LEVEL MEASUREMENT

1.Write the formula for calculating a static head in kpa?

Static Head = pgh

p= Density of the liquid

g= Gravity

h= height of the liquid column

2.What are the simple methods for measuring level?

Gauge glass, Pressure Gauge – scale graduated in % of level, Rope and weight , Dip Tape…etc

3.How to convert a pressure gauge into a level gauge?

Calculate the static head in kpa using the formula "pgh". Select a pressure gauge and calibrate it for the calculated static head. Graduate the pressure gauge scale in terms of %of level.

4.What is the density of crude oil?

The density of crude oil is approximately 0.8.

5.What is an "interface dip tape"? Where it used?

Interface dip tape is an instrument used for measuring the total and the interface liquid level in vessel.

For example: It is used in oil storage tanks to measure the total liquid level and water level.

6.Explain how a Leveltrol works? Name the parts of a pneumatic Leveltrol.

A Leveltrol in and instrument used for measuring the liquid level between two known points. The Leveltrol works on the buoyancy principal. Leveltrol has a float, which submerses proportionately with liquid level raise in the float chamber. The amount of submersion of the displacer depends on the liquid density, which produces a torque. The amount of torque produced in measured in terms of % of level.

Parts of Leveltrol:

Float chamber, Float, Torque lever, Knife edge, Feedback Bellows, Air Relay, Restriction, Flapper, Nozzle, Feedback link, Density range, Action change lever, HP and LP flange,

7.What is a static head level transmitter?

A static head level transmitter is used for measuring the total liquid level in the tank.

8.What are the application limits of a Leveltrol and a static head level transmitter?

A Leveltrol can measure only for a short and fixed height of level. A Leveltrol has a high gain output. In can be used for liquid level as well for the interface level measurement.

Static head transmitter is used for measuring the total liquid level in the tank. The transmitter output is linear.

9.What is the operating principle of a Magnetrol level switch?

The Magnetrol level switch works on the principle of Buoyancy force.

10.What are the points to consider while selecting a level switch for a particular process?

While selecting a level switch, the following points are to be considered:

- The characteristic of process (corrosive or non – corrosive)
- The process pressure
- The liquid density
- The flange ratings
- Proof pressure of the switch
- The micro switch contact rating

11.What type of level measuring instrument is suitable for closed tank?

If the level measurement is required for a fixed and small height, a Leveltrol is more suitable.

If it is for a total height, then either a static head or a differential pressure transmitter with its HP leg connected to the bottom of the liquid level and the LP leg connected to the top of the tank to gas phase.

12.What is Zero suppression and Zero elevation in level measurement?

Zero suppression: when a static head transmitter is installed below the zero liquid level, the transmitter gets a +ve error in the level measurement. This error is corrected by a zero suppression kit.

Zero elevation: when a static head transmitter is installed above the zero liquid level, the transmitter gets a –ve error in the level measurement. The error is corrected by a zero elevation kit.

13.What is an interface in level measurement?

An interface is the separation point between the two de-missible liquids levels In a vessel. This condition arises when the liquid does not mix due to its chemical composition and difference in their density.

14.How to calibrate a leveltrol for an interface level measurement?

Fill the leveltrol chamber 100% with the lower density liquid and adjust its zero for 4.00mA output.

Drain the liquid and fill the leveltrol chamber 100% with the higher density liquid and adjust its span for 20.00 mA output.

The transmitter on line measures the percentage of higher density liquid in the lower density liquid at a known height.

15.How to calibrate a static head level transmitter for an interface measurement?

Static head level transmitter is not commonly used for measuring the interface level. But the following procedure may be used for calibrating it to measure the interface level in a tank.

Fill the vessel 100% with the lower density liquid and adjusts its zero for 4.00 mA output. Drain the liquid and fill with the vessel 100% with

the higher density liquid and adjust its span for 20.00mA output. 100% transmitter level is to be continuously maintained.
The transmitter on line measures the percentage of higher density liquid in the lower density liquid in a know height.

16.Why is a leveltrol more suitable tan a static head level transmitter on a separator?

Leveltrol is more accurate in measuring the small height of liquid level. The process pressure change does not affect the leveltrols performance. Leveltrol offers a high gain output verses the change in the liquid level.

17.Why is static head level transmitter more suitable than a leveltrol on a surge tank?

A leveltrol has a limitation in measuring the maximum height of liquid. Considering huge of the surge tank, a static head level transmitter is more suitable.

18. Why is a gap controller often used in controlling a level in a high pressure vessel?

Gap controllers output changes from minimum to maximum and visa versa when the process measurement deviates the setpoint by the set gap. Hence the final control element i.e. control valve acts like an on-off valve. This helps in minimizing the trim erosion due to a high DP across the control valve while partially open.

19. How to use a DP (differential pressure) transmitter for level measurement?

A differential pressure transmitter gives a linear output for the differential pressure measured across its HP and LP chambers.
Connect the transmitter's HP leg to the bottom of the tank and its LP leg to the top of the tank. The transmitter will read the liquid level accurately irrespective of the change in process pressure above the liquid surface.

FLOW MEASUREMENT

1. **What is 'volumetric' and 'rate of flow'? Write their measuring units in metric.**

Volumetric Flow: The total amount of fluid passed through a process line. Generally it is measured on counters. The measuring unit is cubic meter, Barrels…etc.
Rate of flow: The amount of fluid moving through a process line per period of time. Generally it is measured on indicators, recorders. The measuring unit is cubic meter per day, barrels per day…etc.

2. **What are the types of flow; measuring instruments used in industries?**

Orifice plate and a DP transmitter, Daniel orifice and DP transmitter, Rotameter, Dall Tube, Venturi Tube, PD meters…etc.

3. **What are the types of flow measurements commonly used in DPU-A?**

Orifice plate and a DP transmitter, Daniel Orifice and a DP Transmitter, Rotameter, PD meters.

4. **What is 'Burnollious Theorem'? What does it explain?**

It explains that when there is a restriction line a fluid flow line a 'DP' (differential pressure) is created. The DP is maximum at the veena contract point. The flow measured in the flow line is proportional to the square root of the DP measured where 'K' is a constant.

$$Q = k \times \text{sq root of DP}$$

5. **What is the function of an orifice plate in flow measurement?**

An orifice plate creates a differential pressure in a flow line. The DP created is use for measuring the flow through the process line.

6. **How much maximum and minimum orifice 'd' (orifice diameter) id permitted in a pipeline?**

$$0.25\,D < d < 0.75\,D$$

'd' – the Orifice diameter should be in-between 0.25 and 0.75 of the pipeline 'D' diameter.

7. **What is the difference between an orifice plate used in oil and gas flow measurement?**

The orifice plate used in a gas line will be having a small drain whole at the bottom of the orifice plate.

8. **Draw a simple sketch of an orifice plate showing it's upstream, downstream and the shamper edge.**

9. **How to identify a newly installed orifice plate upstream in a pipeline?**

The upstream can be identified by the orifice plate's Tag number markings. Tag numbers are always marked on the upstream of the orifice plate.

10. **How much upstream and downstream straight length run is essential for an orifice plate flow measurement?**

An upstream of 28D and a down steam of minimum 7D is essential for an accurate orifice plate flow measuring system (where D= pipeline diameter). Greater the upstream and downstream length, lesser the flow turbulence and grater the accuracy in the flow measurement.

11. **What type of orifice tapping is commonly used in P.D.O.?**

PDO in general, is using the 'Flange Tapping'. The upstream and downstream orifice tapping are taken from the flanges.

12. **Why and when is flow measured on a square root scale?**

Flow is measured on a square root scale only when the measurement is done through an orifice plate and a DP transmitter. The flow measured through the orifice plate is always proportional to the square root of the DP across the orifice plate.

Q = k **x** sq root of DP

Q = Flow
K = Constant
DP = Differential Pressure

13. **What is a 'flow factor'?**

A 'flow factor' is to multiply the flow transmitter signal measured on a 0-10 square root or 0-100 linear scale to get the flow calculated by flow metering. This is used due to the standardization of the transmitters signals, to 20-100 kPa or 4-20mA.

14. **What are the important parameters considered in deriving a flow factor?**

The following points are considered for flow calculation and in deriving the flow factor:

D =pipe diameter,
Small d = orifice diameter
Service = gas or liquid
PI =operating pressure
DP = Transmitter differential pressure
T =operating temperature
Small p = density or molecular weight
Small v = viscosity
Q= expected total flow

15. **Explain the installation of a DP flow transmitter on a gas and liquid pipeline?**

Gas line: the transmitter is installed above the orifice plate to prevent the condensation of gas in the signal line and in the HP & LP chambers.
Liquid line: the transmitter is installed below the orifice plate to prevent the gas trapping in the signal line and in the HP & LP chambers.

16. **What is a 'zero check' and 'static zero check' on a DP flow transmitter?**

Zero Check: A procedure for checking the transmitter output is equal to 4.00 mA when its HP & LP chambers are equalized and are at the atmospheric pressure.

Static zero check: A procedure for checking the transmitter output is equal to 4.00 mA when its HP & LP chambers are equalized and are at the operating pressure.

17. **Why is flow measurement not very accurate?**

Flow measurement is less accurate compared to level, temperature and pressure measurement. This is due to the consideration of various parameters while measuring a flow. These parameters, such as the accuracy of the orifice plate diameter, the pipeline diameter their operating parameters such as temperature and pressure do not remain same in the process operation as the designed parameters. Generally, an accuracy of 5% is permitted in a flow measurement.

18. **What is the actual flow, if the operating pressure is higher then the designed pressure?**

If the operating pressure is higher than the desiged pressure the true flow will be higher then the measured pressure. A simple calculation is as follows.

Q = Q1* sq root of p1/p2
Q = True Flow
Q1= Measured Flow
P1= Operating pressure
P2= Designed Pressure

19. **What will be the new flow factor if a DP transmitter is re-ranged from 25 kPa to 50 kPa?**

A simple calculation is as follows:

Q1/Q2 = Sq root of DP1/ Sq root of DP2
Q1 = Q2 * Sq root of DP1/ Sq root of DP2

Q1 = New flow factor, Q2 =Existing flow factor
DP1 = Transmitter new range, DP2= Transmitter existing range

Q1 = Q2*SQ ROOT OF 50/25
Q1 = 1.41*Q2

The new flow factor will be 1.41 times higher than the existing flow factor.

20. Why generally is a flow transmitter installed upstream of a flow control valve?

A flow transmitter is always installed on the upstream of the flow control valve in order to maintain the operating pressure across the flow transmitter sensors. Downstream of the control valve the pressure changes as the control valve opens or closes.

21. Why is a pressure transmitter installed upstream of a flow transmitter?

Upstream of a flow control valve a pressure transmitter is installed to measure the operating pressure. At times it is used for computing the true flow against the designed pressure. Downstream of the control valve the pressure changes as the control valve opens and closes.

22. What is the operating principle of a turbine meter?

A magnetic pickup installed above a turbine meter measures the number of magnetic flux cut by the turbine meter blades and produces pulses proportional to the volume of liquid flow through the meter.

23. What is the output of a turbine meter?

The output of the turbine meter is in pulses. The pulse per the volume of liquid is constant and distinct for each meter. When a known quantity of liquid flows through the meter, a known number of pulses are produced.

24. What does a pre-amplifier do on a turbine meter?

The magnetic pickup inside the turbine meter produces pulses around 30 mv peak to peak. A pre-amplifier magnifies the small signal to a 12 V DC peak to peak square waves and transmits a signal to the control room.

25. What are the advantages and disadvantages of a turbine meter Vs an orifice plate flow measurement?

Turbine meter is a good flow measuring unit when the fluid is low clean fluid. The turbine meter measures the volumetric flow. It is directly installed on the flow line. Its accuracy in flow measurement is high. Accuracy can be re-calculated and the 'k' factor can be reset periodically.

26. What is a 'k' factor on a turbine meter? Who provides the 'k' factor?

Each turbine meter is specified with a 'k' factor which represents the number of pulses produced per a known quantity of liquid.

Example: k = 265 pulsed/gallon

Generally the 'k' factor is provided by the manufacturer.

27. One cubic meter is equal to how many gallons?

1 Cubic Meter = 264.2 gallons.

28. Why are counters (totaliser) used in flow measurement?

Counters are used for measuring the 'volumetric flow' of the fluid in a pipeline.

TEMPERATURE MESUREMENT

1. What instruments are use to measure temperature?

Thermometer, Bi-metallic temperature indicator, Thermo-couples, Resistance Temperature Detectors, Optical Pyrometers.

2. What is standard temperature measuring unit in P.D.O.?

PDO is using the SI unit Deg C for measuring temperature

3. Write the Fahrenheit to Centigrade temperature conversion formula?

Deg C = (Deg F – 32) / 1.8

4. What is the difference between 'Centigrade' and 'Celsius'?

It is one and the same. Celsius is the technical name. In simple words Centigrade is a scale graduated in hundred.

5. What is a thermo-couple? How does it work?

Two dissimilar metals are welded (joined) at one end to form a ‘hot junction’ and the other end to form a ‘cold junction’. When there is a temperature difference between the ‘hot’ and ‘cold’ junction a mV is produced in the loop proportional to the temperature difference. The amount mV production by a thermo-couple depends on the characteristic and type of thermocouple like ‘j’ , ‘k’ type etc.

6. What are the measuring ranges of different thermocouple?

The following thermocouples measure the temperature accurately within the specified range:

Copper- Constantan	0-300 Deg C
Iron – Constantan	0-600 Deg C
Chromel-Alumel	0-1200 Deg C
Platinum-Rodhium-Platinum	0-2000 Deg C

7. What is the name commonly used thermocouples in P.D.O?

On Pump’s bearings: Iron constantan

ON Gas Turbine’s combustion chanmbers:Chromel Alumel

8. what is the name of the cable used to connect a thermocouple to a measuring instrument?

The intermediate cable used for connecting a thermocouple from the field to the control room instrument is called a ‘compensating cable’.

9. What is ;’cold junction compensation’?

‘Cold Junction Compensation’ is used in temperature measurement by means of a thermocouple. This compensation is to correct the error caused by the room (ambient) temperature. The mv produced by a thermocouple is proportional to the temperature difference between its ‘hot’ and ‘ Cold’ junction. The cold junction is the ambient temperature (control room). Without ‘cold junction compensation’ the temperature at the hot junction will measure inaccurately.

10.What is an RTD? How does it work?

RDT – Resistance Temperature Detector

RTD is a positive temperature coefficient resistance which provides a linear rise in its resistance verses the rise in temperature.

11.What is the commonly used RTD in P.D.O.?

Pt 100 platinum resistance 100 Ohms

12. What is ‘pt 100’? What is the resistance (in ohms) of a pt100 at 0 Deg C?

Pt 100 Platinum resistance which offers 100 ohms at 0 Deg C.

13.What are the advantages and disadvantages of an RTD over a thermocouple?

RTDs are accurate at a lower range of temperature measurement such as -200 Deg C to +200 Deg C.

RTDs are expensive compared to Thermocouples, also there are limitations in measuring at the higher range of temperature.

14.Why does RTD measurement use 3 wires for a field signal connection?

3 wire system is used in temperature measurement by an RTD to compensate the line resistance. Three wire system provides a Wheatstone Bridge in the measuring instrument.

15. What is a ‘bi metallic’ temperature instrument? How does it work? Give an example?

In a bi metallic temperature instrument, two metals with different temperature coefficient of expansion are attached together. Due to its expansion characteristics the higher coefficient of expansion responds more than the lower one and a twist on the element is formed. This principle is ;used in designing temperature measuring instrument for the lower range.

Other than the filled type instruments, most of the temperature indicators are of the bimetallic types.

16. What is a ‘filled type’ temperature instrument? Give an example?

Principle of change in the liquid expansion with the change in temperature is used in designing the ‘filled type’ temperature measuring instrument.

For example : The glass thermometers, filled type capillary temperature dial indicators and switches.

Filled type temperature measuring instruments are used for lower range temperature measurement.

17. Name the instruments used to measure temperature?

1 precision glass thermometers

2 RTD with a resistance measuring instrument in terms of Deg C or Deg F.

3 Thermocouple with a mv measuring instrument in terms of Deg C or Deg F.