Module III

LEVEL AND FLOW (T)

→ Level (T) =

* Device used to produce electrical signals in accordance with the liquid level.

* 2 types. →

a) continous level (T)	Discrete level (T).
* measures exact position of the liquid level within a specified range	measures only the position of liquid level is above / below a specific point.
* Indicates the contin.. level of a product as it rises & falls.	Indicates when a product is prsnt at a certain point.
* Give the exact volume of substance prsnt in the vessel.	Gives only an indication whthr the substance is prsnt / not in vessel.
* eg → Float elemnt type L.(T) Diaphragm/pressure L(T) Manometer type L.(T) Ultrasonic L.Sensors capacitor level (T).	eg → automated wtr level controller.

⇒ continous level (T) =

1) Ultrasonic level Sensors =

* working is based on time-of-flight (ToF) Principle.

* ToF is a method which is used for measuring the dis b/w a sensor & an object.

working:
* Ultrasonic transmitter emits ultrasonic pulses towards liquid.
* The emitted pulses reflected back to the ultrasonic receiver frm surface of the liquid.

2) Float elemnt type =

* most common simple method to measure liquid levels.
* AS the liquid level rises in the tank, the float rises.
* It causes to move the wiper ovr the potential divider.

3) Diaphram / pressure type =

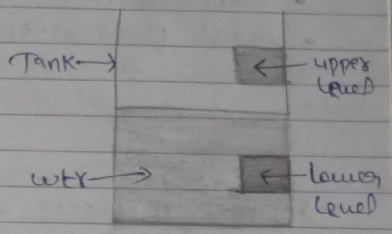
* used to measure liquid level inside a tank by measuring the pressure that produced by the liquid at the bottom of the tank.

4) Manomtr type =

* Hight of mercury Hm rises as the liquid level of tank H rises & vice versa.
* Density of mercury is higher than any other liquid.

=> Discrete level (T) = (point level (T))

a) Automated water level controller =



→ common appli~

Continuous
* waste water treatmnt
* fd & Beverage

Discrete
* semi cond~ manufacturing
* fd & Beverage.

=> Flow Transducers =

* Essential requirement for ~~measuring~~ maintaining the quality of various processes in industries is the accurate measurmnt of flow rate of liquids & gases.

→ * Flow mtrs =
* Device used to measure the flow rate (vol ~~for~~ mass) of liquid / gas.
* types →
  - Obstruction type.
  - Electromag.

- the displacmnt.
- fluid dynamic
- Anemometry
- Ultrasonic
- mass flow metr. = device that measures mass flow rate of a fluid traveling through a tube.

→ Types of flow =

a) Steady & unsteady flow
b) Uniform & non-uniform flow
c) Laminar & turbulent flow
d) compressible & incompressible flow.

⇒ Bernoulli's principle =

* States that "as the speed of moving fluid ↑s, pressure within the fluid ↓s".
* States that "Total mechanical energy of the moving fluid comprising the gravitational potential energy of elevation, the energy associated with the fluid pressure & kinetic energy of the fluid motion remains constnt."

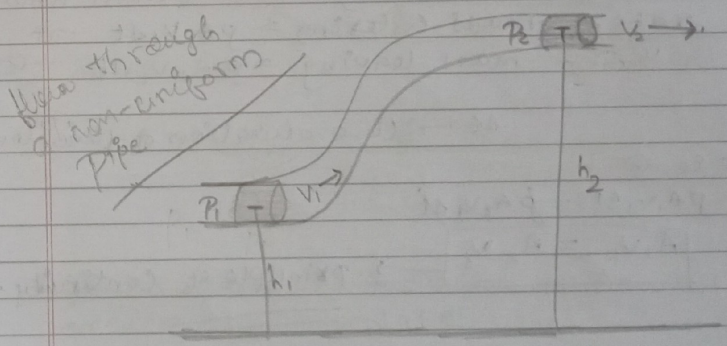
In short
* pressure created by fluid (P) +
  Kinetic energy ($\frac{1}{2}\rho v^2$) +
  gravitational potential energy of elevation ($\rho g h$)
  = constnt

* Formula for B.P,

$$P + \frac{1}{2}\rho v^2 + \rho g h = \text{constnt}$$

v → velocity of fluid
ρ → density "
h → height of container
g → gravitational constnt.

* Consider a steady, incompressible flow of fluid through the pipeline.
* let P_1, v_1, h_1 be pressure, velocity & height at the bottom portion of pipeline. & P_2, v_2, h_2 at the top of pipeline.



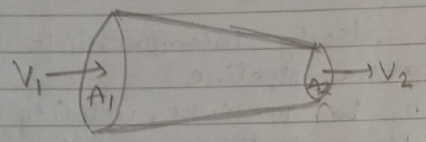
According to B.P,

$$P_1 + \rho g h_1 + \frac{1}{2}\rho v_1^2 = P_2 + \rho g h_2 + \frac{1}{2}\rho v_2^2$$

$$P + \rho g h + \frac{1}{2}\rho v^2 = \text{constnt}$$

⇒ Bernoulli's principle of continuity =

According to the principle of continuity, "If the fluid is in streamline flow then the mass of fluid passing through diffrnt cross sections are equal".



According B.P of continuity,

rate of mass entering = rate of mass leaving.

rate of mass entering = $\rho A_1 V_1 \Delta t$ — ①

" mass leaving = $\rho A_2 V_2 \Delta t$. — ②

Δt → time duration of fluid flow.

→ Eq — ②

$$\rho A_1 V_1 \Delta t = \rho A_2 V_2 \Delta t$$

$$\boxed{A_1 V_1 = A_2 V_2}$$ → principle of continuity.

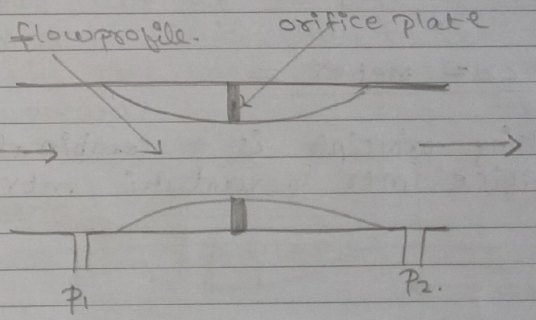
⇒ Obstruction type flow mtr =

* Here, obstruction is created in the flow passage,
* So, a pressure drops across the obstruction
* The pressure drop across the obstruction is a ( ) of flow rate.

* 3 types →

a) orifice meter =

* Here, an orifice plate is placed in the passage.
* There exists a permanent pressure diffrance in b/w the 2 sides of o.plate. This is major disadv of using o.plate. So, it requires more pressure to pump the liquid.

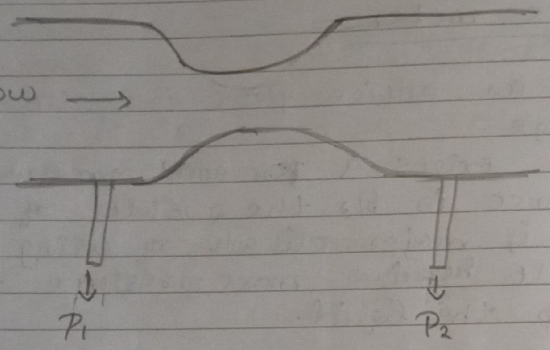


* flow rate is reduced with the prsnce of o.plate.

b) venturi meter =

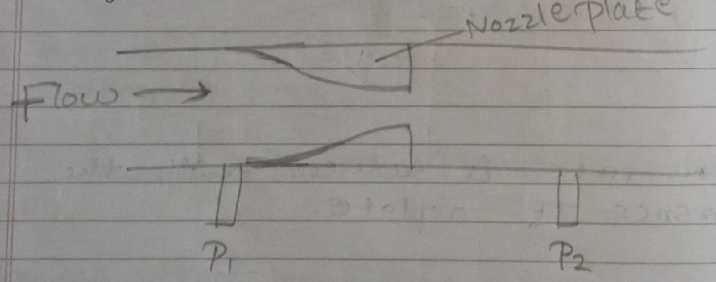
* Device that is based on B. theorem & is used for measuring the rate of flow of liquid through the pipes.
* Here the obstruction is designed in such a way that the change in

the flow path is gradual.



c) Nozzle meter =

* working principle is a combination of orifice mtr & venturi mtr.



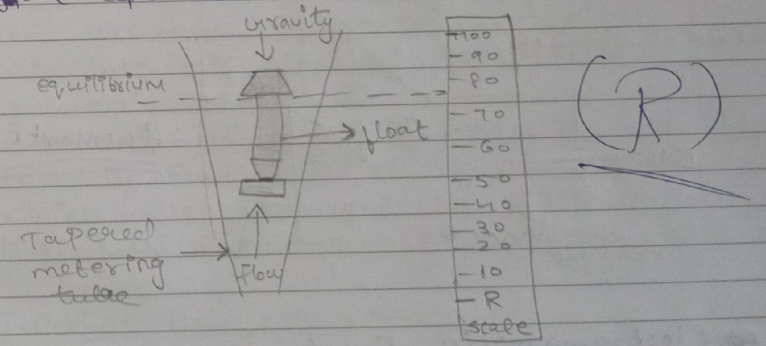
I) Rotameter = (R)

* Type of flow mtr, also → variable area flow mtr.
* used to measure the velocity of air & liquid (wtr, oil, etc.) in industrial sectors.

* Also used in medical instruments like oxygn cylinders, etc.
* Are popular bcz they hve linear scales, low pressure drop & are simple to install & maintain.

working →

* Since there is variation in the cross-sectional area of tube, → variable area fm.
* Inside the tube consists of metering float.
* when there is no flow of fluid through (R), float lies at the base of the tube.
& when the fluid flows to the tube through the base, it pushes the float upward.



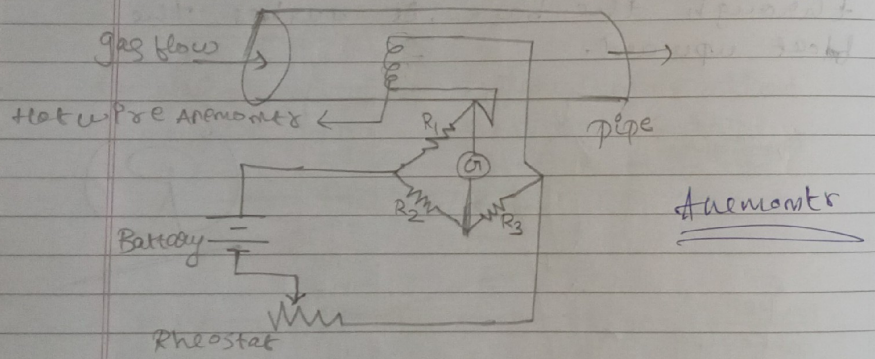
Adv	Dis adv.
Easy installation	Difficult to handle glass type.

II) Anemo mtrs =

* Device useful in measuring wind speed & (gases).

* common weather station instrumnt.
* Also measures wind pressure.
* works on the principle of converting mechanical energy into electrical energy
* types →
  a) cup type
  b) Hot-wire type.
  c) Tube Type.

Adv	Disadv
Relatively economical	liquid flow can contaminate the probe easily.



Anemomtr

III Electromagnetic F.mtr =

* used for precise flow measurmnt of all electrically conductive liquids like milk, wtr, etc.
* work based on Faraday's Law of electromag induction.
* The liquid flowing through the pipe act as conductr & this induces a voltage which is proportional to avg flow velocity.
* Faraday law of E.I. → voltage is given by,

$$E = BlV$$

B = flux density
l = length of cond
V = velocity of cond.

IV Impeller mtr = (I)

* It is a rotating component which uses the pressure of a fluid.
* There are diff types of (I) are used in various pumps.
* open type & closed type (I) are generally used.
* common type used is f.mtrs is lobed (I)
* Lobed (I) F.mtr consists of 2 lobed (I)s which are arranged in such a way that both should rotate at opp dir.

V Turbine flow mtrs =

* Are similar to impeller type.
* Instead of lobed (I), freely suspended turbine blades enclosed in a housing are used.
* Are accurate & suitable for both liquid & gas flow rate measurmnts.

disadv) * Suitable for clean fluids.