velocity, pressure, density at a point do not change with time. | If velocity pressure and density changes with time then the flow is unsteady. |

Uniform/non-uniform flow:

| Uniform flow | Non-uniform flow |
|---|---|
| The flow in which the velocity at any given time does not change with respect to distance. | In this flow, velocity at any given time changes with respect to distance |

Rational/Irrotational flows:

| Rotational flow | Irrotational flow |
|---|---|
| I f the fluid particles flowing alone stream lines, also rotate about their own axes, then flow is rotational. | If fluid particles do not rotate about their own axes, then flow is irrotational |

Different flow pattern.

Three fluid element trajectories are:

- Streamlines.
- Pathlines.
- Streaklines.

These flow patterns depend on the fluid particles motion.

Pathline: It is the actual path travelled by an individual fluid particle over some time period. The pathline of a fluid element A is simply the path it takes through space as a function of time. E.g., is trajectory taken by one puff of smoke carried by the steady or unsteady wind.

A streamline: It is a line that is everywhere tangent to the velocity field. They are obtained analytically by integrating the equations defining lines tangent to the velocity field.

Streakline: Is the locus of particles earlier passed through a prescribed point. It is associated with a particular point P in space with fluid moving past it. All points which pass through this point are said to form a streakline of point P. E.g. Is a continuous line of smoke emitted by a chimney at point P, which will have some curved shape if the wind has a time-varying direction.

APPLICATIONS OF FLUID KINEMATICS MECHANICS IN PRACTICAL LIFE ENGINEERING PROJECTS.

- ❖ Refrigerators and Air Conditioners.

The fluids used in refrigerators and air conditioners are known as refrigerants.

They absorb the heat from the evaporator which is at low temperature and distributes that heat to the atmosphere which is at a high temperature.

In air conditioners the refrigerant absorbs room heat and throws it in the atmosphere keeping the room cool.

- ❖ Airflight.

One of the most ordinary applications of Bernoulli's principle is airflight. The airplane wing is curved from the top and flat from the bottom.

While moving in the sky, the air on the bottom moves slowly and builds more pressure on the bottom and allows the air on the top to move faster, which build less pressure.

This creates lift which allows planes to fly. An airplane is also acted upon by a pull of gravity in which faces lift, drag and thrust. Thrust is the force that allows the airplane to move forward while drag is air resistance that opposes the thrust force.

- ❖ Sailing.

Sail boats have two parts: a sail which points north and a keel which points on the opposite direction.

When the wind movements are on one side, it fills the sail while the air flowing on the other side is moving faster and cannot push as hard and thus the sail receives a force which i9s perpendicular to the direction of the wind.

Usually, it doesn't push the boat against the wind but the keel of the boat again resists much of the horizontal movement so that the boat only moves in the forward direction, providing that the combined forces that are pushing the boat perpendicular to the wind are greater than the force of the wind pushing the entire boat and sails backwards.