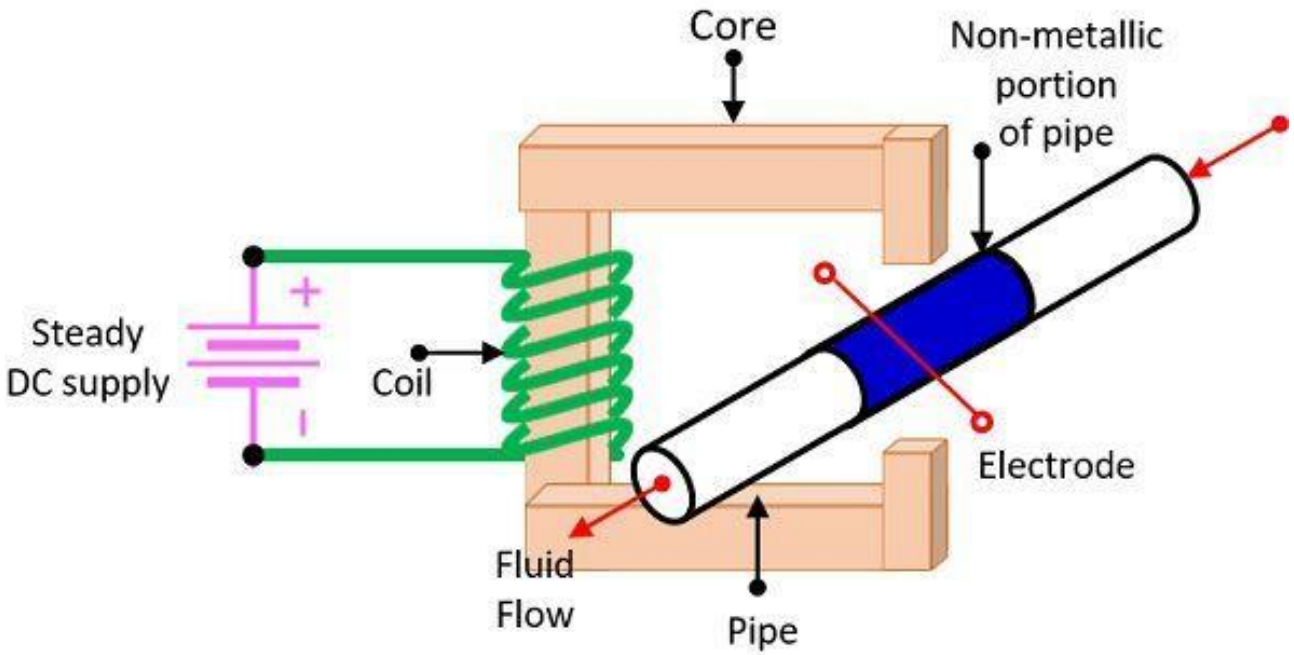
Flow Measurement- **Electromagnetic Flow meter**

- The electromagnetic flow meter is a device used for measuring the flow of the liquid when it passes through the pipeline.
- Or we can say that the electromagnetic flowmeter use for measuring the flow rate of the electrically conducting fluid.
- Slurries, sludges
- The electrically conductive liquid means the liquid allows the current to pass through it.

Working Principle of Electromagnetic Flow Meter

- The electromagnetic flowmeter works on the principle of Faraday's Law of electromagnetic induction.
- This law states that when the conductive liquid passes through the magnetic field, the voltage induces across the conductor.
- The magnitude of the voltage is directly proportional to the velocity, length of the conductor and the strength of the magnetic field

Construction of Electromagnetic Flow Meter/ Mag Flow Volumetric flow



- The electromagnet is placed around the insulated pipe.
- This electromagnet induces the magnetic field around the pipe.
- The arrangement is similar to the conductor moving in the magnetic field.
- The voltage is induced across the coil because of the flow of the liquid.
- The induces voltage is expressed as,

$$V = Blv$$

- Where, v – velocity of conductor (flow); m/s
- l – length of conductor (pipe diameter)
- B = flux X density ; wb/m2

- If the magnetic field around the pipe remains constant than the generating voltage is proportional to the velocity of the fluid.

Advantages of Electromagnetic Flow Meter

1. The output voltage of the electromagnetic flow meter is proportional to the flow rate of the liquid.
2. The output is uninfluenced by the varying characteristic of liquid like viscosity, pressure, temperature etc.
3. The electromagnetic flow meter can measure the flow of slurries, greasy, and can handle the corrosive fluid liquids.
4. It is used as a bidirectional meter.
5. The extremely low flow rate can also be measured by the electromagnetic flow meter.

4. No obstruction to flow

5. No pressure head loss

6. Electric power requirement is less

Disadvantages of Electromagnetic Flow Meter

1.The electromagnetic flow meter has low accuracy.

2.It is heavy and extremely large in size.

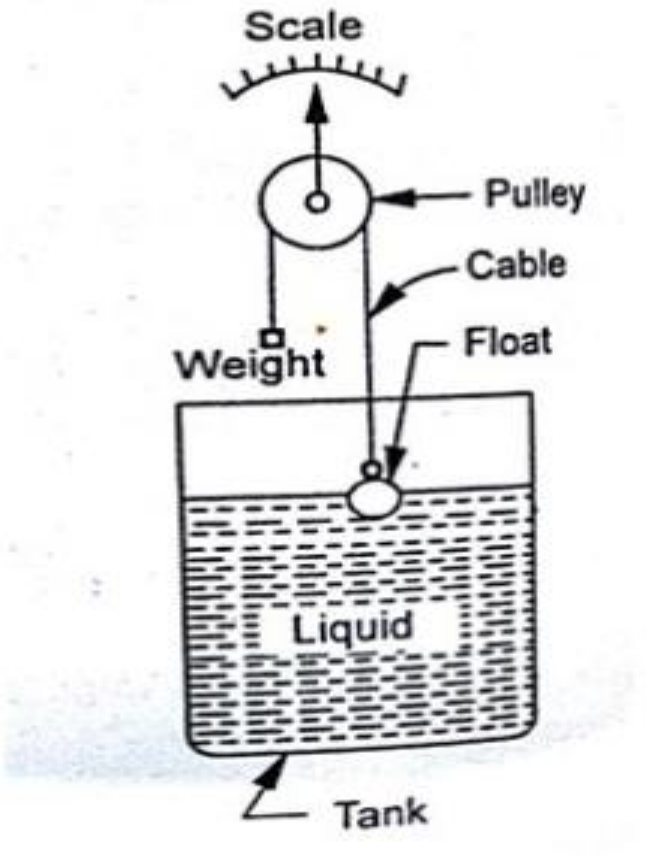
3. Fluids should have reasonable electric conductivity

4.Expensive

LEVEL MEASURMENT

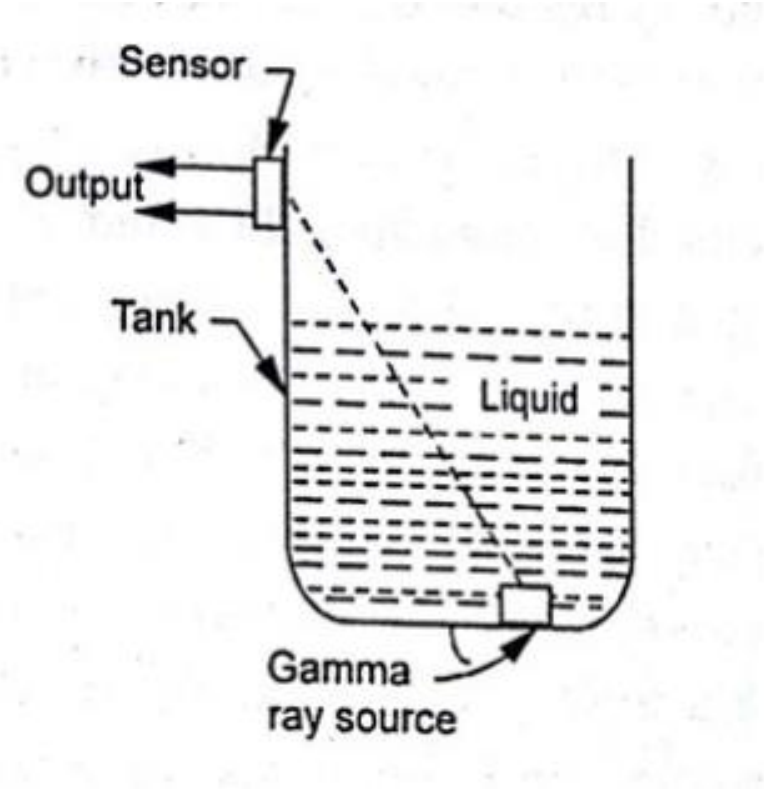
- Hight of the liquid inside a tank
- Direct measurement- Float type
- Indirect measurement- hydrostatic pressure measurement

Float type level measurement system



- Float devices use the buoyancy of a float to indicate the liquid level in the tank.
- One common approach is to attach the float to a cable. The chain is attached to a counterweight which indicates the level as the float moves up and down.
- Float- spherical or cylindrical
- Density of float material should be less than that of the liw=quid
- Non corrosive
- Synthetic, metallic, ceramic

Level measurement- Gamma Rays



- Gamma ray source is placed at the bottom of the tank
- It is continuously producing gamma rays
- Sensor- Gieger Muller tube -- analyses the density of gamma rays received

Placed outside the tank near the top of the tank

- As the liquid level changes, the intensity of the gamma rays changes
- For empty tank-high intensity
- As the level increases intensity decreases
- GM tube measures the intensity and liquid level is evaluated
- The output of GM tube is inversely proportional to the liquid level
- Output-Pulses-Counter-calibrated in terms of liquid level

Ultrasonic type Level measurement

- Direct method
- Ultra sonic Sound waves for level measurement

20kHz to 200kHz

Ultrasonic transmitter receiver placed on the top of the tank

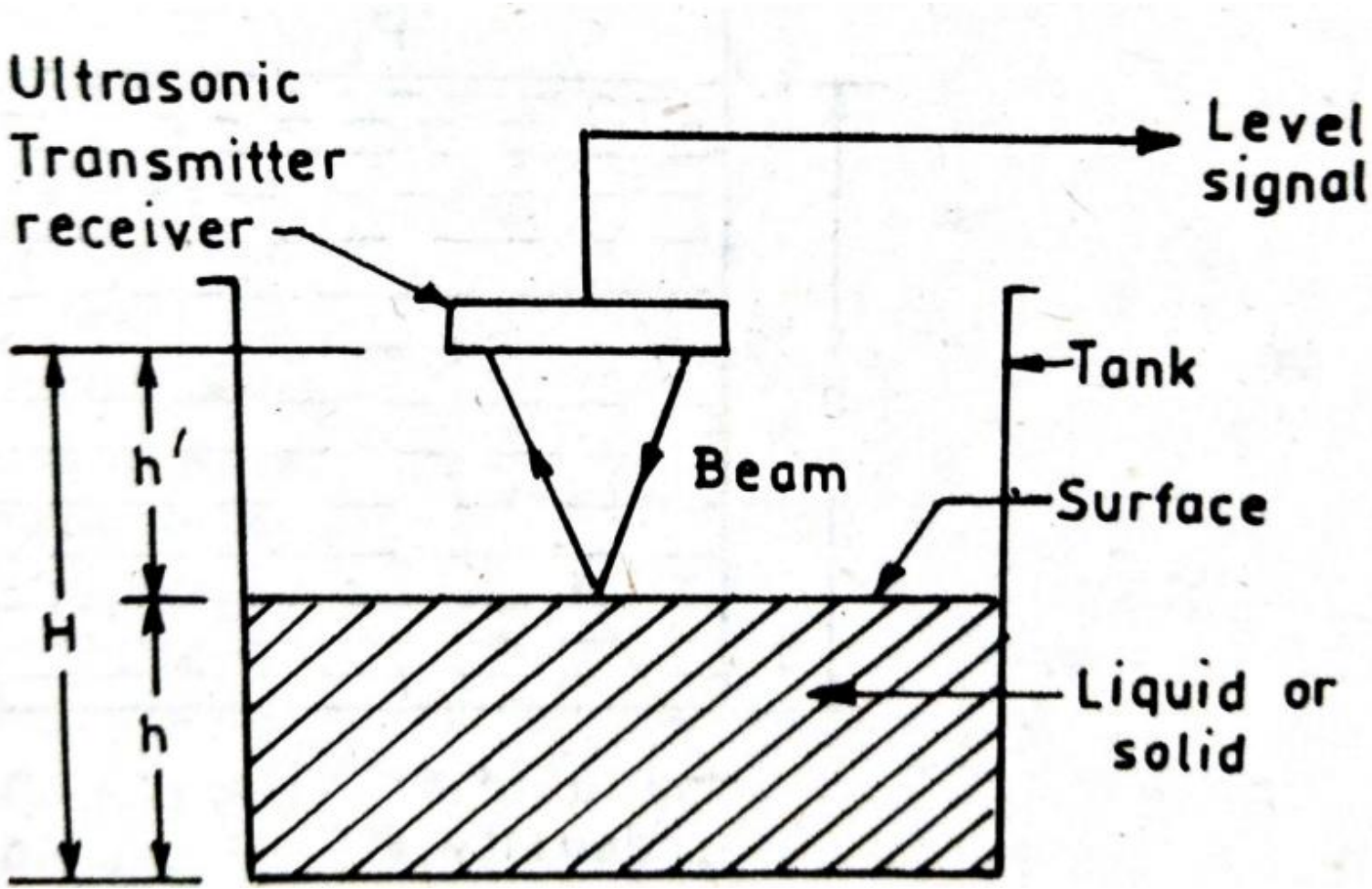
The beam is projected downwards by the transmitter and is reflected back by the surface of liquid contained in the tank

The reflected beam is received by the receiver

The time taken by the beam is a measure of the distance travelled by the beam

The time t between transmitting and receiving a pressure pulse is proportional to the distance h' between the ultrasonic set and the surface of liquid. $t \propto h' \propto (H - h)$

Since the distance H between the ultrasonic set and bottom of the tank is fixed, t is a measure of level h


Ultrasonic
Transmitter
receiver
Level
signal
Tank
Beam
Surface
h'
H
h
Liquid or
solid

Hydrostatic Pressure head-level measurement

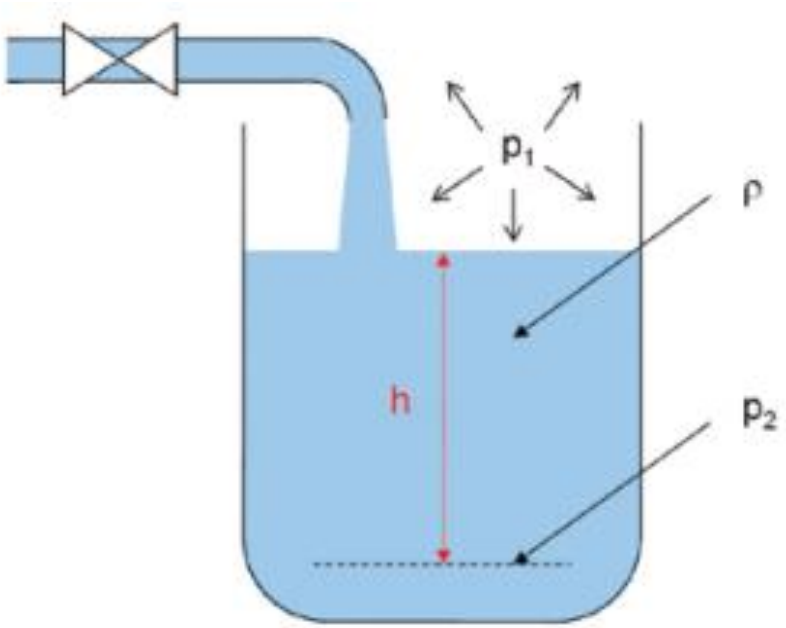
- Hydrostatic level sensors provide continuous measurement of liquids in tanks and vessels by measuring the pressure.
- These level sensors are used for level measurement of water, oil and chemicals in industrial applications and processes.
- Hydrostatic level sensors measure the hydrostatic pressure which is proportional to the measured liquid height.
- Consisting of a pressure measuring cell, the stainless steel or other material diaphragm of the sensor reacts to changes in level.
- The force exerted by the diaphragm is converted by the level sensor into an analog electrical output signal.

- The relationship between the height h of the liquid and the hydrostatic pressure P in a liquid at rest and at atmospheric pressure, can be written as follows:

$P = \rho gh$

- g = 9.81 m/s 2 , constant, the Earth's acceleration of gravity (at sea level)
- ρ = density of the liquid
- h = height of the liquid

- The pressure measured by the transmitter is proportional to the liquid column.
- Open tank



Formula:

$h = p_2 / (\rho * g)$

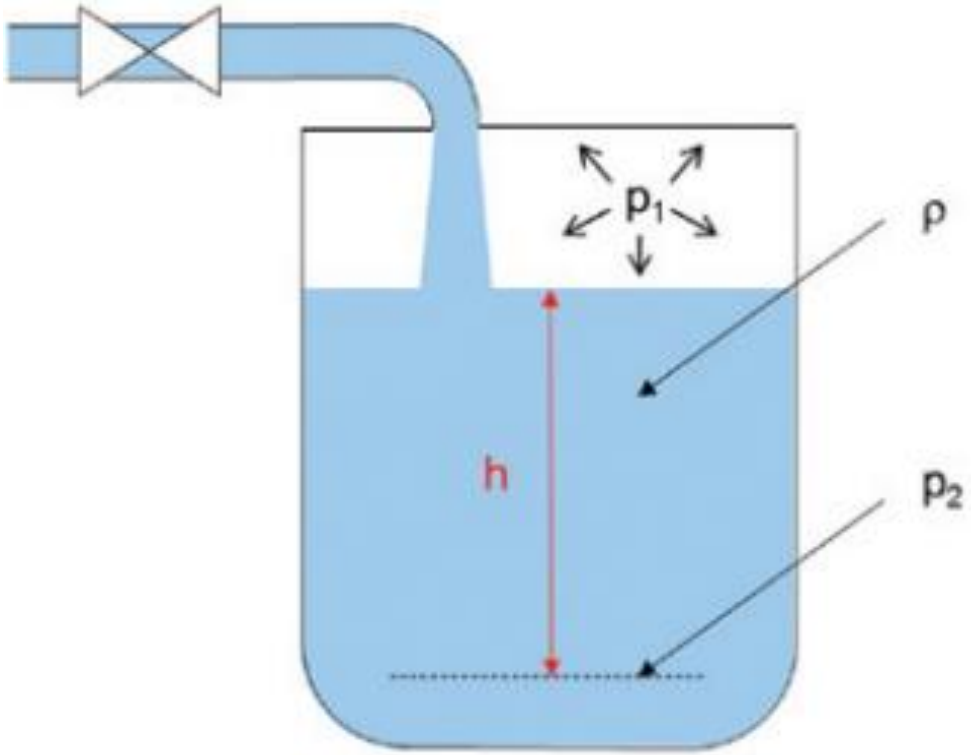
h Filling height / Filling level

p_1 Ambient pressure

p_2 Pressure at depth h

ρ Density of the liquid

Closed tank



Formula:

$h = (p_2 - p_1) / (\rho * g)$

h Filling height / Filling level

p_1 Pressure at the surface

p_2 Pressure at depth h

ρ Density of the liquid