

INSTRUMENT QUESTIONS



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INSTRUMENTATION**

INTRODUCTION :

It is the branch of engineering which deals with the measurement, monitoring, display etc. of the various of energy exchanges which take place during process operations. "In short Instrumentation is the study of Instrument."

INSTRUMENT :

Instrument is a devices which is used to measure, monitor, display etc. of a process variable.

Que. : What are the process Variable ?

Ans. : The process Variable are :

1. Flow
2. Pressure
3. Temperature
4. Level
5. Quality i. e. % D2, CO2, pH etc.

Que. : Define all the process Variable and state their unit of measurement. ?

Ans. : FLOW : Kg / hr, Litter / min, Gallon / min. M3 / NM3 / HR. (GASES)

PRESSURE : Force acting per unit Area. $P = F/A$

Units : Bar / Pascal / Kg / CM /, Pounds

LEVEL : Different between two heights.

Units : Meters, mm, cm, %.

TEMPERATURE : It is the degree of hotness or coldness of a body.

Units : Degree Centigrade, Degree Fahrenheit, Degree Kelvin, Degree

Rankine.

QUALITY : It deals with analysis

pH, % CO2, % O2, Conductivity, Viscosity.

Que. : What are the primary elements used for flow measurement. ?

Ans. : The primary elements used for flow measurement are :

1. Orifice Plate.
2. Venturi tube.
3. Pitot tube.
4. Annubars.
5. Flow Nozzle.

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6. Weir & Flumes._

Que. : What are the different types of orifice plates and state their uses ?

Ans. : The different types of orifice plates are :

1. Concentric.
2. Segmental.
3. Eccentric.
4. Quardent.

CONCENTRIC :

The concentric orifice plate is used for ideal liquid as well as gases and steam service. This orifice as a hole in concentric and hence known as concentric orifice.

Eccentric & Segmental :

The eccentric orifice plate has a hole eccentric. The use this is made in viscous and sherry flow measurement.

The segmental orifice place has the hole in the form segment of a circle. This is used for colloidal and sherry flow measurement.

Que. : How do you identify an orifice in the pipe line. ?

Ans. : An orifice tab is welded on the orifice plate which extends our of the line giving an indication of the orifice plate.

Que. : Why is the orifice tab provided. ?

Ans. : The orifice tab is provided due to the following reasons.

1. Indication of an orifice plate in a line.
2. The orifice diameter is marked on it.
3. The material of the orifice plate.
4. The tag no. of the orifice plate.
5. The mark the inlet of an orifice.

Que. : What is Bernoulli's theorem and where it is applicable. ?

Ans. : Bernoulli's theorem states the "total energy of a liquid flowing from one point to another remains constant." It is applicable for non compressible liquids.

Que. : How do you identify the H. P. side or inlet of an orifice plate in line. ?

Ans. : The marking is always done H. P. side of the orifice tab which gives an indication of the H. P. side.

Que. : How do you calibrate a D. P. transmitter. ?

Ans. : The following steps are to be taken which calibrating :

1. Adjust zero of the Xmtrs.

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2. Static pressure test : Give equal pressure on both sides of the transmitter. Zero should not shift. If it is shifting carry out static alignment.
3. Vacuum test : Apply equal vacuum to both the sides. The zero should not shift.
4. Calibration Procedure :
 1. Give 20 psi air supply to the transmitter.
 2. Vent the L.P. side to atmosphere.
 3. Connect output of the Instrument to a standard test gauge. Adjust zero.
 4. Apply required pressure to high pressure side of the transmitter and adjust the span.
 5. Adjust zero again if necessary.

Que. : What is the seal liquid used for filling impulse lines on crude and viscous liquid ?

Ans. : Glycol.

Que. : How do you carry out piping for a Different pressure flow transmitter on liquids, Gas and steam services ? Why ?

Ans. : Liquid lines :

On liquid lines the transmitter is mounted below the orifice plate. Since liquids have a property of self draining.

Gas Service :

On gas service the transmitter is mounted above the orifice plate because Gases have a property of self venting and secondly condensate formation.

Steam Service :

On steam service the transmitter is mounted below the orifice plate with condensate pots. The pots should be at the same level.

Que. : Draw and explain any flow control loop ?

Ans:



Que. : An operator tells you that flow indication is more ? How would you start checking ?

- Ans. :
1. First flushing the transmitter. Flush both the impulse lines. Adjust the zero by equalizing if necessary. If still the indication is more then.
 2. Check L.P. side for choke. If that is clean then.
 3. Check the leaks on L.P. side. If not.
 4. Calibrate the transmitter.

Que. : How do you do a zero check on a D.P. transmitter ?

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Ans. : Close one of the valve either H.P. or L.P. open the equalizing valve. The O/P should read zero.

Que. : How would you do Glycol filling or fill seal liquids in seal pots ? Draw and explain.

Ans. : The procedure for glycol filling is :

01. Close the primary isolation valves.
02. Open the vent on the seal pots.
03. Drain the use glycol if present.
04. Connect a hand pump on L.P. side while filling the H.P. side with glycol.
05. Keep the equalizer valve open.
06. Keep the L.P. side valve closed.
07. Start pumping and fill glycol.
08. Same repeat for L.P. side by connecting pump to H.P. side, keeping equalizer open and H.P. side isolation valve closed.
09. Close the seal pot vent valves.
10. Close equalizer valve.
11. Open both the primary isolation valves.

Que. : How do you calculate new factor from new range using old factor and old range ?

Ans. : $\text{New Factor} = \frac{_}{\text{New Range}}$

$\text{Old Factor} = \frac{_}{\text{Old Range}}$

$\text{Flow} = K \frac{_}{\text{Range}}$

$Q = \text{Factor} \times \text{Unit Flow}$

$\text{New Factor} = \text{Old Factor} / \frac{_}{\text{Old Range}} \times \frac{_}{\text{New Range}}$.

Que. : How will you vent air in the D.P. cell ? What if seal pots are used ?

Ans. :

1. Air is vented by opening the vent plugs on a liquid service transmitter.
2. On services where seal pots are used isolate the primary isolation valves and open the vent valves. Fill the line from the transmitter drain plug with a pump.

Que. : Why is flow measured in square root ?

Ans. : Flow varies directly as the square root of differential pressure $F = K \text{ square root of } \Delta P$. Since this flow varies as the square root of differential pressure the pen does not directly indicate flow. The flow can be determined by taking the square root of the pen. Say the pen reads 50% of chart.

DEFINITION.

ACCURACY :

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A number or quantity which defines the limit of error under reference conditions.

ATTENUATION :

A decrease in signal magnitude between two points, or between two frequencies.

DEAD TIME :

The interval of time between initiation of an impact change or stimulus and the start of the resulting response.

DRIFT :

As undesired change in output over a period of time, which change is unrelated to input, operating conditions, or load.

ERROR :

The difference between the indication and the true value of the measured signal.

SPAN ERROR :

It is the difference between the actual span and the specified span and is expressed as the percent of specified span.

ZERO ERROR :

It is the error of device operating under the specified conditions of use when the input is at the lower range value.

STATIC GAIN :

It is the ratio of the output change to an input been change after the steady state has been reached.

HYSTERESIS :

The maximum difference between the upscale and downscale indications of the measured signal during a full range traverse for the same input.

INTERFERENCE :

Interference is any spurious voltage or current arising from external sources and appearing in the circuits of a device.

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COMMON MODE INTERFERENCE :

It is the form of interference which appears between the measuring circuit terminals and ground.

NORMAL MODE INTERFERENCE :

It is the form of interference which appears between measuring circuit terminals.

LINEARITY :

The closeness to which a curve approximate a straight line.

RANGE :

The region between the limits within which a quantity is measured received or transmitted, expressed by stating the lower and upper range values.

REPEATABILITY :

The closeness of agreement among a number of consecutive measurements of the output for the same value of the measured signal under the same operating conditions.

REPRODUCIBILITY :

The closeness of agreement among repeated measurements of the output for the same value of the input made under the same operating conditions.

RESPONSE :

It is the general behavior of the output of a device as a function of input both with respect to time.

SIGNAL TO NOISE RATIO :

Ratio of signal amplitude to noise.

TIME CONSTANT :

The time required for the output to complete 63.2 % of the total rise or decay.

SPAN :

The algebraic difference between upper and lower range values.

ZERO SHIFT :

Any parallel shift of the input output curve.

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P R E S S U R E.

PRESSURE CONVERSIONS :

$$\begin{aligned} 1 \text{ psi} &= 27.74 \text{ " H}_2\text{O} \\ 1 &= 14.223 \text{ psi} \\ \text{Kg/cm}^2 & \\ &= \\ 1 \text{ Bar} &= 14.504 \text{ psi} \\ 1 \text{ Kpa} &= 0.145 \text{ psi} \\ 1 &= 10.000 \text{ mm of} \\ \text{Kg/cm}^2 &= \text{H}_2\text{O} \\ &= \\ 1 \text{ Bar} &= 1.0197 \\ &= \text{Kg/cm}^2 \\ 1 &= 0.98 \text{ Bar} \\ \text{Kg/cm}^2 & \\ &= \\ 1 \text{ Torr} &= 1 \text{ mm of Hg.} \end{aligned}$$

Que. : What is absolute pressure ?

Ans. : Absolute pressure is the total pressure present in the system

Abs. pressure = Gauge pressure + Atm. pressure.

Que. : What is absolute zero pressure ?

Ans. : Absolute zero = 760 mm Hg Vacuum.

Que. : What is the maximum Vacuum ?

Ans. : The maximum Vacuum = 760 mm Hg.

Que. : What is Vacuum ?

Ans. : Any pressure below atmospheric pressure is vacuum.

Atm = 760 mm 0 Vacuum Zero Gauge

_____ Max. Vacuum 760 mm HG

Zero Absolute.

Que. : What are the primary elements for measuring pressure ?

Ans. : The primary elements used for measuring pressure are :

1. Bourdon tube.
2. Diaphragm.
3. Capsule.
4. Bellows.
5. Pressure Springs.

The above are known as elastic deformation pressure elements.

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Type of Bourdon tubes.

1. 'C' type.
2. Spiral.
3. Helix.

Diaphragm : The diaphragm is best suited for low pressure measurement.

Capsules : Two circular diaphragms are welded together to form a pressure capsule.

Material Used : phosphor bronze, Ni-spand stainless steel.

Bellows : Bellows is a one - piece, collapsible, seamless metallic unit with deep folds formed from very thin walled tubing.

Material used : Brass, phosphor bronze, stainless steel. Used for high pressure.

PRESSURE SPRINGS : Pressure springs of helical or spiral shape used for measuring high pressures.

Que. : What is the principle of a pressure gauge ?

Ans. : Pressure works on Hooke's law.

Principle : "Measuring the stress in an elastic medium"

Que. : Draw and explain a pressure gauge ? What is the use of a Hair spring ?

Ans. : The parts of a pressure gauge are :

1. 'C' type Bourdon tube.
2. Connecting link.
3. Sector gear.
4. Pinion gear.
5. Hair Spring.
6. Pointer.
7. Dial.

Uses of Hair Spring : Hair spring serves two purposes name

1. To eliminate any play into linkages.
2. It serves as a controlling torque.

Que. : How will you calibrate an absolute pressure transmitter vacuum manometer Range 0-400mm abs. ?

Ans. : The procedure for calibration is as follows :

1. Connect air supply to the transmitter.
2. Connect a test gauge of 0-1.4 Kg/cm² to the output.
3. Connect Vacuum pump with tee off to the manometer.
4. Apply 760 mm Vacuum (or nearest) and adjust zero.
5. Apply 360 mm Vacuum adjust span. (760 - 360 = 400 mm abs.)

Que. : You are given a mercury manometer range 0 -760 mm ? A vacuum gauge reads 60 mm vacuum. The test manometer reads 50 vacuum ? Which of the two is correct.

Ans. : The transmitter is correct because 760 - 50 = 710 mm abs.

LEVEL

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Que. : Explain the different methods of level measurement in brief ?

Ans. : There are two ways of measuring level :

(1) Direct & (2) Indirect.

(1) DIRECT LEVEL MEASUREMENT :

1. BOB AND TOP :

2. SIGHT GLASS : This consists of a graduated glass tube mounted on the side of the vessel. As the level of the liquid in the vessel change, so does the level of the liquid in the glass tube.

(2) INDIRECT LIQUID LEVELMEASUREMENT :

1. PRESSURE GAUGE : This is the simplest method, for pressure gauge is located at the zero level of the liquid in the vessel. Any rise in level causes an increase of pressure which can be measured by a gauge.

2. PURGE SYSTEM : In this method a pipe is installed vertically with the open end at zero level. The other end of the pipe is connected to a regulated air supply and to a pressure gauge. To make a level measurement the air supply is adjusted so that pressure is slightly higher than the pressure due to height of the liquid. This is accomplished by regulating the air pressure until bubbles can be seen slowly leaving the open end of the pipe.

The method above are suitable for open tank applications. when a liquid is in a pressure vessel, the liquid column pressure can't be used unless the vessel pressure is balanced out. This is done through the use of different pressure meters.

DIFF.PRESSURE METHOD : Connection are made at the vessel top and bottom, and to the two columns of the D.P. meter. The top connection is made to the L.P. column of the transmitter and the bottom to H.P. column of the transmitter. The difference in pressure in the vessel is balanced out, since it is fed to both the column of the meter. The difference in pressure deducted by the meter will be due only to the changing, level of the liquid.

DISPLACER TYPE LEVEL MEASUREMENT :

The leveltrol is one of the most common instruments used measuring level in closed tanks. This instrument works of Archimedes principle. The displacer is immersed in the liquid due to which there is loss of weight depending on the specified gravity of the liquid. This displacer hangs freely on a knife transmitted to the pneumatic or electronic counterpart at the other end.

Que. : Explain how you will measure level with a different pressure transmitter.

Ans. : The bottom connection of the vessel is connected to high pressure side of the transmitter.

Different Pressure = $H \times D$

This difference pressure is applied to H.P. side of the transmitter and calibrated.

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Que. : How is D.P. transmitter applied to a close tank ?

Ans. : In close tank the bottom of the tank is connected to the high pressure side of the transmitter and top of the tank is connected to L.P. side of the transmitter. In this way the vessel pressure is balanced.

Que. : How is D.P. transmitter applied to an open tank ?

Ans. : On an open tank level measurement the L.P. side is vented to atmosphere. Whatever pressure acts is on the H.P. side which is a measure of level.

Que. : What is purge level system ?

Ans. : This method is also known as bubbler method of level measurement. A pipe is installed vertically with its open end at the zero level. The other end of the pipe is connected to a regulated air supply and to a pressure gauge or to ΔP transmitter. To make a level measurement the air supply is adjusted so that pressure is slightly higher than the pressure due to the height of the liquid. This is accomplished by regulating the air pressure until bubbles can be seen slowly leaving the open end of the pipe. The gage then measures the air pressure needed to overcome the pressure of the liquid.

$$\Delta P = H \times D$$

USE : On for corrosive liquids where the transmitter cannot be directly connected to process eg... Acids, Some organic liquids.

Que. : Explain the working of a leveltrol.

Ans. : The leveltrol is used for measuring level of liquids in a closed vessel.

PRINCIPLE. : It works on Archimedes principle "The loss in weight of a body immersed in a liquid is equal to amount of liquid displaced by the body". The leveltrol basically consists of the following :

DISPLACER : It consists of a cylindrical shape pipe sealed and filled inside with sand or some weight. The purpose of this is to convert change in level to primary motion. The variation in buoyancy resulting from a change in liquid level varies the net weight of the displacer increasing or decreasing the load on the torque arm. This change is directly proportional to change in level and specific gravity of the liquid.

RELAY : Amplifies pressure variations at the nozzles.

REVERSING ARC : It is used for the following purposes.

1. Motion take off from Torque tube.
2. Means of reverse control action.
3. Adjustment for specific gravity.

PROPORTIONAL UNIT. : Converts primary motion to a proportional output air pressure.

CONTROL SETTING UNIT : Provides a motion of varying the set point.

Que. : Explain the working of an electronic leveltrol.

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Ans. : The variation in buoyancy resulting from a change in liquid level, varies the net weight of the displacer increasing or decreasing the load on the torque arm. This change is directly proportional to the change in level and specific gravity of the liquid. The resulting torque tube movement varies the angular motion of the rotor in the RVDT (Rotary Variable Differential Transformer) providing a voltage change proportional to the rotor displacement, which is converted and amplified to a D.C. current.

Que. : How will you reverse an action of the leveltrol.?

Ans. : The reversing arm serves as motion take off arm from the torque tube. It is provided with a slot on each side of the center so that link can be connected either for reverse or direct action.

Que. : What is interface level ? How do you calculate it ?

Ans. : When a vessel is filled with two liquids of two different specific gravities the level measurement refers to as interface level.

$$DP = H (D - d)$$

On a level set the difference of two specific gravities.

Que. : How will you calibrate a leveltrol in the field ?

Ans. : 1. First close both the primary isolation valves and drain the liquid inside the chamber.

2. Adjust the zero to get 0% output.


3. Connect a transparent PVC tube to the drain point as shown in hook up.

4. Fill it to the center of the top flange.

5. Adjust the specific gravity or span adjustment (Electronic Level).

6. Fill it up to 50 %, check linearity.

Que. : How will you calibrate on interface level control. ?

Ans. : On,  two different specific gravities.

1. The level will be zero when it is full of lighter liquid.

$$\text{Zero \% level} = H \times d.$$

H = Displacer length

d = Specific gravity of lighter liquid.

2. The level will be 100 % when it is full of heavier liquid.

$$100 \% \text{ level} = H \times D.$$

D = Specific gravity of heavier liquid.

Calibration : (with water)

1. Fill H X d level with water adjust zero.

2. Fill H X D level with water adjust Sp. gravity or span.

3. Check linearity.

Que. : How will you apply wt. test calibration to a leveltrol.

Ans. : Wt. test calibration method :

1. Remove the displacer from the torque arm.

2. Apply equivalent weight on the torque arm that is equal to the wt. of the displacer.

Adjust zero % output.

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3. For Span : $V = TTr2h$

Loss in weight = Wt. of float - wt. of the float immersed in liquid

Loss in weight = [wt. of float - Vol. x d]

Span wt. = (wt. of float - Loss in wt.)

r = radius of the displacer.

h = ht. of displacer.

4. Apply equivalent wt. equal to the (Wt. of float - Loss in weight). Adjust Span to get 100 % out put.

5. To check linearity apply average of the two weights.

Que. : What will happen if the displacer has fallen down while in line ?

Ans. : The output will be minimum. (wrong)
The output will be maximum (100 %) true.

Que. : What will happen if the displacer has a hole in it while in line ?

Ans. : The output will be maximum.

Que. : What is the used of Suppression and elevation ?

Ans. : Suppression and elevation are used on Level applications where (1) transmitters are not mounted on some level (2) Wet leg. i.e. condensable vapors are present.

Que. : What are the limitations of leveltrol ?

Ans. : The limitations of a level control that it cannot be used for lengths more than 72".

Que. : How will you commission D.P. transmitter in field in pressurized vessel.

Ans. : 1. Close both the isolation valves, Vent the H.P. side.
2. Fill it with the sealing liquid.
3. Open the L.P. side vent valve.
4. Adjust zero with suppression spring.
5. Close the L.P. side vent valve.
6. Open both the isolation valves.

Que. : How will you check zero of a level D.P. transmitter while is line ?

Ans. : 1. Close both the isolation valves.
2. Open the vent valve on L.P. leg and H.P. leg drain.
3. Check and adjust zero if necessary.

Que. : Explain the working of an Enraf level gauge ?

Ans. : The Enraf level precise level gauges are based on servo powered null balance technique. A displacer serves as continuous level sensing element.

Principle :

A displacer A with a relative density higher than that of a product to be measured, is suspended from a stainless steel wire B that is attached to a measuring drum. A two phase servo motor controlled by a capacitive balance system winds/unwinds the measuring wire until the tension on the weight springs is in balance with the wt. of the displacer part immersed in the liquid. The sensing system in principle measures the two capacitance formed by the moving central sensing rod E provided with two capacitor plates and the side plates. In balance position the capacitance are of equal value. A level variation will cause a

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difference in buoyancy of the displacer. The center sensing rod will move in to direction of one of the side capacitor plates. This causes difference in value of this capacitance. By an electrolyte rotation of the servo motors the can driven transmitter continuously change the voltage pattern to remote indicate of which the receiver motor drives a counter indicating low variation.

TEMPERATURE

Que. : What are the different methods of temperature measurement ? Explain.

Ans. : The different methods of temperature measurement are :

1. MECHANICAL 2. ELECTRICAL.

MECHANICAL METHOD :

1. Mercury in glass thermometers : This consists of a glass tube of very fine bore joined to a reservoir at the bottom and sealed at the top. A measured quantity of mercury is the enclosed. When the thermometer is heated the mercury expands much more than the glass and is therefore forced to rise up in the tubing A scale is fixed at the side.

2. Bimetallic Thermometer : Two metals whose coefficient of linear expansion is different are welded and rolled together to the desire thickness. The actual movement of a bimetal is its flexivity with one end fixed, a straight bimetal strip deflects in proportion to its temperature, to the square of its length and inversely with its thickens.

Pressure Spring Thermometers :

There are four classes of pressure spring thermometers.

1. Liquid filled.
2. Vapor pressure.
3. Gas filled.
4. mercury filled.

Liquid filled & Mercury filled :

Both type, operate on the principle of thermal expansion. Where the bulb is immersed in a heated substance. The liquid expands causing the pressure spring to unwind. The indicating, recording or controlling mechanisms are attached to pressure spring.

Compensated Thermometer System :

Compensations are provided in order to nullify the effect of changes in ambient temperature. The compensation in liquid filled expansions thermal system consists of the second tubing and helical element, both liquid filled. The two elements are so constructed that the measuring helical floats on a movable base the position of which is governed by the compensating helical. The two tubing and helicals are matched in volume so that variation in temperature at the instrument case and along the capillary tubing produce equal motion from both helicals. Such motion nullity each other so that only motion produced by varying the bulb temperature actuates the recorder pen.

Gas filled Thermometers :

This type depends upon the increase in pressure of a confirm gas (constant volume) due to temp. increase. The relate between temp. and pressure in this kind of system follow Charles law and may be expressed.

P1

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P2

The system is filled under high pressure. The increase pressure for each degree of temperature rise is therefore greater than if the filling pressure were low. Nitrogen the gas most after used for such systems, because it chemically inert and possesses a favorable coefficient thermal expansion.

Vapor - Pressure Thermometers :

Vapor pressure thermometers depend upon vapor pressure of liquid which only partially fills the system. At low temperatures the vapor pressure increase for each unit temperature change is small, at higher temperature the vapor pressure change is much greater.

ELECTRICAL METHOD OF TEMPERATURE MEASUREMENT :

1. THERMOCOUPLES : It is a simple device consisting of a dissimilar metal wires joined at their ends. when an of each wire is connected to a measuring instrument thermocouples becomes an accurate and sensitive temperature measuring device.

Type of Thermocouples :

1. Iron - Constantan (J) ---- 0 - 800°C.
2. Chromel Alumel (K) ---- 0 - 1000°C.
3. Platinum - Platinum %
Rhodium ---- 0 - 1500°C.
4. Platinum - Rhodium 13% (S) ---- 0 - 1700°C.
5. Chromel - Constantan (E) ---- 0 - 700°C.
6. Copper - Constantan (T) ---- 0 - 400°C.

RESISTANCE - TEMPERATURE DETECTERS (RTD) :

RTD's are generally used for precise temperature measurement. It consists of a fine wire wrapped around an insulator and enclosed in a metal. The metal sheath of a resistance thermometer resembles that of bimetallic thermometer bulb.

PRINCIPLE : "Resistance increases as temperature increase"

$$R_t = R_o (1 + \alpha t)$$

R_t = Resistance of Temperature to measured.

R_o = Resistance of zero temperature.

α = Co. of thermal (expansion).

t = Temperature to be measured.

These metals have a positive temperature co-efficient of expansion. Therefore resistance increases as the temperature increases.

CALCULATION OF RESISTANCE FOR Pt100.

$$R_o = 100$$

$$\alpha \text{ for platinum} = 0.00385 / ^\circ\text{C}$$

To calculate Resistance at 100°C.

$$R_{100} = 100 [1 + (38.5 \times 10^{-4} \times 100)]$$

$$= 100 + (100 \times 0.385)$$

$$R_{100} = 138.5$$

$$\text{Resistance at } 100^\circ\text{C} = 138.5$$

Que. : What is Pt 100 mean. ?

Ans. : Pt100 means 100 OHMS at 0°C for a platinum resistance bulb.

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Que. : What is two wire and three wire R.T.D. system ?

Ans. : Two wire R .T .D. system :

Two wire RTD system use for short distance like a compressor field local panel.

Three wire System :

Three wire system use for long distance coke a field to control Run.

The third wire is used for compensation of lead wire resistance.

Que. : Draw a potentiometric temp. measuring circuits and explain its . ?

Ans. :

OPERATION :

The input to the instrument is a measurement of some in the processes using a sensing element (such as thermocol) or a device to produce direct voltage, which is the voltage (signal). This voltage is subtracted from a voltage developed by a known constant voltage in a potentiometric measuring circuit. The subtraction occurs by connecting two voltages in series with the opposing polarity, difference between these two voltages produces signal, the voltage going to the amplifier. The error will positive or negative depending on which of the two voltages greater. When amplified, the error signal will drive servo balancing motor in appropriate direction to adjust circuit (actually drive the slide wire) until the difference between the feedback voltage and the input voltage is balance out. An error signal equal to zero results (null point) the balancing (servo motor is be longer driven)

Que. : What is the constant voltage unit ?

Ans. : The constant voltage circuit consists of a rectifier, CR, a filter capacitor C1, followed by two stages of zener regulation. Abridge configuration is provided to 1amp line voltage regulation zener CR3, R1 and R2 combine provide relatively constant current to zener CR4, Thus variations. Resisters R2 and R3 form a bridge that any remoment line voltage effects.

Que. : Explain the working of a balancing motor.

Ans. : Signal in control win appears as due tank circuit formed by win and capacitor of amp. board.

+ve signal : It lags 90' from due to line phase capacitor amp. board.

-ve signal : Leads 90' from line due to line phase capacitor of amp. board.

The servo (balancing) motor is an induction motor that functions by creating a rotating magnetic field in the stator.

The rotor (armature) turns by following this field. The field is developed by the use of two windings in the stator.

It has got two windings, one of which is continuously energized by the line voltage. The other winding is energized by the power amplifier, with a current whose phase with respect to line current determines the direction of rotation of motor.

Que. : What is burnout feature ? Explain.

Ans. : Burnout provides the warning feature of driving indicator the end of scale if the input circuit should open.

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A burnout resistor is provided which develops a voltage drop between the measuring circuit and the amplifier. The polarity of the signal determines the direction of the servo drive upon an open circuit in the input.

Upscale burnout : R value 10 M

Downscale burnout : R value 2.2 M

Que. : Explain the block diagram of an amplifier in a temp. recorder.

Ans. :

Que. : Why is a converter used in a temp. recorder ?

Ans. : The converter is designed to convert D. C. input voltage into an A. C. input voltage proportional in amplitude to the input.

Que. : Why are thermowells used ?

Ans. : In numerous application it is neither desirable nor practical to expose a temperature sensor directly to a process material. Wells are therefore used to protect against damage corrosion, erosion, abrasion and high pressure processes. A thermowell is also useful in protecting a sensor from physical damage during handling and normal operation.

Selecting a thermowell :

The significant properties considered in selecting a material for the well are as follows :

1. Resistance to corrosion and oxidation.
2. Resistance to mechanical and thermal shock.
3. Low permeability (Resistance to gas leakage).
4. Mechanical strength.
5. Thermal conductivity.

Material for Wells :

1. Stainless steel.
2. Inconel.
3. Monel.
4. Alloy steel.
5. Hastelloy 'C'.

Que. : How will you calibrate a temp. recorder using a potentiometer ?

Ans. : Connect the potentiometer output the input of temp. recorder.

1. Connect the (+ve) to the (+ve) and (-ve) to the (-ve).
2. If ambient compensation is provided in potentiometer set it to the correct ambient temp.
3. If no ambient compensation is provided take a thermometer and measure the correct ambient temp.. Find out the corresponding mV s for that temp. for the given input type of thermocouple.
4. While feeding subtract the ambient temp. m v s from the corresponding temp. every time.
5. Adjust the necessary adjustments.

MEASURING TEMPERATURE WITH A POTENTIOMETER :

1. Connect the input of the potentiometer to the thermocouple.

INSTRUMENT QUESTIONS

2. If no ambient compensation is provided find out the corresponding millivolts for that ambient temp. for the type of thermocouple used.

3. Add the ambient temp. millivolts to the corr. input millivolts measured. Find out from the chart the corresponding temperature.

Que. : What type of sensing element would you use to measure very low temperature ?

Ans. : The sensing element used for measuring very low temperature is R. T. D.

Que. : What are skin temperature thermocouples ?

Ans. : Skin thermocouples are those which are directly connected to the process without any thermowell.

Used for measuring the skin temperature of heaters furnaces, flue gas etc.

Que. : What is the specialty of thermocouples lead wires ?

Ans. : They should be of the same material as the thermocouple.

Que. : What is the difference the a wheatstone bridge and a potentiometer ?

Ans. : The difference between a potentiometer and a wheatstone bridge measuring instrument is that potentiometer is a voltage measuring instrument and wheatstone bridge is a current measuring instrument.

Que. : Explain the continuous balance potentiometer system using R. T. D.'s.

Ans. : In a balance wheatstone bridge resistance thermometer a resistance bulb is connected into one branch of a d.c. bridge circuit; in another branch is a variable resistance in the form of a calibrated slidewire. Variations in temp. of the measured medium cause a change in resistance of the bulb and a consequent unbalance of the bridge circuit. A self balancing wheatstone bridge recognizes the condition of unbalance, determines its direction and magnitude and position the slidewire contractor to rebalance the bridge and indicate the temp. on the scale.

The D. C. potential appearing at AA is converted by the converting stage to an A. C. voltage appearing at BB and is multiplied by the voltage amplifier to a large value at CC. It is then used to control the power amplifier output DD which drives the balancing motor in the proper direction to balance the bridge.

The polarity of the signal at AA determines the phase of the alternating voltage at BB which in turn determines the direction of rotation of the balancing motor.

Que. : How is automatic Reference junction compensation carried out in temp. ?
Recorders etc.,

Ans. : For automatic reference junction compensation a variable nickel resistor is used. As the temperature changes, so does its resistance. This reference junction compensatory is located, so that it will be at the temperature of the reference junction. The reference junction is at the position where the dissimilar wire of the thermocouple is rejoined, which invariably is at the terminal strip of the instrument.

INSTRUMENT QUESTIONS

CONTROL SYSTEMS

AUTOMATIC CONTROLLER :

It is a device which measured the value of variable quantity or condition and operates to correct or lie it deviation of this measured value from a selected reference.

AUTOMATIC CONTROL SYSTEM :

It is any operable arrangement of one or more automatic controllers in closed loops with one or more processes.

SELF OPERATED CONTROLLER :

It is one in which all the energy needed to operate the final control element is derived from the controlled medium through the primary element.

RELAY OPERATED CONTROLLER :

It is one in which the energy transmitted through the primary element is either supplemented or amplified for operating the final control element by employing energy from another sources.

PROCESS :

A process comprises the collective function performed in and by the equipment in which a variable is to be controlled.

SELF REGULATION :

It is an inherent characteristic of the process which aids in limiting the deviation of the controlled variable.

CONTROLLED VARIABLE :

The controlled variable is that quantity and condition which is measured and controlled.

CONTROLLED MEDIUM :

It is that process energy or material in which a variable is controlled. The controlled variable is a condition or characteristic of the controlled medium. For e.g. where temperature of water in a tank is automatically controlled, the controlled variable is temperature and controlled medium is water.

MANIPULATED VARIABLE :

It is that quantity or condition which is varied by the automatic controller so as to affect the value of the controlled variable.

CONTROL AGENT :

It is that process energy or material of which the manipulated variation is a condition or characteristic. The manipulated variable is a condition or characteristic of the control agent. For e.g. when a final control element changes the fuel gas flow to burner the manipulated variable is flow the control agent is fuel gas.

INSTRUMENT QUESTIONS

ACTUATING SIGNAL :

The actuating signal is the difference at anytime between the reference input and a signal related to the controlled variable. This basically known as error signal.

DEVIATION : It is the difference between the actual value of the controlled variable and the value of the controlled variable corresponding with set point.

OFFSET :

It is the steady state difference between the control point and the value of the controlled variable corresponding with setpoint

CORRECTIVE ACTION :

It is the variation of the manipulated variable produced by the controlling means. The controlling means operates the final control element (control value) which in turn varies the manipulated variable.

REFERENCE INPUT :

It is the reference signal in an automatic controller.

SET POINT :

It is the position to which the control point setting mechanism is set.

CONTROL POINT :

It is the value of the controlled variable which under any fixed set of conditions the automatic controller operates to maintain.

PRIMARY FEEDBACK :

It is the signal which is related to the bJNtrJH_iÂ3œĬÂd“Âfÿ»@_i‘ÿ19~‡ÿHÿ€ä §,“ß÷Mith the reference input to obtain the actuating signal. Simply stated primary feedback is the actual measurement of the controlled variable which when compared with the desired measurement of the controlled variable produces the actuating signal.

POSITIONING ACTION :

It is that in which there is a predetermined relation between the value of the controlled variable and the position of the final control element.

PROPORTIONAL ACTION :

It is that in which there is a continuous linear relationship between the value of the actual measurement of the controlled variable and the value position.

FLOATING ACTION :

It is that in which there is a predetermined relation between the deviation and speed of final control element.

DERIVATIVE ACTION :

INSTRUMENT QUESTIONS

It is that in which there is a predetermined relation between a time derivative of the controlled variable and position of final control element.

REST ACTION :

It is the value movement at a speed proportional to the magnitude of deviation.

RATE ACTION :

It is that in which there is a continuous linear relation between the rate of change of controlled variable and position of final control element. Rate action produces value motion proportional to the rate of change of actual measurement.

PROPORTIONAL BAND :

It is the range of values of the controlled variable which correspond to the full operating range of the final control element.

RESET RATE :

It is the number of times/minute that the effect of proportional position action upon the final control element is repeated by proportional speed floating action.

There are two ways of expressing reset action :

1. Reset time and 2. Reset Rate

1. Reset Rate : It is commonly expressed as a number of "repeats" per minute. It is determined by dividing.

- a) Travel of final control element (Value stroke) in one minute as a result of the effect of proportional speed floating action.
- b) The travel as a result of the effect of proportional position action with the same deviation in both cases.

2. Reset Time : It is the time interval by which the rate is commonly expressed in minutes. It is determined by subtracting.

- a) The time required for a selected motion of the final control element resulting from combined effect of the proportional position plus rate action.
- b) The time required for the same motion as a result of the effect of proportional position action alone with the same rate of change of controlled variable in both cases or expressed in another way. It is the time lead in terms of air pressure on the control valve produced by rate action compared with proportional position action for the same rate of change of actual measurement in both cases.

Que. : Explain the application of proportional integral and derivative.

Ans. :

PROPORTIONAL CONTROL ONLY :

Proportional control only attempts to return a measurement to the set point after a load upset has occurred. However it is impossible for a proportional controller to return the measurement exactly to the set point.

USE : It is normally used for level controls. It reduces the effect of a load change but it can not eliminate it.

INSTRUMENT QUESTIONS

PROPORTIONAL + RESET CONTROL :

Reset action is introduced to eliminate offset. It will integrate any difference between measurement and setpoint and cause the controller's output to change until the difference between the measurement and set point is zero. Reset will act as long as the error exists.

USE: Proportional + Reset controllers are by far the common types used in industrial process control and where predominate dead times occur.

PROPORTIONAL + RESET + DERIVATIVE :

Derivative or rate action helps the controller overcome system inertia and result in faster, more precise control. Derivative action occurs whenever the measurement signal changes. Under study conditions the rate action does not act. Derivative allows the controller to inject more corrective action.

USED : On temperature controls.

Que. : What is difference gap control ?

Ans. : Differential gap control is similar to on off control except that a band or gap exists around the control point.

USE : In industry differential gap control is often found in non critical level control applications where it is desirable only to prevent a tank from flooding or drying. When a measured variable exceeds the upper gap the control valve will open fully or be closed fully. Similarly when it exceeds the lower gap it will open or close fully.

Que. : Where is on off control used ?

Ans. : On off control is used when

1. Precise control is not needed.
2. Processes that have sufficient capacity to allow the final operator to keep up with the measurement cycle.
3. It is mainly used in refrigeration and air conditioning systems.

Que. :

Ans. : When reset action is applied in controllers Where the measurement is away from the set point for long periods the reset may drive the output to its maximum resulting in reset wind up. When the process starts again the output will not come off its maximum until the measurement crosses the set point causing large overshoots. This problem can be avoided by including antireset wind up circuit which eliminates the problem of output saturation.

Que. : Why is reset called integral and Rate derivative ?

Ans. : RESET is called integral because of the mathematical relationship to the output.

RATE is called derivative because

$$O_i = r d(e) / dt + O_0$$

O_i = Output at any instant

e = error signal

O_0 = Output at zero error.

t = time.

INSTRUMENT QUESTIONS

PROPORTIONAL ACTION :

$$O_i = 100 / PB \times e + O_0$$

Que. : Explain tuning of controllers.

Ans. : Tuning basically involves adjustment of proportional, Integral and derivative parameters to achieve good control. The gain, time constants, and dead times around the loop will dictate the settings of various parameters of the controller.

Tuning methods are broadly classified into two :

1. Closed Loop Method : e.g. Ultimate Gain Method.
2. Open Loop Method : e.g. process Reaction curve.

ULTIMATE GAIN METHOD :

The term ultimate gain was attached to this method because its use require the determination of the ultimate gain (sensitivity) and ultimate period. The ultimate sensitivity K_u is the maximum allowable value of gain (for a controller with only Proportional mode) for which the system is stable. The ultimate period is the period of the response with the gain set at its ultimate value.

PROCERS REACTION CURVE :

To deter mine the process reaction curve, the following steps are recommended. :

1. Let the system come to steady state at the normal load level.
2. Place the controller on manual.
3. Manually set the output of the controller at the value at which it was operating in the automatic mode.
4. Allow the system to reach the steady state.
5. With controller on manual, impose a step changes in the output of controller, which is an signal to value.
6. Record the response of controlled variable.
7. Return the controller output to its previous value and return the controller to auto operation.

Que. : Explain the working of an electronic P.I.D. controller.

Ans. :

Input from the measurement transmitter is compared with the set point voltage to produce a deviation signal. The deviation signal is combined with a characterized feed back signal to provide the input for the function generator amplifier. This amplifiers output is delivered to the feed back network, and to the final output which is a 10-50m.a. do signal for actuation of final operators.

PROPON ACTION : It is a obtained by adjusting the magnitude of feed back signal. An increase in negative feed back means less effective gain and thus a broader proportional band.

REST ACTION : It is obtained by charging the reset capacitor at a rate determined by the value of reset resistor. The reset resistor is variable, and constitutes reset adjustment.

DERIVATIVE ACTION : The connection of a derivative capacitor across the feedback circuit delays feedback until the capacitor is charged to a value approaching amplifier output. This delay is controlled by value of derivative resistor. This resistor is variable and constitutes derivative adjustment.

INSTRUMENT QUESTIONS

Que. : What is an analogue integrator and an analogue differentiator ?

Ans. :

ANALOGUE INTEGRATOR :

ANALOGUE DIFFERENTIATER :

Que. : What is anti reset wind up ?

Ans. : If the limit acts in the feed back section of the control amplifiers integral circuit, the controller output will immediately begin to drive in the opposite direction as soon as the process signal crosses the set point. This approach is referred to as antireset wind up.

Que. : What are De saturators ?

Ans. : When, in some processes, e.g. batch process, long transient responses are expected during which a sustained deviation is present the controller integral action continuously drives the output to a minimum or maximum value. This phenomenon is called "integral saturation of the control unit". When this condition.

Que. : Explain the working of Rotameter.

Ans. : Variable area meters are special form of head meters. Where in the area of flow restrictor is varied. So as to hold the differential pressure constant. The rotameters consists of a vertical tapered tube through which the metered fluid flows in upward direction. A "float" either spherical or cone shaped, actually more dense than the fluid being measured, creates an annular passage between its maximum circumference and the weight of the tapered tube. As the flow varies the "float" rises or falls to vary the area of the passage so that the differential across it just balances the gravitational force on the "float" i.e. the differential pressure is maintained constant. The position of the "float" is the measured of the rate of flow.

Que. : Explain the working of a magnetic meter.

Ans. : An electric potential is developed when a conductor is moved across the magnetic field. In most electrical machinery the conductor is a "wire"; the principle is equally applicable to a moving, electrically conductive liquid. The primary device of commercial magnetic meters consists of a straight cylindrical electrically insulated tube with a pair of electrodes nearly flush with the tube wall and located at opposite ends of a tube diameter. A uniform a.c. magnetic field is provided at right angles to electrode diameter and to the axis of the tube. The a.c. voltage developed at the electrodes is proportional to the volume flow rate of fluid, and to a magnetic field strength. This device is limited to electrically conducting liquids. The magnetic meter is particularly suited to measurement of slurries and dirty fluids, since there are no location for solids to collect except the walls of the tube itself.

Que. : Explain the working of a turbine meter.

INSTRUMENT QUESTIONS

{ Cst Fa Fm Fc cf }

Que. : Where is a quadrant orifice used ?

Ans. : If the fluid is viscous and the operating Reynolds number is low quadrant orifice is preferred

Que. : What are types of taps used for orifices ?

Ans. :

1. FLANGE TAPS :

This are most commonly used on pipe sizes of 2 inches or larger. They are located in the orifice flange 2 inch from upstream and 1 inch downstream from the faces 0 orifice plate.

2. CORNER TAPS :

On pipe sizes less than 2 inches corner taps located directly at the face of the orifice plate.

3. VENA CONTRACTA AND REDIUS TAE :

Vena contracta taps located at 1 pipe diameter upstream and at point of minimum pressure downstream. There are mostly widely used for measurement of steam.

Radius taps are located 1 pipe diameter upstream and 1/2 pipe diameter downstream for the inlet face of the orifice are a close approximation to vena contracta taps upto $0.72 d / D$.

4. FACE FLOW TAPS :

Face flow taps are located at $2 \frac{1}{2}$ pipe diameter upstream and B pipe diameter downstream. Full flow taps at $2 \frac{1}{2}$ and B pipe diameter have the same advantage as vena contracta or radius taps.

QUE. : What is Reynolds number ?

Ans. : Dynamic similarity implies a correspondence of fluid forces in two systems. In general situation there are many classes of forces that influence the behavior of fluids. Some of these are inertial viscous, gravitational, compressibility, pressure and elastic forces. Certain dimensionless ratio are developed based on fluid properties. Velocities and dimension, which are essentially force ratio.

The more important of these are Reynolds number

$$\frac{SVD}{\mu}$$

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For most applications in practical flow measurement the Reynolds number is taken to be sufficient criterion of dynamic similarity. The magnitude of Reynolds number not only indicates whether the flow is laminar or turbulent but also furnishes the probable shape of velocity profile. Due to the strong role it plays as an indicator of varying flow characteristics, many of the deviation from the theoretical equations are called Reynaldo number effects.

Que. : How would you choose differential range ?

Ans. : The most common diff. range for liquid measurement is 0-100" H₂O. This range is high enough to minimize the errors caused by unequal heads in the seal chambers, differences in temps. of load lines etc. The 100" range permits an increase in capacity upto 400" and a decrease down upto 20" by merely changing range tubes or range adjustment.

INSTRUMENT QUESTIONS

Que. : What are positive Displacement meters ?

Ans. :

PRINCIPLE :

The principle of measurement is that as the liquid flows through the meter it moves a measuring element which seals off the measuring chamber into a series of measuring compartments each holding a definite volume. As the measuring element moves, these compartments are successively filled and emptied. Thus for each complete of the measuring element a fixed quantity of liquid is permitted to pass from the inlet to the outlet of the meter. The seal between measuring element and the measuring chamber is provided by a film of measured liquid. The number of cycle of the measuring element is indicated by means of a pointer moving over the dial, a digital totalizer or some other form of register, driven from the measuring element through an adjustable gearing.

The most common forms of positive displacement meters are :

1. Reciprocating Piston type.
2. Rotating or Oscillating Piston type.
3. Nutating Disc type.
4. Fluted Spiral Rotor type.
5. Sliding vane type.
6. Rotating vane type.
7. Oval Gear type.

\$\$ CONTROL VALVES \$\$

Que. : What is a control valves ?

Ans. : A control valve is the final control element, which directly changes the value of the manipulated variable by changing the rate of flow of control agent.

A control valve consists of an operator and valve body. The operator provides the power to vary the position of the valve plug inside the body. The plug is connected to the operator by a stem, which slides through a stuffing box. The air signal from the controller is applied above the diaphragm. The increasing air signal from the controller is applied above the diaphragm. An increasing air signal will push the operator stem downwards against the force exerted by the spring on the diaphragm plate. The valve is adjusted in such a way that the plug starts moving when 3 psi is applied to the diaphragm and touches the seat when 15 psi is applied. Thus an increase in air pressure will close the valve. Hence the home "Air to Close". Another type is "Air to open", such that 3 psi on the diaphragm the valve is closed and 15 psi air signal it in fully open.

Que. : What are the different types of control valves ?

Ans. : The commonly used control valves can be divided as follows.

1. Depending on Action.
2. Depending on the Body.

1. DEPENDING ON ACTION :

Depending on action there are two types of control valves, (1) Air to close, (2) Air to open.

2. DEPENDING ON BODY :

INSTRUMENT QUESTIONS

1. Globe valves single or double seated.
2. Angle valves.
3. Butterfly valves.
4. Three way valves.

Que. : What is the use of single seated valve ?

Ans. : The single seated valve is used on smaller sizes, and in valve of larger sizes, where an absolute shut off is required. The use of single seated valve is limited by pressure drop across the valve in the closed or almost closed position.

Que. : What is the use of double seated valve ?

Ans. : In double seated valves the upward and downward forces on the plug due to reduction of fluid pressure are nearly equalized. It is generally used on bigger size valves and high pressure systems. Actuator forces required are less i.e. A small size actuator.

Que. : What is Cv of a valve ?

Ans. : Cv is the capacity of a valve and is defined as :

"No of gallons per minute of water which passes through a fully open valve at a pressure drop of 1 psi.

The valve coefficient Cv is proportional to the area 'A' between the plug and valve seat measured perpendicularly to the direction of flow.

Que. : What are the different types of actuators ?

Ans. : The different types of actuators are :

1. Diaphragm Operated.
2. Piston Operated.

Que. : What types of bonnets would you use of high temp. and low temp. ?

Ans. :

HIGH TEMP. : Bonnets are provided with radiation fins to prevent gland packing from getting damaged.

ON VCF LOW TEMP. : Extended bonnets are used to prevent gland packing from getting frcored._

Que. : How will you work on a control valve while it is line ?

Ans. : While the control valve is in line the control valve has to be got by passed and secondly the line has to be drained and depressurized.

Que. : What is the use of a valve positioner ?

Ans. : The valve positioner is used for following reasons :

1. Quick Action control valve.
2. Valve hysteresis.
3. Valves used on viscous liquids.
4. Split Range.
5. Line pressure changes on valve.
6. Valve Bench set not standard.

INSTRUMENT QUESTIONS

7. Reversing valve operation.

Que. : When can a by pass be not used on a positioner ?

Ans. : A by pass on a positioner cannot be used when :

1. Split Range operation.
2. Reverse Acting Positioner.
3. Valve bench set not standard.

Que. : What is the use of link connected to the valve positioner ?

Ans. : The link serves as the feed back to the valve. Ant valve movement is sensed by this link. Sometimes due to line pressure changes on H.P. service the valve position may be changed, the link in turn senses this change and the positioner will produce an output which will operate the valve to the original position.

Que. : What is the use of booster relays ?

Ans. : Booster relays are essentially air load, self contained pressure regulators. They are classified into three broad groups :

1. Volume Boosters : These are used to multiply the available volume of air signal.
2. Ratio Relays : Use to multiply or divide the pressure of an input signal.
3. Reversing Relays : This produces a decreasing output signal for an increasing input signal.

Que. : What is the use of Angle valves ?

Ans. : Angle valves are used where very high pressure drops are required and under very severe conditions. Where the conventional type of valve would be damaged by erosion.

Que. : What is the use of butterfly valves ?

Ans. : Butterfly valves are used only in systems where a small pressure drop across the valve is allowed. The butterfly is fully open when the disc rotates by 90. A drawback of this valve is that even a very small angular displacement produces a big change in flow.

Que. : What is the use of three way valves ?

Ans. : Three way control valves are only used on special systems, where a dividing or mixture of flows according to a controlled ratio is required.

Que. : What is a cage valve ?

Ans. : A cage valve uses a piston with piston ring seal attached to the single seated valve "plug". Here the hydrostatic forces acting on the top or the piston or below the valve plug tend to cancel out. The seat ring is clamped in by a cage. Cage valves are generally used for noise reduction.

Que. : What are the advantages of Camflex valves ?

Ans. : Camflex valves are intermediates between globe valve and butterfly valve. The plug rotates 60° for full opening.

ADVANTAGE :

INSTRUMENT QUESTIONS

1. Actuator forces required are very less.
2. Extended bonnet and hence can be used on any service i.e. on high temp. and very low temp.
3. Variations in flow.
4. Light weight.

Que. : What are the different types of plugs ?

Ans. : The different types of plugs are generally used are :

- (1) V. port plug (2) Contoured plug

V. PORT PLUG :

Ported plug are generally used on double seated valves. This is because ported plugs, have a more constant off balance area.

CONTOURED PLUGE :

Contoured plugs are generally used on single seated valve with small trim sizes.

Que. : What are the different valve characteristic ?

Ans. : The different types of valve characteristic are :

1. Linear
2. Equal Percentage
3. Quick Opening.

LINEAR : The valve opening to flow rate is a linear curve

EQUAL PERCENTAGE :

For equal increments of valve opening it will give equal increment in flow rate range. At small opening the flow will also be small.

QUICK OPENING :

At small opening the increments in flow rate is more. At higher opening the flow rate becomes steady.

QUE. : What is a solenoid valve ? Where it is used ?

Ans. : A solenoid is electrically operated valve. It consist of a solenoid (coil) in which a magnetic plunger moves which is connected to the plug and tends to open or close the value. There are two types of solenoid valves :

1. Normally open
2. Normally closed

USE : It is used for safety purpose.

Que. : How will you change the valve characteristics with positioner ?

Ans. : The positioner contains different types of came in it. selection of the proper can the valve opening characteristics can be changed.

Que. : How will you change the action of a control valve ?

Ans. :

1. If the control valve is without bottom cap. The actual needs to be changed.
2. If bottom cap is provided.
 - a) Disconnect the stem from the actuator stem.

INSTRUMENT QUESTIONS

- b) Separate the body from the bonnet.
- c) Remove the bottom cap and the plug from body.
- d) Detach the plug from the stem by removing the pin.
- e) Fix the stem at the other end of the plug and fix the pin back.
- f) Turn the body upside down. Connect it to the bonnet after inserting the plug and stem.
- g) Connect back the stem to the actuator stem.
- h) Fix back the bottom cap.
- i) Calibrate the valve.

Que. : How will you select the control valve characteristics ?

Ans. : The graphic display of flow versus lift shows that the desired or inherent characteristic is changed by variations in pressure drop. This occurs as the process changes from a condition where most of the pressure drop takes place at the control valve to a condition where most of the pressure drop is generally distributed through the rest of the system.

% Flow : This variation in where most of the total drop takes place is one of the most important aspects. Choosing the proper valve characteristics for a given process.

Flow control : Normally an equal percentage valve is used.

Pressure Control : Normally a linear valve is used to maintain a constant pressure drop.

Temp. Control : Normally an equal percentage valve is used.

Liquid Level Control : Normally a linear valve is used.

Basically, in selecting a valve characteristic, two important points have to be taken into account.

- a) There should be a linear relationship between the position of the plug and the flow through the valve in a wide range of change in the pressure drop across the valve.
- b) The pressure drop across a valve should be as low as possible.

Que. : An operator tells you that a control valve is stuck? How will you start checking?

Ans. :

1. First of all, get the control valve out of operation.
2. Check the linkage to the diaphragm of the control valve.
3. Disconnect, if possible, the actuator stem from the control valve stem.
4. Stroke the actuator and see whether the actuator operates or not. If not, then the diaphragm may be punctured.
5. If the actuator operates, connect it back to the plug stem, stroke the control valve. If it does not operate, loosen the gland nuts a bit and see if it operates. If it does not, then the control valve has to be removed from the line to the workshop.

Que. : Where are air-to-close and air-to-open control valves used ?

Ans. :

AIR TO CLOSE :

1. Reflux lines.
2. Cooling water lines.
3. Safety Relief services.

AIR TO OPEN :

1. Feed lines.

INSTRUMENT QUESTIONS

2. Steam Service.

Que. : Why does control valve operate at 15 psi ?

Ans. : On higher pressure the actuator size becomes bigger in area. The actual force produced by the actuator.

Force = Pressure x Area.

= 15 psi x Area If Area = 15"

Force produced = 15 psi x 25" pounes.

\$\$ GENERAL QUESTIONS. \$\$

Que. : Explain Cascade Control system with a diagram. What would happen if a single controller were used ?

Ans. : Cascade means two controllers in series. One of them is the Master or Primary and the second is the secondary or slave controller. The output of the secondary controller operates the final control element, that is the valve.

LOOP EXPLANATION :

The output of the temp. transmitter goes as measurement signal to the TIC which is the master controller. Similarly the output of pressure transmitter goes as measurement signal to the PIC which is the secondary controller.

The output of TIC comes at set point to PIC which in turn operates the valve. The reqd. temp. is set on the TIC.

USE OF CASCADE SYSTEM :

Cascade loops are invariably installed to prevent outside disturbances from entering the process. The conventional single controller as shown in the diagram cannot respond to a change in the fuel gas pressure until its effect is felt by the process temp. sensor. In other words an error in the detected temperature has to develop before corrective action can be taken. The cascade loop in contrast responds immediately correcting for the effect of pressure change, before it could influence the process temperature. The improvement in control quality due to cascading is a function of relative speeds and time lags. A slow primary (Master) variable and a secondary (Slave) variable which responds quickly to disturbances represent a desirable combination for this type of control. If the slave can respond quickly to fast disturbances then these will not be allowed to enter the process and thereby will not upset the control of primary (master) variable. It can be said that use of cascade control on heat transfer equipment contributes to fast recovery from load changes or other disturbances.

Que. : Explain ratio control system.

Ans. : A ratio control system is characterized by the fact that variations in the secondary variable do not reflect back on the primary variable. In the above diagram of a ratio control system the secondary flow is held in some proportion to a primary uncontrollable flow.

If we assume that the output of primary transmitter is A, and the output of the secondary transmitter is B, and that multiplication factor of the ratio relay is K, then for equilibrium

INSTRUMENT QUESTIONS

conditions which means set valve is equal to measured valve, we find the following relation :

$$KA - B = 0$$

or $B/A = K$, where 'K' is the ratio setting of the relay.

Que. : Explain fuel to air ratio control of furnaces.

Ans. :

Que. : What is Furnace Draft control ?

Ans. : Balanced draft boilers are generally used negative furnace pressure. When both forced draft and induced draft are used together, at some point in the system the pressure will be the same as that of atmosphere. Therefore the furnace pressure must be negative to prevent hot gas leakage. Excessive vacuum in the furnace however produces heat losses through air infiltration. The most desirable condition is that the one have is a very slight (about 0.1" H₂O) negative pressure of the top of furnace.

Que. : What is feed back control ? What is feed forward control ? Discuss its application ?

Ans. :

FEEDBACK CONTROL :

Feed back control involves the detection of the controlled variable and counteracting of charges its it's value relative to set point, by adjustment of a manipulated variable. This mode of control necessities that the disturbance variable must affect the controlled variable itself before correction can take place. Hence the term 'feedback' can imply a correction 'back' in terms of time, a correction that should have taken place earlier when the disturbance occurred.

FEED FORWARD CONTROL :

Feed forward control system is a system in which corrective action is based on measurement of disturbances inputs into the process. This mode of control responds to a disturbance such that is instantly compensates for that error which the disturbance would have otherwise caused in the controlled variable letter in time.

Feed forward control relies on a prediction. As can be seen from the figure of feed forward control a necessary amount of input goes to the process. This measurement goes to the controller which gives output to the control valve. The control valve regulates the flow.

FEED BACK CONTROL :

In feed forward control no difference between the desired result and actual result need exist before corrective action is taken in feed back control a difference must exist. Hence, open loop or feed forward control is capable of perfect control, but feed back is not. Due to economic impracticality of precision , predicting the amount of correction necessary to achieve satisfactory results with feed forward control, feed back control is most often used. In order to properly choose the type of feed back controller for a particular process application, two factors time and gain must be considered.

\$\$ GENERAL QUESTION - II \$\$

INSTRUMENT QUESTIONS

Que. : Draw an electronic two wire system control loop.

Ans. :

Que. : What are Intrinsically safe system ?

Ans. : Intrinsic safety is a technique for designing electrical equipment for safe use in locations made hazardous by the presence of flammable gas or vapors in air.

"Defn. :" Intrinsically safe circuit is one in which any spark or thermal effect produce either normally or under specified fault conditions is incapable of causing ignition of a specified gas or vapor in air mixture at the most easily ignited concentration.

HAZARDOUS AREAS :

The specification of products or systems sold as intrinsically safe must state in what hazardous areas they are intrinsically safe. Universal cooling of hazardous areas has not, unfortunately, been adopted in all countries. However two sets of codes in common use are.

Que. : What does a transmitter output start from 3-15 psi or (0.2 - 1 Kg/Cm²) or 4 - 20 ma. etc. ?

Ans. : The transmitter output starts from what is known as "live zero". This system has specific advantages :

1. The systems automatically alarms when the signal system becomes inoperative.
2. The output areas is linear (Ratio of 1 : 5).

DEAD ZERO SIGNAL :

The advantage is that it does not have to be biased to true zero. A "Live zero" gives the computer additional information, so that it can take appropriate alarm action in case of a measurement failure, because it can discriminate between a transmitter operating, but transmitting a zero measurement and a failure, in the signal system.

Que. : What is force balance and motions balance principle ?

Ans. :

FORCE BALANCE PRINCIPLE :

"A controller which generates an output signal by opposing torque's".

The input force is applied on the input bellows which moves the beam. This creates nozzle back pressure. The nozzle back pressure is sensed by the balancing bellows which brings the beam to balance. The baffle movement is very less about 0.002" for full scale output.

MOTION BALANCE PRINCIPLE :

"A controller which generates an output signal by motion of its parts".

The increase in input signal will cause the baffle to move towards the nozzle. The nozzle back pressure will increase. This increase in back pressure acting on the balancing bellows, will expand the bellows, thereby moving the nozzle upward. The nozzle will move until motion (almost) equals the input (baffle) motion.

Advantages of force Balance :

1. Moving parts are fewer.

INSTRUMENT QUESTIONS

2. Baffle movement is negligible.
3. Frictional losses are less.

ELECTRONICS

Que. : What is a diode?

Ans. : A diode consists of two electrodes (1) Anode (2) Cathode. The current flow is only in one direction.

A diode is the most basic solid state (semi conductor) device. The above figure shows a P.N. junction. The P. material has holes and the N. material has electrons.

FORWARD BIAS :

REVERSE BIAS :

(1) Where the applied voltage overcomes the barrier potential (the p side is more positive than the n side) the current produce is large because majority carriers cross the junction in large numbers. This condition is called forward bias.

(2) When the applied voltage aids the barrier potential (n side + ve than p side) the current in small. This state is known as Reverse Bias.

Que. : What is a half wave, full wave and bridge rectifier ?

Ans. :

HALF WAVE RECTIFIER :

FULL WAVE RECTIFIER :

BRIDGE RECTIFIER :

PEAK INVERSE VOLTAGE : Maximum Reverse voltage across the diode during the cycle.

Que. : What is a filter used for ?

Ans. : The half wave and full wave signals are pulsating D . C . voltages. The use of such voltages is limited to charging batteries, running D. C. motors, and a few other applications. What we really have is a D.C. voltage that is constant in value, similar to the voltage from a battery. To get a constant voltage from this, we can use a capacitor input filter.

Que. : What is Zener Diode ? What is a voltage Regulator ?

Ans. : The breakdown region of a p n diode can be made very sharp and almost vertical. Diodes with almost vertical breakdown region are known as Zener Diodes.

A Zener diodes operating in the breakdown region is equivalent to a battery. Because of this current through Zener diode can change but the voltage remains constant. It is this constant voltage that has made the zener diode an important device in voltage regulation.

VOLTAGE REGULATOR :

INSTRUMENT QUESTIONS

The output remains constant despite changes in input voltage due to Zener effect.

Que. : What is transistor ? What are the different types ?

Ans. : A transistor is a three layered semi conductor device. Basically a transistor means (transfer - resistor).

Whether the transistor is pnp or npn it resembles two diodes (back to back). The one on the left is called emitter diode, and the one on the right is the collector diode. Since two types of charges are involved transistor : are classified as bipolar devices.

Biasing the transistor :

Emitter- Base - Forward Bias.

Collector - Base - Reverse Bias.

Que. : What is CB, CE and CC configuration ?

Ans. :

Buffer : A device or a circuit used to isolate two parts of circuits or stages. The emitter follower is an example of buffer.

Alpha = I_C / I_E

Beta = I_C / I_B

Que. : How will you test a transistor with a multimeter. ?

Ans. :

1. Emitter +ve of meter and Base -ve output = Low resistance
2. Emitter -ve of meter and base +ve output = High resistance.
3. Collector +ve and Base -ve output = Low.
4. Collector -ve and base +ve output = High.

Emitter : Collector = High Resistance.

PNP : Opposite Results.

Que. : What is a thyristor ? What are its uses ?

Ans. : A thyristor is a special kind of semi conductor device that uses internal feedback to produce latching action.

Use : Used for controlling large amounts of load power in motors, heaters, lighting systems etc.

Explanation : Because of the unusual connection we have a +ve feedback also called regeneration. A change in current at any point in the loop is amplified and returned to the starting point with the same phase. For instance if the 02 base current increases, the 02 collector current increases. This forces base current through 01. In turn this produces a large 01 collector current which drives the 02 base harder. This build up in currents will continue until both transistors are driven in saturation. In this case the latch acts like a closed switch.

On the other hand , if something causes the 02 base current to decrease, the 02 collector current will decrease. This reduces the 01 base current. In turn, there is less 01 collector current, which reduces the 01 base current even more. This regeneration continues until both transistors are driven into cut off. At this time the latch acts like an open switch. This latch will always stay in open or close position.

INSTRUMENT QUESTIONS

Que. : What are logic gates ? Explain with truth table.

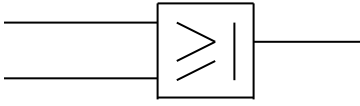
Ans. :

GATE : A gate is a logic circuit with one output and one or more inputs . An output signal occurs only for control combination of input signals.

1. OR - GATE :

SYMBOL :

TRUTH TABLE :	A	B	Y
	0	0	0
	0	1	1
	1	0	1
	1	1	1



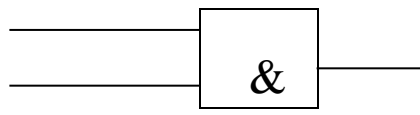
Define : An OR Gate has one output if any or all of its input are 1's.

2. AND GATE :

Define : An AND Gate has output when all inputs are present.

SYMBOL :


TRUTH TABLE :	A	B	Y
	0	0	0
	0	1	0
	1	0	0
	1	1	1



3. NOT GATE :

A not gate is also known as an inverter. This circuit has one input and one out put . All it does is invert the input signal; if the input is high, the output is low and vice versa.

TRUTH TABLE :	Inpu	Output
	t	t
	0	1
	1	0



Buffer : This is a non inverting gate, used to drive low impedance loads.

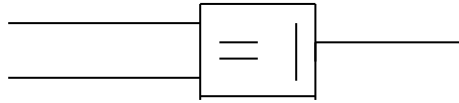
NOR GATE : This is an OR GATE followed by an inverter.

SYMBOL :

TRUTH TABLE :	A	B	Y
	0	0	1
	0	1	0

INSTRUMENT QUESTIONS

	1	0	0
	1	1	0
Exclusive OR GATE	A	B	Y
	0	0	0
	0	1	1
	1	0	1
	1	1	0



NAND GATE : This is an AND GATE followed by an inverter.

TRUTH TABLE :	A	B	Y
	0	0	1
	0	1	1
	1	0	1
	1	1	0

Que. : Explain the working of TIL - NAND GATE.

Que: what is the vibration?

Ans: static and dynamic imbalance are the most common causes of vibrations in machines. Imbalance occurs when the center of gravity of a rotating part is not located exactly at the center of rotation.

CAUSES OF VIBRATION:- Imbalance, resonance, misalignment, mechanical and electrical asymmetry, worn ball bearings, slippage, oil whirl and oil whip.

This vibrations are two types 1. Mechanical system, 2. Electro-mechanical system. Mechanical systems limited for lower frequencies above 40 c/s.

Electrical systems are working on principles of :

1. electro-magnetic, 2. Electrostatic, 3. piezo-electric, 4. Magneto-strictive.

The vibration pick-ups are working on EDDY CURRENT principle.

Vibration measurements are 1. Displacement, 2. Velocity, 3. Acceleration, 4. RMS, 5. zurek,

1. DISPLACEMENT:- The movement of a particle one place to another place is called displacement. units p/p (peak to peak).

2. VELOCITY:- The rate of change of displacement is called velocity. Meter / second or inches / second.

3. ACCELERATION:- The rate of change of velocity is called acceleration. Meter / second square or inches / second square.

ON MICROMETER OF TK – 3 -2 E

1 division = 0.01 mm

1 full turn = 0.01 x 50 = 0.5 mm

INSTRUMENT QUESTIONS

$$0.5 \text{ mm}/0.0254 = 19.685 \text{ mills}$$

$$1 \text{ mill} = 0.0254 \text{ v ac (across the proxmitter)}$$

$$1 \text{ micron} = 0.001 \text{ mm}$$

$$1 \text{ mill} = 25 \text{ microns}$$

$$1 \text{ mm} = 40 \text{ thou} = 40 \text{ mills}$$

$$1 \text{ inch} = 1000 \text{ mills}$$

$$1 \text{ volt} = 5 \text{ mills (200 mv} = 1 \text{ mill scale factor of proxmitter)}$$

$$\text{gap voltage} = \text{mills} \times \text{factor} + 7.5 \text{ for counter side of axial floating}$$

$$\text{gap voltage} = \text{mills} \times \text{factor} - 7.5 \text{ for normal side of axial floting.}$$

$$\text{Ex:- 1) } 9.125 \times 0.2 + 7.5 = 9.325 \text{ v dc. (counter)}$$

$$2) 9.125 \times 0.2 - 7.5 = - 5.675 \text{ v dc (normal)}$$

$$\text{mills} = \text{gap voltage} / \text{factor} - 37.5$$

$$\text{Ex:- } 9.325 / 0.2 - 37.5 = 9.125 \text{ mills (counter)}$$

$$5.675 / 0.2 - 37.5 = - 9.125 \text{ mills (normal)}$$