BASIC INSTRUMENTION

Pressure measurement

1.what are the application advantages of a dead weight tester and a gauge comparator?

Dead weight tester: Generally it is used for calibrating a test gauge. It works on the hydraulic principle, where a test gauge is compared with the standard dead weights.
Calibration procedure is laborious.

Gauge comparator: It is used for calibrating a pressure gauge against a test gauge. Calibration procedure is simple and quicker.

2.How would you select a pressure gauge for a process?

While selecting a pressure gauge for a process, consider the following points:
_ Characteristic of the process (corrosive or non-corrosive)
_ Operating pressure
_ Maximum process pressure
_ The gauge range should be a minimum of twice the process operating pressure.

3. Write the types of Bourdon tubes? Explain the purpose of different Bourdon tubes.

The following are the commonly used Bourdon tubes used in industries:
- Spiral –Low range 10 –100kpa
- C type –Medium range 100 – 5000kpa
- Helical – High range 5000 – 20000kpa
  (refer to the manufacturers manuals for correct parameters)

4.What is function of a hair –spring in a pressure gauge?

Hair – spring in a pressure gage eliminates the Hysterisis (backlash/angularity) error caused in the quadrant (gear and pinion mechanism) and the weight of the pointer.

5.Name a few pressure switch manufacturing companies.

Barksdale, United electric, CCS…etc.

6.What is the output of a pressure switch?

Output of an electric switch is a contact- open or close.
Out put of a pneumatic switch is a port operation- open or close, vent

7.How would you select a pressure switch for 500kpa Hi operatin?

The following points are to be considered wile selecting a pressure switch for any process operation:

- The process operating pressure
- The maximum process pressure
- The process pipeline vibration
- The maximum working pressure of the pressure switch should be times greater then the maximum operating pressure
- The micro switch contact rating
- Process connection
- Local or remote mounting
- …etc.

8.Expain the contact selection on high and low pressure alarm switches? And explain why?

On a high pressure switch, the wiring is terminated on the “common” and the “normally close” contact terminals.

On a low pressure switch, the wiring is terminated on the “common” and the “normally open” contact terminals.

This type of contact termination is done to achieve a close contact from the switch during a normal (healthy) process condition which is a fail safe method.

9.What is to be done, if a transmitter gives a maximum output , where the transmitter range (jumper) is already in maximum selection?

Replace the capsule (sensor) for a higher range in the transmitter.

10.Explain how to carryout a field zero check on a pressure transmitter?

- If the transmitter signal is used for controlling, then put the controller on manual.
- Connect a digital multimeter in the current range in series with the transmitter output.
- Isolate the process valve
- Isolate the instrument isolation valve.
- Open the equalising valve
- Open the bleed valve and de-pressurise the transmitter.
- Check for 4.00mA output signal, if not, adjust the zero screw.

11.What-test equipment is required to calibrate a pressure transmitter in the field?

If it is a low range transmitter, then precision pneumatic test equipment like “wallace and tiernier” and pneumatic pump (or air supply) may be used.

If it is a high range transmitter, then a hydraulic pump and a test gauge is to be used.

12.What are pressure measuring/feeding test equipment?

The following are a few commonly used test equipment to measure and feed pressure: Tradinco, Wallance & tiernier, Ralston, Gauge comparator, Dead weight tester…etc.

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 uit 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 smal 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= pipe line 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.

CONTROLLERS

1.What is a 'controller'? Where are its application areas?

A controller is an instrument used for controlling a process variable (measurement). Its continuously monitors the error signal and gives a corrective output to the final control element.

2.Explain the following terms in a controller?

1) measurement variable
2) desired variable
3) deviation
4) output

Measurement variable: It is the demand variable measured and controlled.

Desired Variable: it is the demand signal (setpoint) to which the process variable is controlled.

Deviation: it is the error signal caused by the difference between the measurement and the demand signal.

Output: It is the corrective signal from the controller to the final control element.

3.Explain what is 'direct action' and 'reverse action' on a controller?

Direct action : In a direct acting controller, the output increases when the process measurement (variable) increases.

Reverse action : In a reverse action controller, the output decreases when the process measurement (variable) increases.

4.What is a gap controller?

A controller whose output changes from ;minimum to maximum (on-off) and vice-versa when the error signal (deviation) exceeds the set gap depending on the controller action.

5.What is a 'proportional band'? Explain with an example?

It is the range in percentage for which the controller output changes proportionally from minimum to maximum and vice-versa when the measurement deviates from the setpoint.

For example: A controller set at 50% proportional band
The controller output changes from minimum to maximum and vice-versa when the measurement exceeds 25% either side of the setpoint depending on the controller action.

6.What is a 'gain'? Write the relation (formula) between a gain and proportional band?

A controller 'gain' is inversely proportional to its proportional band.

. g = (1/p)*100
. g = gain
. P = proportional band

7.What is a 'reset action'? Explain with an example?

Reset action in a controller is the integration of the proportional action by the set period. The reset action repeats the proportional action's output per the reset time set, until the error signal becomes zero or the output gets saturated.

For example :if the reset action is set for 30 sec.
For a 0.5 volt correction output ;by the proportional action will be repeated by the reset action every 30 secs., until the error signal becomes zero or the output gets saturated.

8.What is a 'batch' facility on a controller?

Whenever a deviation persists for a long time the controller output saturates at the maximum of minimum output (-2.5 VDC or + 12.5 VDC/0 kPa or 140 kPa) depending on the controller action. In a normal controller when the process reverts to normal the output takes its time to come into control range.

In a batch controller the output reverts to the control limit (0VDC OR 10.00V DC 20 kPa or 100 kPa) as soon as the deviation enters the batch limits

9.What will be the output (increases or decreases) of a direct action controller when the process goes above the setpoint?

In a direct acting controller, the controller output increases when the process (measurement) goes above the setpoint)

10.What will be the output of a reverse acting controller when the process changes from 50% to 75% where the proportional band is set at 50%, setpoint is set at 50%?

The controller output will be zero.

11.What is a 'bump-less transfer' in a controller's auto/manual change over?

'Bump-less transfer' is to eliminate the change in the controller's output when the controller is changed from auto to manual control and vice-versa.

12.Explain how to change a controller from auto to manual and vise-versa?

Pneumatic controllers	:While taking the controller from auto to manual, the manual output is to be balanced to the auto output and then transfer the auto-manual switch to manual. While changing the controller from manual to auto, the controller setpoint is matched to the manual output and then auto-manual switch is transferred.
Electronic controllers	:Auto to manual control may be transferred directly as the electronic circuit keeps the auto and manual output matched. But while changing the controller from manual to auto, the controller setpoint is to match to the process variable and then auto-manual switch is transferred.

13.What type of controller (P, PI, PID) is preferred on the following process control loops?

1) **Pressure**
2) **Level**
3) **Flow**
4) **Temperature**

Pressure: If the load change is minimum, then a proportional controller is suitable. If a frequent load change is expected then a Proportional + Integral controller is preferred.

Level : Normally a proportional controller is preferred.

Flow: Proportional + Integral controller is preferred

Temperature: Proportional + Integral + Derivative controller is preferred

14.Why is there a direct and reverse action on a controller when the control valves are already having direct (air fail to close)/reverse(air fail to open) actions"?

The type of control valve action requirement on a process line, depends on the protection required on the upstream or downstream of the control valve incase of an air failure. Depending on the control valve action, the controller action has to be set to control the process.

For example : Station back pressure control valve is reverse acting and its controller is set for reverse acting. If there is an air failure the control valve opens fully and prevents the separator from high pressure. If the separator gas pressure goes below the setpoint the controller output goes high and keeps the control valve closed.

Separator level control valve is direct acting and its controller is set for direct acting. If ;there is an air failure, the control valve closes fully and prevents the surge tank from high pressure. If the separator level goes below the setpoint the controller output goes low and keeps the control valve closed.

CONTROL VALVES

.1. What is a 'control valve'?

A control valve is a final control element (end element) used in a process line to control the process.

2. Explain the types of control valves?

Commonly used control valve types are:

1. Globe valve
2. Butterfly valve
3. Ball vale

3. What is a double seated control valve? Where in general is it used?

It is a control valve whose trim (plug and seat) has two seats (contact points). A double seated control valve is commonly used in high differential, huge capacity, turbulent flow lines.

4. What is a single seated balanced trim?

It is a trim having a single seat and balance holes on its plug. A single seated balanced trim is used in a process line where the DP across the valve is high. These kind of trims are useful in reducing the vibration on the valve body and also assists in closing the valve.

5. What is a 'direct acting' and 'reverse acting' control valve?

Direct acting control valve : The valve port closes on air failure.

Reverse acting control valve: The valve ports on an air failure.

6. Explain the following on a control valve:

1) Trim
2) CV
3) Actuator
4) Stem travel
5) Valve body
6) Yoke
7) Gland packing

Trim : Trim is a matched pair of 'plug' and 'seat'
CV : The amount of water flow in gallons through the control valve when the valve port is fully open and the pressure differential across the valve is 1 Psi.
Actuator : The drive unit having a diaphragm and a piston that operates the valve stem.
Stem travel: The scale that shows the stem movement in inches or centimeter.
Valve body: The bottom portion of a control valve installed on a pipeline to control a process. The valve body contains a trim, pipe flange, bonnet, gaskets, guide bush, gland packing, lantern ring, grease, cooling fins…etc.
Yoke : A portion of the actuator which connects the actuator to the valve body carrying a stem travel plate.
Gland packing: A sealing system in the valve body which prevents the process fluid coming out through the valve stem.

7. **What is an ‘over sized’ control valve? How to solve an oversize problem?**

A control valve is said to be oversized when a minimum signal to the valve (minimum opening of the valve) brings process to the set point rapidly. This situation leads to an imbalance and high gain in the control loop. The problem can be solved by changing the valve trim to a reduced trim size or by replacing the control valve for the correct size.

8. **What is a bench set on a control valve actuator?**

On a pneumatic control valve, this is the minimum and maximum air pressure to be applied to achieve the full stroke length of the actuator.

9. **Why does a bench set differ on actuators of the same size?**

A higher bench set actuator is selected when the control valve is operating on a high pressure process line.

10. **What is a valve positioner? How does it work?**

Valve Positioner is a unit used on a control valve to keep the valve in position.It works as a booster relay with a valve stroke feed back. A controller output is fed to the valve positioner and the valve position provides an output to the control valve actuator to achieve the pre-calibrated stroke length. In case the require stroke length isnt achieved, then the positioner either increases or decreases its output until the valve achieves the desired stroke length. This situation may occur when there is a great change in the process pressure, gland is too tight…etc.

11. **Why is a valve positioner preferred even on a control valve having a bench valve having a bench set 20-100 kPa?**

It makes the valve response (movement) quicker.
When there is a load change in the process, the positioner assists the valve to achieve the stroke length per the controller’s instruction.

12. **What are the possible reasons if a control valve fails to open/close?**

Gland packing is too tight
Actuator bench set is not proper or suitable
Process load change is too high
Trim is an unbalanced type
Actuator spring is broken
Air supply to the valve positioner / actuator is close or high ..etc

13. **What is ‘gland packing’? Name the types of commonly used gland packing in P.D.O.?**

A sealing system in the valve body which prevents the process fluid coming out through the valve stem.
Commonly used gland packing in PDO are Teflon, Graphite Asbestos..etc

14. What is a 'lantern ring'? Where is it located on a control valve?

A greasing ring placed in the valve bonnet across the gland packing. The unit provides lubrication to the valve stem when lit travels up and down.

Vibration measurement

1.What is 'vibration'?

Vibration is defined as the motion of the equipment or its part to and from its rest (static) condition.

2.Explain following with their sensitivity (output) and the measuring units:

1) Radial B) Velocity C) Acceleration

Radial: A vibration measurement across the radius of a rotating shaft. It is measured in terms of Micron. The sensitivity of a radial vibration pickup (eddy probe) is 200mv DC/mill (refer to the drawings for the exact parameters).

Velocity: It is defined as the rate of change of distance travelled by the equipment. Velocity measurement is generally used for measuring the equipment body vibration. The sensitivity of a velocity pickup is 500mv DC/inch/sec (refer to the manufacturer drawings for the exact parameters).

Acceleration: It is defined as the rate of change of velocity. Acceleration measurement is generally used for measuring the equipment body vibration. The sensitivity of a velocity pickup is 100mv DC/inch/sec2 (refer to the manufacturer drawings for the exact parameters).

3.What is the resistance of an 'Eddy probe'?

An eddy probe resistance should be between 5-8 ohms.

4.Draw a sketch of an eddy probe calibration graph?

Eddy probe calibration graph

5.What is gap voltage? Why and how is it set?

Gap voltage is feed back voltage derived by setting the standard gap between the eddy probe tip and the rotating shaft.

The gap voltage is the base DC voltage set to get the AC pulses peak per the radial vibration measured on the shaft. The gap voltage is set at –8.00V DC i.e. equal to a gap of 40 mill (between the probe tip and the measuring surface).

6.Why an eddy probe and its probe driver is a matched pair?

Eddy probe output is always measured after the probe driver. The characteristic of the eddy probe slightly differs from one to another. Always an eddy probe is installed on the shaft, after measuring and plotting an eddy probe calibration graph with its driver. The calibration is done by adjusting the sensitivity potentiometer on the eddy probe driver assigned for that particular eddy probe.

7.What do the AC and DC signal represent in radial vibration, where 'AC is super imposed on DC'?

DC signal is the gap voltage set for –8.00V DC. DC signal is always present whether the unit is running or stopped.

8.How much is the radial vibration, if the signal measured on a DVM is 135.00mv AC?

The DVM measures the AC voltage in RMS (root mean square value).
AC peak to peak =135.00*2 root 2
=181.837mv
Eddy probe sensitivity=200mv/mill or 200mv/25.4 Microns
Hence, the vibration in Micron =(381.837*25.4)/200
=48.49 Micron

9.Why is vibration measurement very important on gas turbine and compressor?

Gas turbines and compressors are high speed rotating equipment. On equipment when vibration exceeds the manufacturer limits can cause sever damage to both itself and to its associated components/parts. Hence it is important to measure and monitor vibration on the running equipment. Generally a high vibration pre-alarm and shutdown limits are set as per the manufactures recommendations.

10.What type of vibration measuring instrument is used on a gas turbine? Where are the vibrations measuring points?

Since a gas turbine is hot engine, its bearing vibration measurement cannot be done through an eddy probe system. Generally a velocity or an acceleration pick-up is used for measuring and monitoring the vibration on the body of the gas turbine. The vibration pick-ups are generally installed on the turbine's CT/GP and PT points.

11.What is the type of vibration pick-up (contact or non-contact type) commonly installed on a gas turbine?

On gas turbine vibration measurement, the 'contact type' peck-up such as a velocity or acceleration pick-up is used.

12.What type of vibration measuring instrument is used on the compressors? Where is the vibration measuring points?

On a gas compressor shaft/bearing, measurement is carried out using a eddy probe displacement system.
On each gas compressor, on both forward and aft radial bearings (journal bearing) two eddy probes are installed in the 'x' and 'y' positions.

13.What is the type of vibration pick-up (contact type or non-contact type) commonly installed on a gas compressor?

A 'non contact type'- eddy probe is installed on gas compressors.

14.What is 'x or y function' and, 'x and y function' selection on a radial vibration monitor?

X or Y function: in this mode, the unit shutsdown when either 'X' or 'Y' probe detects a high vibration exceeding the setpoint.

X and Y function: in this mode, the unit shutsdown only when 'X' and 'Y' probes detects a high vibration exceeding the setpoint.

15.What is a 'Probe driver'? What does is it do? What is the other name for a probe driver?

Probe driver is an amplifier installed in the field closer to the sensor. It transmits the field vibration signal to the remote control panel. The other name for the probe driver is 'proximeter'. Radial, velocity and accelerometer probe drivers are of different types.

16.What are the three wires used on a probe driver?

The three wires terminated on the probe driver are: -24V DC (power supply), common and output signal.

17.What is a 'charge amplifier'? Where is it used?

Charge Amplifier is a probe driver installed for the accelerometer pick-up.

18.What is an ‘axial displacement’? How is it measured?

Axial displacement is the movement of the rotary shaft in the axial direction to and fro. Every centrifugal shaft is permitted to have a fixed axial movement designed by the manufacturer, this is to allow the compressor to take the load on the thrust collar.

Axial displacement is measure using an eddy probe system. It is measured using the proportional change in the DC voltage (gap voltage) caused by the movement of the shaft from its center position to either side (+or-).

19.What is the unit measurement of axial displacement?

Axial displacement is measured in terms of “Microns”

20.What is the term ‘float/end float’ in a compressor?

It is the free axial movement of the compressor shaft. End float is the maximum possible movement of the shaft. It is a small amount approximately 250 Microns (refer to the manufacturer drawings for drawings for the exact parameters).

21.What are the following assessments/recommendations of a vibration analysis? How are they corrected?

1) misalignment b)unbalance c)overhauling

Misalignment: misalignment may cause two time RPM vibration. This is corrected by re-aligning the compressor shaft one to another.

Unbalance: unbalance in the compressor shaft may cause one time RPM vibration. This is corrected by balancing the compressor shaft on a balancing wheel.

Overhauling: multiple RPM vibration is symptom of damaged bearings. This is corrected by a total overhaul of the compressor or replacement of parts.

(The above are only a simple clue and not a standard confirmed judgment)

22.What precautions are to be taken when installing a vibration measuring instrument?

Vibration measuring instrument such as a eddy probe, velocity and acceleration pick-ups, eddy probe drivers, charge amplifiers are sensitive instruments. The following care has to be taken while installing in the field.

-Do not drop the instrument, this may result in the loss of their characteristic.

-Fixing and tightening to be done as per the manufacturers recommended torque.
-Proper care of the signal cable insulation.
-Prevent any loose connections.
-…Etc.

23.What are the reasons for a vibration ‘spike signal’?

The following may cause a ‘spike signal’ in the vibration measurement.
-Loss of signal cable insulation.
-Signal cable passing next to high voltage lines.
-Improper earthing facility.
-Grounding of the wires.
-Loose mounting of the instrument field components
-…Etc.

24.List the manufacturers names of vibration measuring instruments?

The common vibration measuring instrument manufacturers are:
1. Bently nevada
2. Dymac
3. Bell and Howell

25.Which of the above manufacturer’s product is more reliable and why?

With past experience, it is observed that the ‘Bently nevada’ vibration measuring system is more reliable due to its component layout on the control panel, accuracy and high gauge signal cable system in the field.

Bearing temperature measurement

1.what approximately is the bearing high temperature alarm and shutdown setting?

High speed bearings are protected against high temperatures. The high temperature alarm and shutdown instrument are generally set at 95degee C and 105degee C (refer to the station drawings for the exact settings/parameters).

2.What types of primary elements are used to measure the compressor bearing temperature? Give example with the equipment name.

At lower range of temperature ‘RTD’ (resistance temperature detector)is preferred to thermo-couples.

On dresser gas compressors: PT 100-RTD is used for measuring the journal and thrust bearing temperature.

On solar gas compressors: ‘k’ type thermo-couple is used for measuring the journal and thrust bearing temperature.

3.What maybe the reasons, if a compressor bearing temperature increases?

The following are the possible for compressor bearing temperature rise:
- Defective bearing
- Low lube oil supply pressure
- Aged lube oil
- Excessive compressor load
- Dirty lube oil cooler
- Lube oil cooler fan running at low speed
- Defective thermostatic valve in the lube oil to cooler line
- …etc.
-

4.which of the two-‘resistance and thermo-couple’- is recommended for measuring a bearing temperature?

Resistance Temperature Detector- RTD is preferred to thermo-couple for measuring the bearing temperature. RTD is more accurate and linear in measuring temperature between the range -200degee C to +200degee C.

5.What are the bearing temperature instrument manufactures names?

PDO is using the following manufacture instruments for measuring the bearing temperature:
DYMAC, RIS-Rochester instruments Ltd.…etc.

6.Which of the above manufacturer’s product is more reliable and why?

RIS-Rochester Instrument Ltd. Performance is better than DYMAC.
- RIS has less drifting in temperature measurement.
- On line zero and span can be read
- Individual card output can be recorded
- Choice can be made in the input for a RTD or a Thermo-couple

Fire detection system

1.What is a ‘fire triangle’?

A fire triangle represents the three elements, which causes a fire in a combustible mixture. The three elements are fuel, air and ignition.

2.What is importance or a ‘hood’ on a gas turbine?

During a gas turbine normal running condition, a hood provides:
- prevention of turbine high dB noise to outside areas
- keeps the gas turbine clean from external dust
- provides a draft for the gas leak to the exhaust through the hood fan

During a gas turbine shutdown condition a hood provides:

- cooling the turbine body by way of the hood fan
- During a fire shutdown it facilitates to put out the fire by confining the fire extinguishers on the gas turbine.
-

3.Why do we use 'Halon' as a fire extinguisher in a gas turbine hood?

Halon is stored in liquid form in a cylinder. When it is released in a hood during the occurrence of the fire, it discharges the halon in gas from. Halon does not act or react on electrical components.

4.What is the expansion from of B.C.F?

The expansion form of B.F.C is Bromo chloro floride.

5.In a Ruston gas turbine, why are there two Halon cylinders in each bank? How do they function?

The first bottle is the 'first shot' and the second bottle is 'Extended shot'. The first bottle discharges the Galon into the hood through a 1'' pipe in approximately 15 seconds, where as the extended bottle discharges the Halon through a ¼'' pipe for another ½''hour period to maintain the inert atmosphere.

6.How many UV detectors are installed in Solar, Ruston TB-5000 and Ruston TA-1750 gas turbine hoods?

Solar gas turbine hood: 4 UV detectors
Ruston TA-1750 hood: 4 UV detectors
Ruston TB 5000 hood: 12UV detectors

7.What is voting Logic of UV detectors in Soar and Ruston gas turbines?

There are two voting logics, they are: 1 out of 4 UV s and 2 out of 4 UV s

8.What happens when UV detectors detect a fire?

1out of 4 UV s: creates annunciation, audible alarm on the control panel and siren in the field (refer to the station drawings for the exact function and operations).

2 out of 4 UV s: creates annunciation, audible alarm on the control panel, a siren in the field, shutdown of the turbine and release of the fire extinguisher (refer to the station drawings for the exact function and operations).

9.How much is the time delay between fire sensing by a UV detector and confirming with an alarm?

Generally it is set for 4 secs. The UV detectors initiates a fire alarm only when the UV is detecting the fire continuously for 4 secs (refer to the station drawings for the exact settings parameters).

10.What are the Halon manual release facilities available on a Solar gas turbine?

Auto Halon cylinder can be discharged manually from the fire & gas control panel in the control room. On instiating the manual release:
- The unit shuts down.
- The auto Helon cylinder gets discharged in the hood.
- Auto halon discharge confirmation and the auto Halon cylinder pressure low alarm appears on the control panel.
- Audible alarm in the control room and siren in the field occurs.

Manual Halon cylinder can discharged manually from the field through a pall string. On initiating the manual release:
- The unit shutsdown.
- The manual Halon cylinder gets discharged in the hood.
- Manual Halon discharge confirmation and the manual Halon cylinder pressure low alarm appears on the control panel.
- Audible alarm in the control room and siren in the field occurs.

11.Why are there 'heat switches' in side the hood, when there are UV detectors?
Heat switches are a mechanical type and they are considered to be a positive type of fire detection system. The heat switch settings are much higher than the hood temperature.

12.What maybe the reasons if a unit shutdown on false heat detected alarm?

The reason could be:
- Hood ventilation fan has failed or stopped.
- Major hot gas leak inside the hood.

13.What happens when a heat switch actuates?

On detection of heat, the heat switch initiates the following.
Annunciation, audible alarm on the control panel, a siren in the field, shut down of the turbine and release of fire extinguisher (refer to the station drawings for the exact settings parameters).

14.Wxplain the operating principle of a gas monitor?

Gas monitor measures the imbalance in the current loop caused by its active and in-active filaments in the presence of a combustible gas.

15.Explain the calibration procedure of a gas monitor system.

- Gas sensor loop current or voltage at the sensor head is set as per the manufacturer's recommended value.
- Gas monitor zero is adjusted to the instrument air.
- A test gas with a known quantity of combustion gas (Generally methane 2% by volume) is fed to the sensor and the span is adjusted to read 40% on the monitor scale (refer to the station drawings for the exact settings parameters).
- The calibration procedure is repeated until the zero and span reads correctly.

16.What are the alarm and shut down setting on a gas monitor?

Generally on the gas monitor, the alarm is set at 20%rising and the shut down is set at 60%rising (refer to the station drawing for the exact settings parameters)

17.What has to be done prior to entering a gas turbine hood?

Prior to entering a gas turbine, turn on the 'ventilation defeat switch'.

18.What is a ventilation defeat switch?

On activating, the ventilation defeat switch inhibits the release of Halon in the auto mode and also the unit shutdown on 'ventilation failure'.

19.How much is the delay between fire detection and Halon release? Why is the time delay required?

A time delay of 15 secs. Is set between the detection of fire and the initiation of Halon release. This is to achieve effective fire extinguishing by allowing the hood fan to run-down to zero speed and the bleed valves to release the compressed air.

20.What does a hood ventilation fan do when a fire is detected? And why?

On detection of fire, the fire system initiates the hood fan shutdown. This is to minimize the presence of air the hood for releasing the extinguisher.

Gas detection system

1.What is a 'combustible gas mixture'?

Combustible gas mixture is the proper ration of fuel and air within the ignition limits.

2.Explain the operating principle of a gas detection system.

Gas detection system measures the imbalance in the current loop caused by its active and in-active filaments in the presence of a combustible gas.

3.Why is gas detection as important as fire detection?

Presence of combustible gas Is the first stage of a possible occurrence of a fire.

4.What are the components used in a gas detection loop?

A gas sensor, 3 wire system and a gas monitor.

5.What is a 'flame arrester' in a gas sensor? What does it do?

Flame arrester is used on the sensors head. The sensors are continuously powered to burn the combustible gas for measuring. The flame arrester prevents the occurrence of fire outside the sensor.

6.What are the name of the filaments inside the gas sensor?

There are two filaments. They are called 'active' and 'non-active' filaments.

7.How much approximately is the resistance of a gas sensors filament?

From manufacturer to manufacture the sensor resistance varies. It is approximately 3 ohms on each of the filament (refer to the station drawings for the exact parameters).

8.How to check a gas monitor without test gas?

Some gas monitors are provided with a self test facility to check its alarm and shutdown functions(levels).

9.Why is a three wire system used on the sensors?

The three-wire system is used to compensate the line resistance. The active and non-active filament loop form a whetstone bridge in the gas monitor. The amount of unbalance in the current loop during the occurrence of combustible gas is detected as the percentage of combustible gas.

10.What are the types (manufacturer) of gas monitor systems used in P.D.O.?

The commonly use gas monitor systems are:

1. General monitor
2. Seiger monitor
3. Detection instruments

11.What is test gas used to calibrate a gas monitor?

Methane gas is used for calibrating a gas monitor.

12.How much is the gas concentration in the test gas cylinder?

Generally methane 2% by volume is used as a test gas to calibrate a gas monitor.

13.What is the important factor set on a gas monitor loop?

Depending on the manufacturer, either it is the loop current or the voltage at the sensor head which has to be set precisely for better accuracy and sensitivity.

14.why is it that Halon is not released on a high gas shutdown alarm in a gas turbine hood?

Halon (fire extinguishing agent) is not released on detection of combustible gas because the presence of gas is not a fire.

15.Why are there gas sensors on the combustion air intake of Ruston TB-5000gas turbines?

The presence of combustible gas in the air intake may result in the failure of stopping the gas turbine during a shutdown, due to the fuel and air mixture continuously available to the turbine.

Smoke detection system

1.What are the types of 'smoke detectors' in use in P.D.O.?

Two types of smoke detectors are used in PDO. They are:
1. Optical type, 2. Radioactive type, 3. Ionisation type.

2.Explain the operating principle of the different types of smoke detectors.

Optical type: when the smoke cuts the optical detection path, and unbalance in the detector current loop raises a smoke alarm. These type detectors are sensitive to larger particles of combustion 0.5 to 10 microns. It is suitable for applications where thermal turbulence can be expected.

Radio active type: when the smoke is detected by the radio active substance, the unbalance in the detector current loop raises a smoke alarm.

This type of detectors are sensitive to air movement greater than 5m/sec. It is normally installed with the photoelectric (optical type) type smoke detectors.

3.Why is a smok4e detector as important as a 'heat switch' and 'UV detector'?

Smoke detectors are used in confined areas such as control rooms and electrical switch rooms.

4.Where are smoke detectors generally installed in P.D.O.?

Smoke detectors are used in confined areas such as control rooms and electrical switch rooms.

5.What happens when a smoke detector detects smoke?

When a smoke detector detects smoke, the detector loop current changes. The unbalance in the loop current is detected as smoke.

Once in every 10 secs the L.E.D on each smoke detector blinks as self loop check. On detection of smoke, this L.E.D remains continuous on (bright).

6.name the manufacturers of smoke detection systems.

Name of the smoke detector manufactures are Firecheta, Cloride Gent…etc.

7.why are periodic checks and maintenance required on smoke detection system?

Particularly on the optical type smoke detectors, the collection of dust in the sensor path may result in a false alarm. Also the periodic maintenance ensures the reliability of the detection system.

8.What are the common problems faced when maintaining a smoke detection system?

- False alarm due to accumulation of dust, floor cleaning, water vapour
- Loose connection results in the fluctuation of the detector loop current.

Improper base plug-in connection.