Fluid Statics

Paolo Bettelini

Contents

1 Hydrostatic Pressure

Pressure is defined as

$$P = \frac{F}{A}$$

Where F is a force acting on an area A.

The hydrostatic pressure is given by

$$\begin{aligned} P &= \frac{F_g}{A} = \frac{A \cdot h \cdot \rho \cdot g}{A} \\ &= \rho \cdot h \cdot g \end{aligned}$$

This means that the pressure of a fluid doesn't depend on the area.

2 Stevin's law

Stevin's law states that the pressure at any point in a resting fluid is only proportional to the depth of that point.

$$P = P_0 + \rho \cdot g \cdot h$$

where P_0 is the external pressure (pressure at the surface).

3 Pascal's Principle

Pascal's Principle states that a pressure change in one part is transmitted without loss to every portion of the fluid and walls of the container.

4 Archimede's Law

4.1 Definition

Archimedes' principle states that «every body partially or completely immersed in a fluid receives a vertical thrust from the bottom upwards, equal in intensity to the weight of the displaced fluid».

The intensity of the force is given by

$$F = \rho_{\text{fluid}} \cdot g \cdot V_{\text{body}}$$

The force is the same no matter the shape of the body.

4.2 Accelleration

An object dropped in a fluid will sink or float up depending on its density and the density of the fluid. The body will move with the following accelleration

$$\begin{aligned} F &= F_g - F_{\text{Archimede}} \\ &= gm - \rho_{\text{fluid}} V_{\text{body}} g \\ &= gm - \rho_{\text{fluid}} \frac{m}{\rho_{\text{body}}} g \\ ma &= m\left(g - \frac{\rho_{\text{fluid}} g}{\rho_{\text{body}}}\right) \\ a &= \frac{g\rho_{\text{body}}}{\rho_{\text{body}}} - \frac{g\rho_{\text{fluid}}}{\rho_{\text{body}}} \\ &= \frac{\rho_{\text{body}} - \rho_{\text{fluid}}}{\rho_{\text{body}}} g \end{aligned}$$

where m is the mass of the body.

A submerged body will

$$\begin{cases} \text{if } \rho_{\text{body}} < \rho_{\text{fluid}}, & \text{float up} \\ \text{if } \rho_{\text{body}} = \rho_{\text{fluid}}, & \text{float} \\ \text{if } \rho_{\text{body}} > \rho_{\text{fluid}}, & \text{sink} \end{cases}$$