

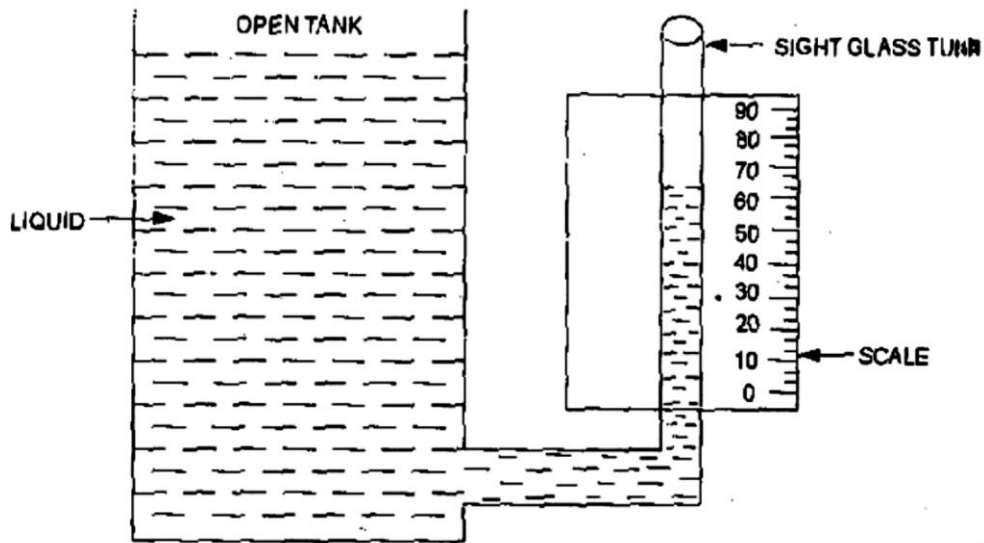
# IoT 4211: Sensor Technology

## Level Measurement

# Level Measurement

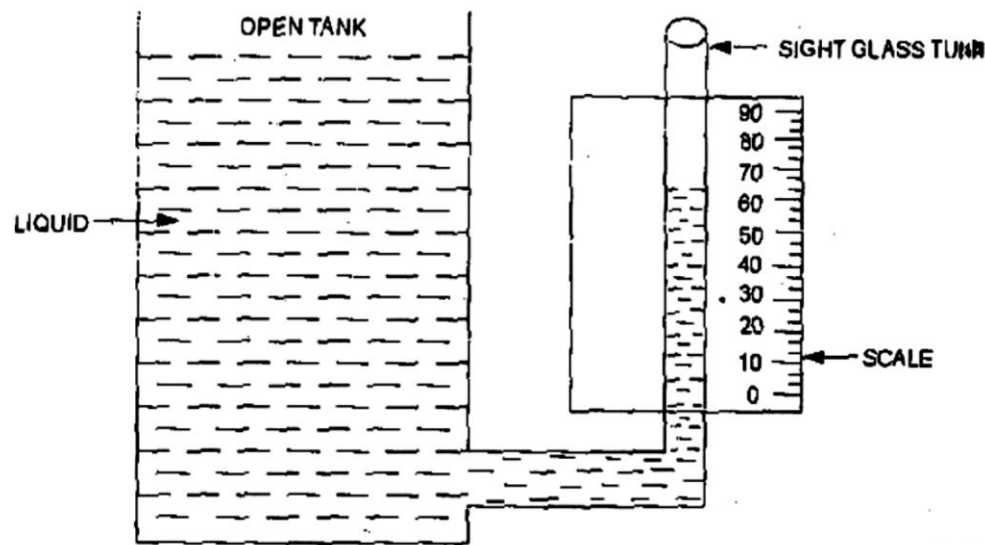
- The liquid level is expressed in terms of liquid length in the liquid column or in terms of pressure the liquid exerts on a datum level.
- It is important to measure liquid content in pressure vessels, reservoirs, tanks, level in fuel tanks or aircrafts and liquid column height in open channel stream.

# Sight Glass



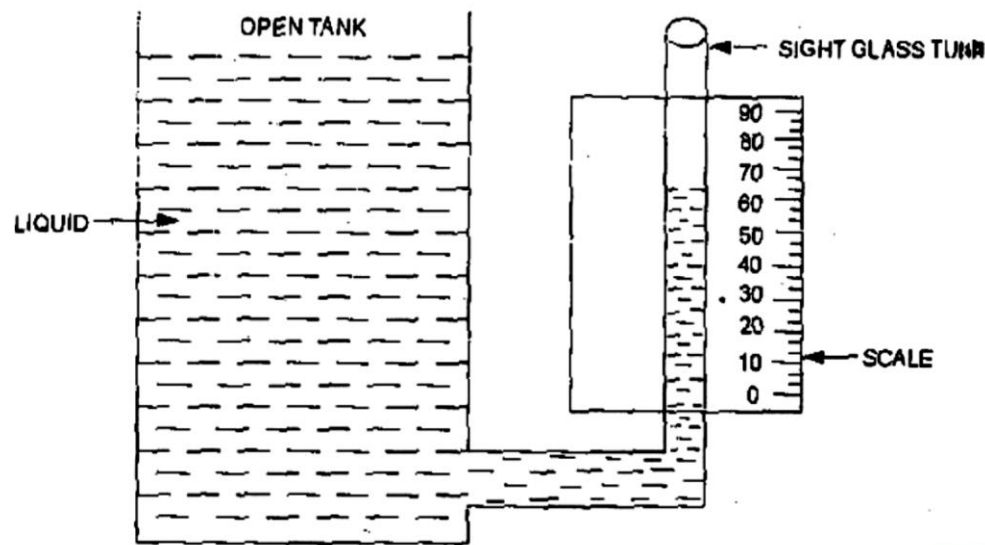
- A sight glass is used for continuous indication of liquid level within a tank or vessel.
- It consists of a graduated tube of toughened glass, which is connected to the interior of the tank at the bottom in which the liquid level is required.
- When level of the liquid in the tank rises and falls, level in the sight glass rises and falls accordingly due to pressure variation.
- The length of the tube is generally not more than 900 mm.
- It can withstand 350 psi of steam pressure at 252°C or 1000 psi of liquid pressure.
- Special design is available for use up to 316°C and 10,000 psi.

# Advantages of Sight Glass



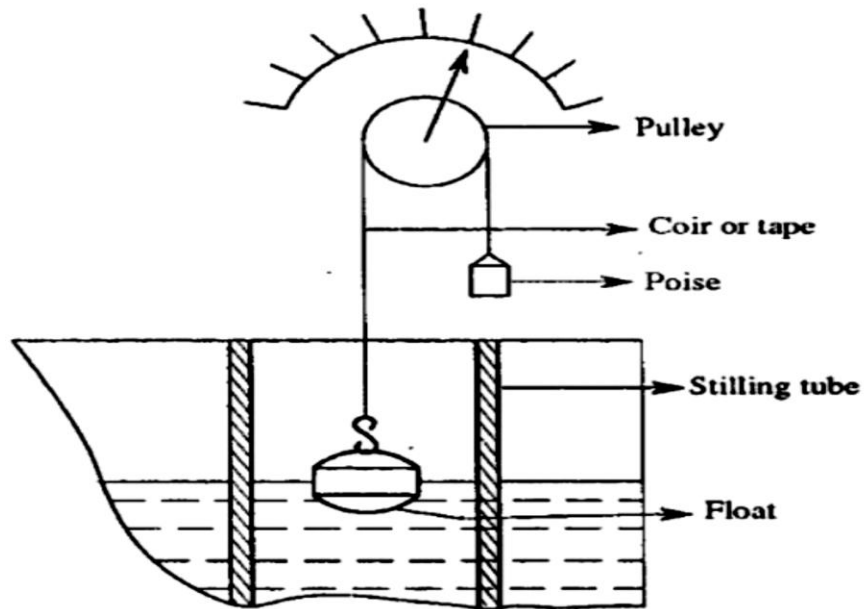
- Direct reading is possible.
- Glass less designs are available in numerous materials for corrosion resistance.

# Disadvantages of Sight Glass



- Readings are noted where the glass is located, which is **not always convenient**.
- **Heavy viscous liquid or liquid containing materials clog the tube**. Hence, level cannot be measured satisfactorily.
- Accuracy and readability depends on **cleanliness** of the glass and fluid.

# Float-and-Cable



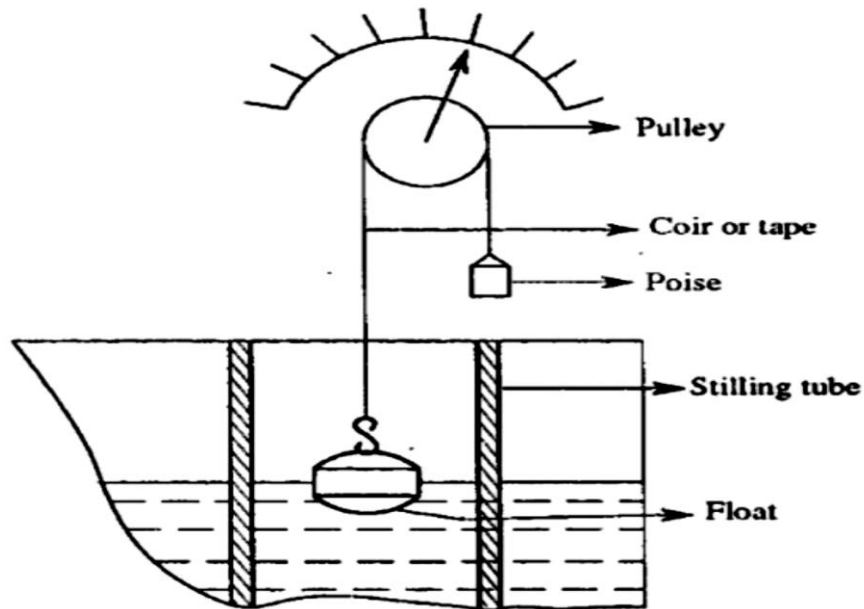
**Float:** A **buoyant object** (usually made from materials like plastic or metal) that floats on the liquid surface. The float rises and falls with the liquid level.

**Cable or Chain:** The float is connected to a cable or chain that runs through a pulley system or an arm connected to a counterweight. As the liquid level changes, the movement of the float is translated into vertical movement along the cable.

**Pulley or Measuring Device:** The cable typically passes over a pulley, which is connected to a level indicator or measuring device. As the float moves up or down, the pulley rotates, allowing the system to gauge the liquid level accurately.

**Counterweight:** In some setups, a counterweight is attached to the other end of the cable to keep the system stable and balanced, ensuring that the float stays on the liquid surface.

# Advantages of Float-and-Cable



- Economical.
- Reliable design.
- It is possible to read the liquid level in tanks below the ground level.
- Operated at large temperature ranges.

# Disadvantages of Float-and-Cable

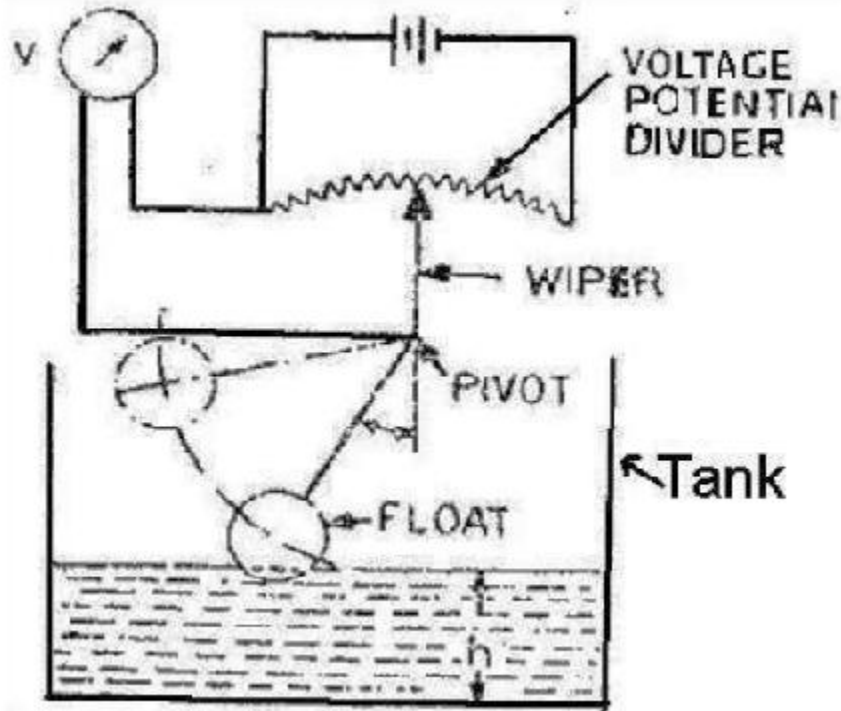
- Over time, mechanical parts like the cable, pulley, and float can **wear out**, especially in tanks with aggressive liquids or high particulate matter. This requires **regular maintenance** to ensure accuracy..
- The float and cable method may not provide the high precision of electronic or ultrasonic sensors, making it unsuitable for applications requiring very fine level measurements.
- The float may be affected by the properties of the liquid (e.g., viscosity, density, or surface tension), potentially impacting accuracy. For example, liquids with high viscosity or floating debris can cause the float to get stuck or produce inaccurate readings.
- This method typically requires **periodic checks and maintenance** to ensure reliable operation, especially in environments where debris or particles may build up and interfere with the float or cable.



# Resistive type level indicator

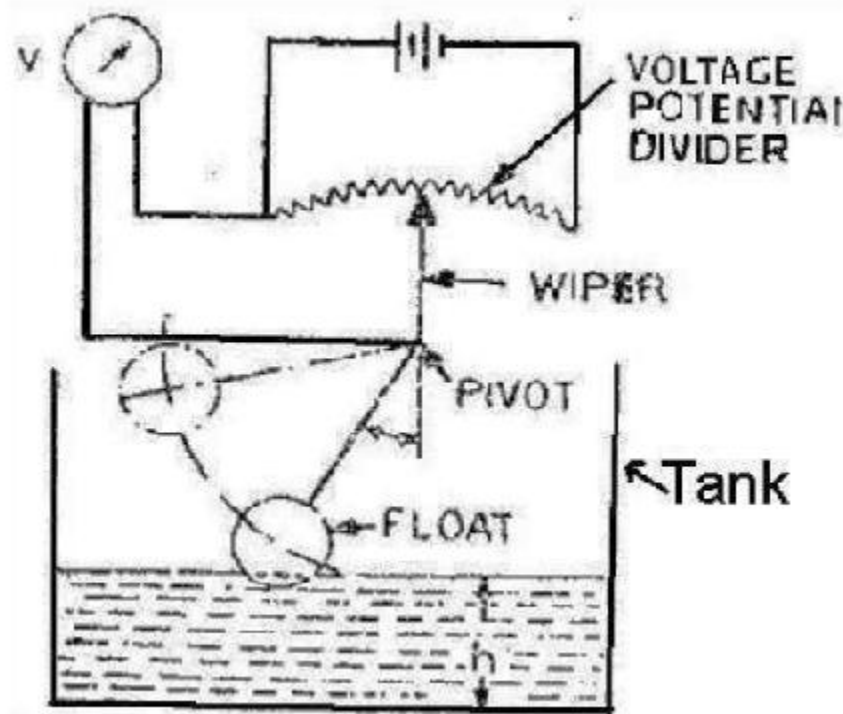
A **resistive type level indicator** is a device used to measure the level of liquid in a tank or container based on **changes in electrical resistance**. This type of level indicator is commonly used in applications such as fuel tanks, water reservoirs, and other liquid storage systems. The basic working principle is that the resistance changes as the liquid level varies, which is then translated into a measurable signal representing the liquid level.

# Resistive type level indicator



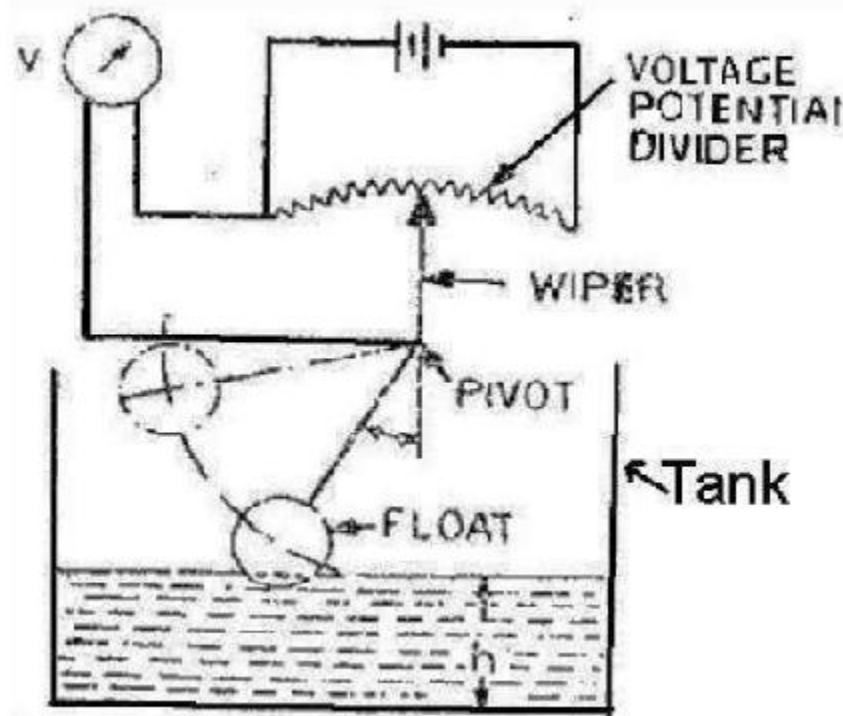
- **Resistive Sensing Element:** The sensing element consists of a series of resistive segments or a resistive wire that is partially or fully submerged in the liquid. As the liquid level changes, the submerged length of the resistor also changes, affecting the overall resistance.
- **Float Mechanism:** Many resistive level indicators use a float connected to a variable resistor. The float moves up and down with the liquid level, adjusting the position of a contact (known as a wiper) on a resistive track.
- **Electrical Circuit:** The device is integrated into an electrical circuit that measures the resistance value, which varies with the liquid level. This resistance change is then converted into an output voltage or current signal that correlates to the level of the liquid.

# Advantages of Resistive type level indicator



- Continuous record of level is possible.
- Signal can be transmitted to any desired point.
- Can be used in pressurized containers without packing glands or shafts.
- Simple to calibrate.

# Disadvantages of Resistive type level indicator

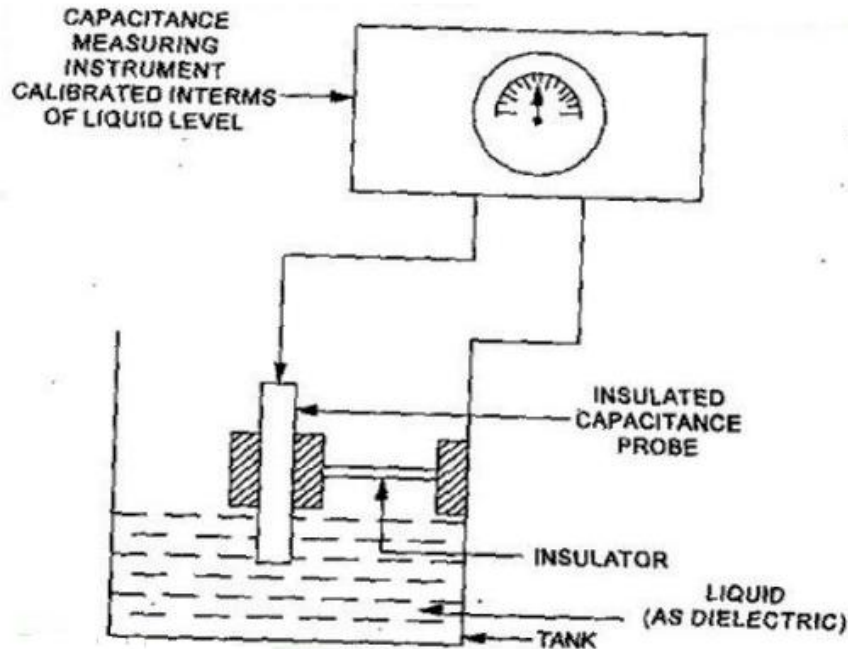


- Resistive sensors are generally better suited for non-corrosive liquids, as **conductive or corrosive liquids can damage the resistive elements.**
- Resistance can be **affected by temperature changes**, which may lead to inaccuracies in high-temperature environments.
- Moving parts, such as the float and wiper, can **wear out** over time, affecting accuracy and requiring maintenance.

# Capacitive Level Measurement

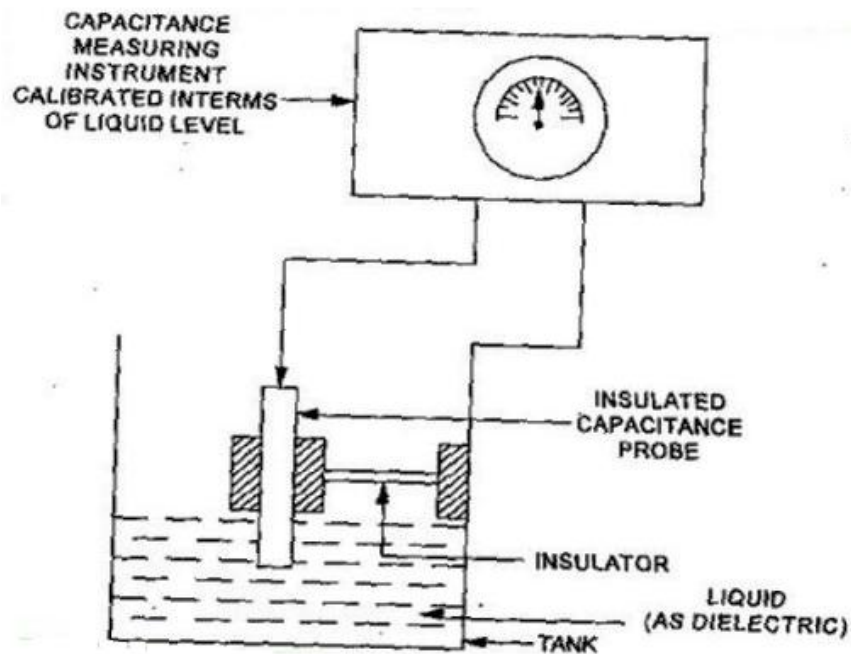
**Capacitive Level Measurement** is a method used to determine the level of liquids or solids in a tank by measuring changes in capacitance. Capacitive sensors work based on the principle that the capacitance between two conductive plates (or electrodes) changes when the space between them is filled with different materials, such as air or a liquid. These sensors are widely used for monitoring liquid and bulk solid levels in industries like food processing, pharmaceuticals, and chemical manufacturing.

# Capacitive Level Measurement



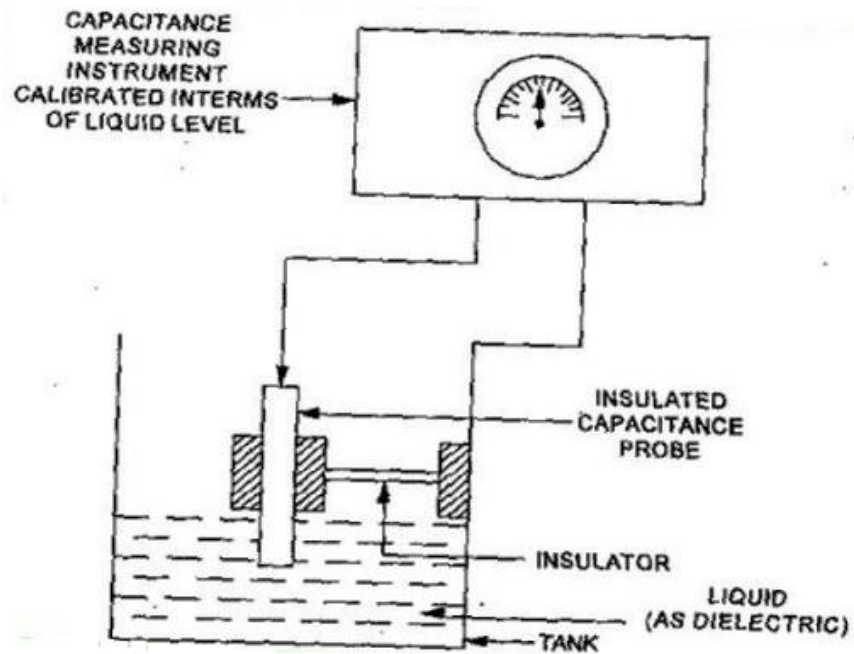
- The electrical conducting container holds the liquid.
- A metal rod completely covered by insulating material placed inside the container.
- The metal rod and container walls form the two-plates of the capacitor.
- Liquid acts as a dielectric medium.
- The capacitance varies linearly with the increase or decrease of the liquid in the tank.

# Advantages of Capacitive Level Measurement



- Useful for small systems.
- Very sensitive.
- Suitable for continuous indication and control.
- Good for use with slurries.

# Disadvantages of Capacitive Level Measurement



- Variations in the dielectric constant due to temperature, humidity, or composition changes can affect accuracy.
- They may need recalibration if the material type or properties change significantly, as each material has a different dielectric constant.

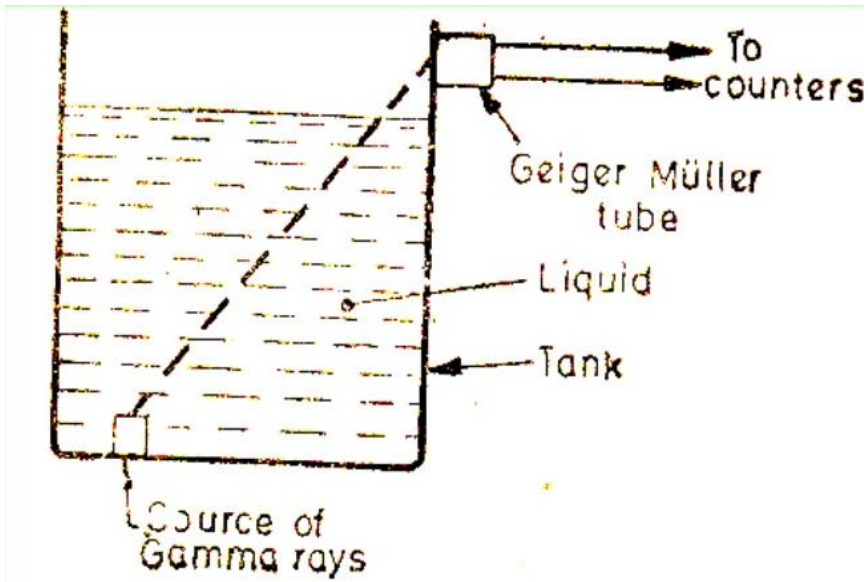


# Capacitive Level Measurement

## Factors Necessitating Recalibration

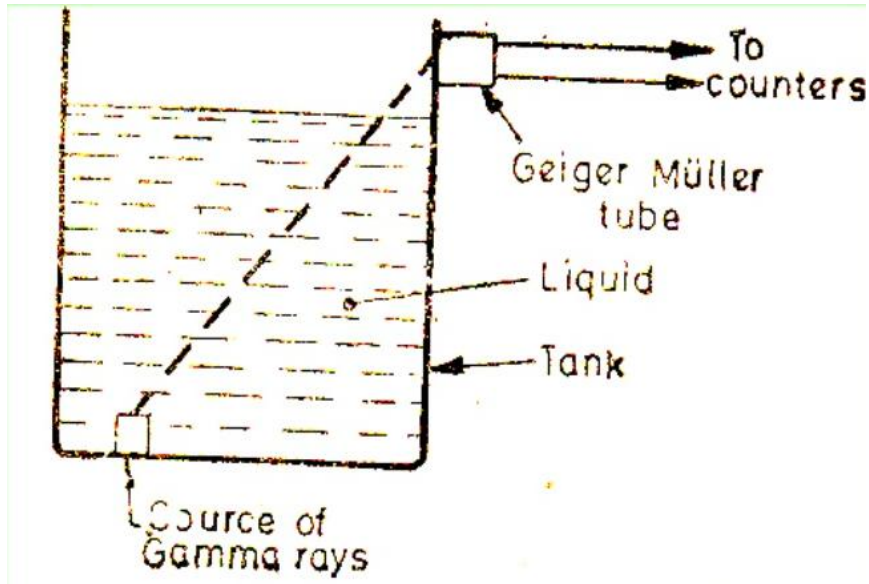
- 1.Environmental Changes:** Variations in temperature, humidity, or atmospheric pressure that could affect sensor performance.
- 2.Sensor Aging:** Over time, components may degrade or drift from their calibrated state, necessitating recalibration to ensure accuracy.
- 3.Physical Impact:** If the sensor has been subjected to physical shock, vibration, or other disturbances, recalibration may be required.
- 4.Changes in Regulatory Standards:** Updates in safety regulations or measurement standards may require recalibration to maintain compliance.
- 5.New Applications:** If the sensor is repurposed for different materials or environments, recalibration is essential to ensure accurate readings.
- 6.Maintenance or Repair:** Following significant maintenance or repair work, recalibration is necessary to verify that the sensor operates correctly.

# Radiation Level Measurement



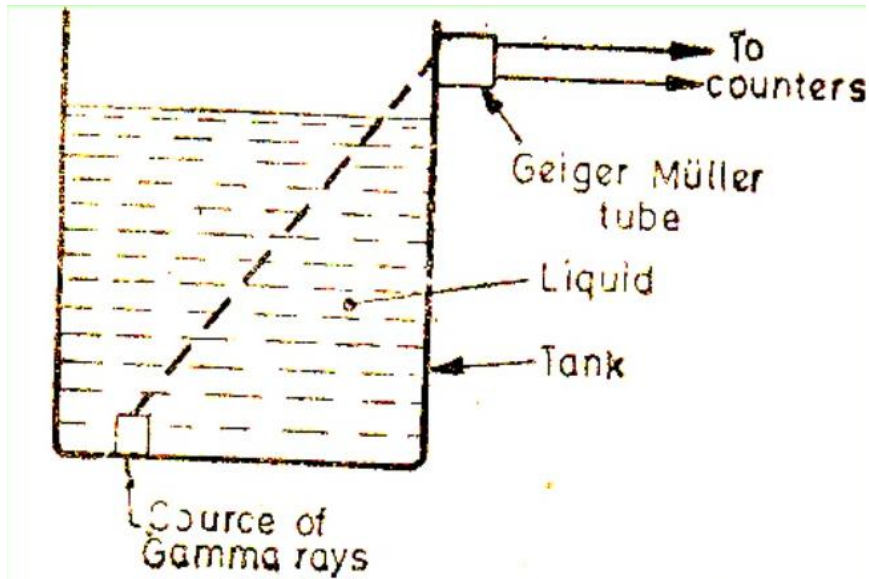
- The gamma ray is directed towards the detector through **thick walls** of the tank.
- **Intensity of the gamma ray received at the detector side is inversely proportional to the thickness of the walls and medium.**

# Advantages of Radiation Level Measurement



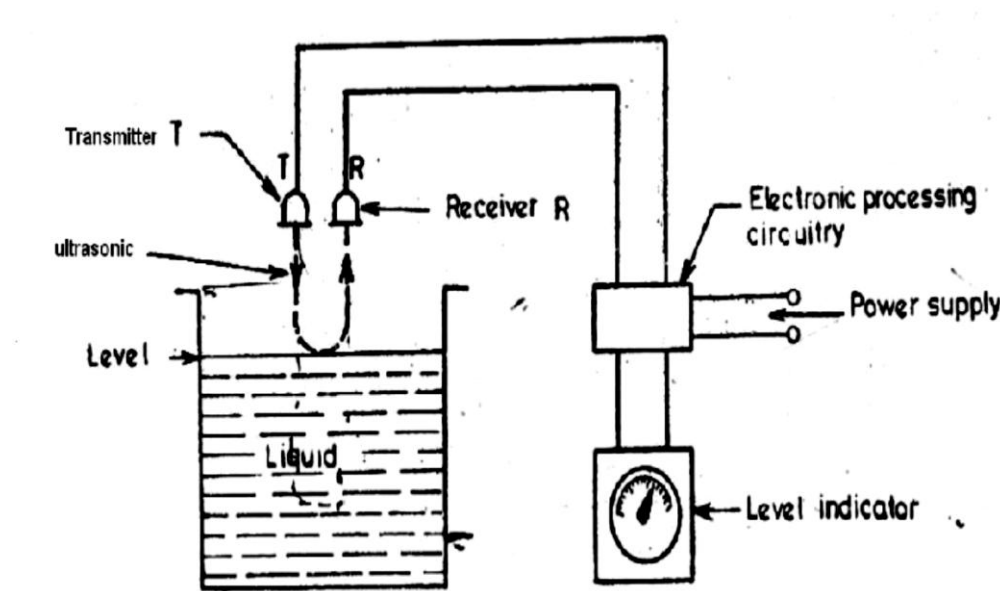
- No physical contact with the liquid.
- Suitable for molten metals as well as liquids of all types.
- Useful at very high temperature and pressure.
- Good accuracy and response.
- No moving parts.

# Disadvantages of Radiation Level Measurement



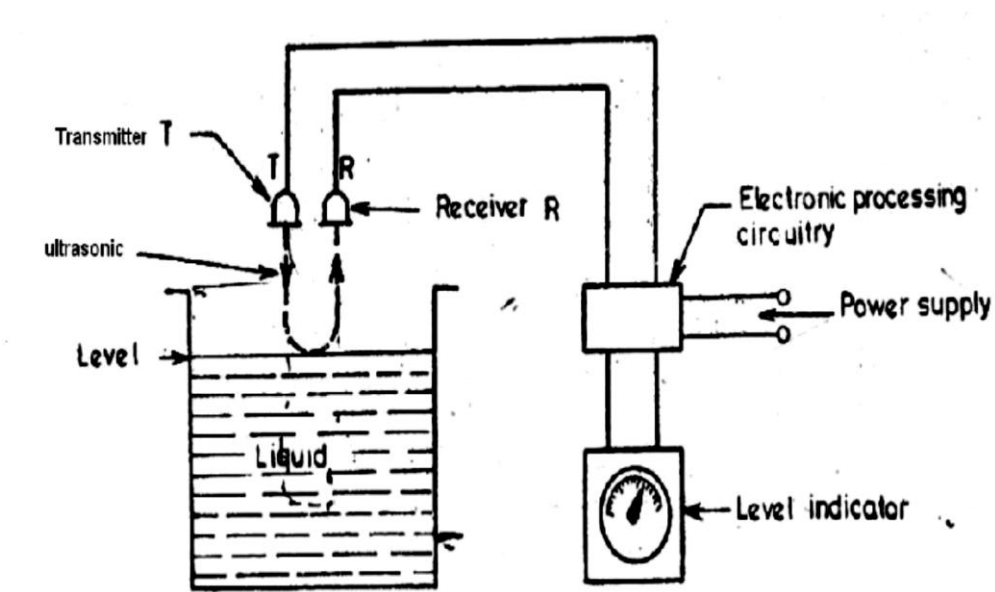
- Reading is affected by the density change of the liquid.
- Cost is relatively high.

# Ultrasonic Level Gauges



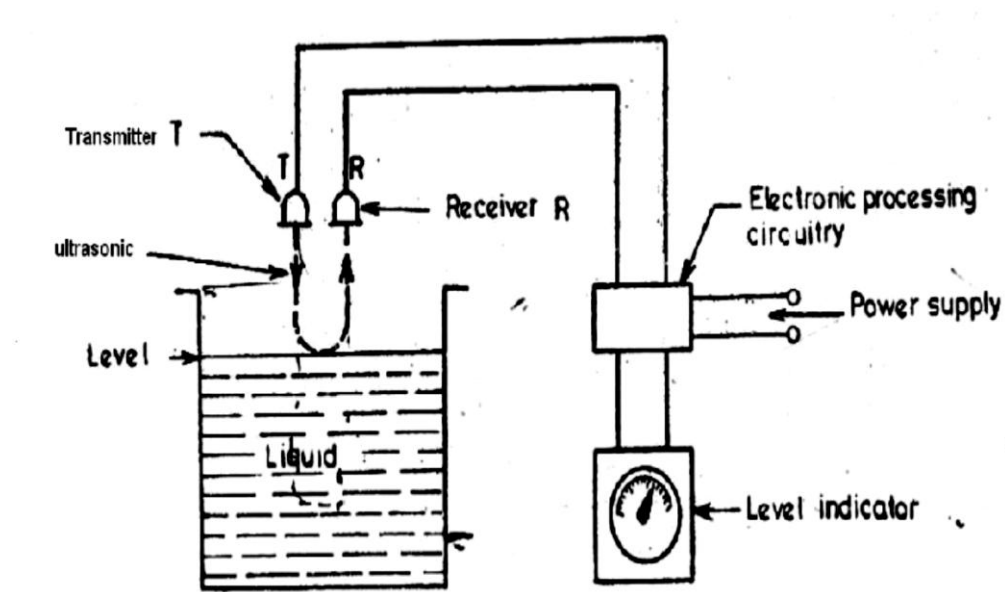
- The acoustic wave sent by the source (Transmitter T).
- It is reflected by the interface and receives by the receiving crystal R.
- As the level of the liquid changes, the time taken by the beam changes.
- The time is a measure of level.

# Advantages of Ultrasonic Level Gauges



- No physical contact with the process material.
- Absence of moving parts.
- The reading is unaffected by the changes in moisture, density, composition, electrical conductivity or dielectric constant of the process fluid.

# Disadvantages of Ultrasonic Level Gauges



- The echo can be weak due to dispersion of absorption.
- The reflective properties of the process surface results error in the output.