Instrumentation Books

Volume 12

Instrumentation Interview questions

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INSTRUMENTATION BOOKS SERIES

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Volume 12 Interview Questions

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Interview Question for E&I, I&C Graduates

Prepared by Gowtham

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

1. What are the process Variables?
The process Variables are:

- Flow.
- Pressure.
- Temperature.
- Level.
- Quality i.e. % 02, C02, pH etc.

2. Define all the process Variable and state their unit of measurement.?
Flow: Any fluids or liquids flowing from one place to another place is called flow and it is defined as volume per unit oftime at specified temperature and pressure Conditions, is generally measured by positive- displacement or rate meters. Units: kg / hr, litter / mm, gallon / mm, m3 / hr, Nm3 / hr. (Gases)

Pressure: It is defined as Force per unit Area. P = F/A
Units : bar, Pascal, kg / cm2, lb / in2.

Level: The height of the water column, liquid and powder etc., at the desired measurement of height between minimum level points to maximum level point. is caljed level. The measurement principle is, head pressure method. Units: Meters, mm, cm, percentage.

Temperature: It is the degree of hotness or coldness of a body is called temperature.
Units : Degree Centigrade, Degree Fahrenheit, Degree Kelvin, Degree Rankin.

Quality: It deals with analysis.(pH, % C02, % 02, Conductivity, Viscosity)

3. What are the primary elements used for flqw measurement?

The primary elements used for flow measurement are:

- Orifice Plate.
- Venturitube.
- Pitot tube.
- Annubars.
- Flow Nozzle.
- Weir & Flumes.

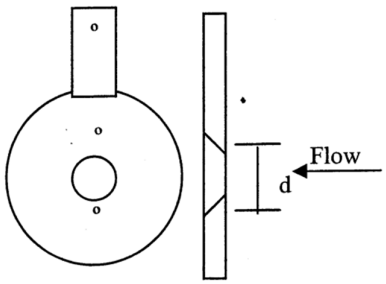
4. What are the different types of orifice plates and state their uses?

The different types oforifice plates are:

Concentric.
Segmental.
Eccentric.
Quadrant Edge.

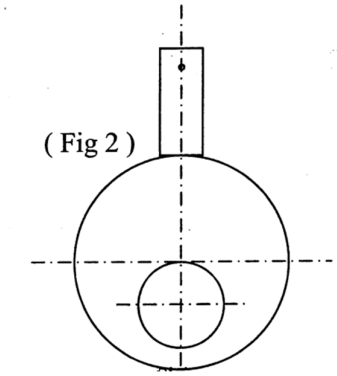
Concentric:

The concentric orifice plate is used for ideal liquid as well as gases and steam service. This orifice plate beta ratio fall between of 0. 15 to *0.75* for liquids and 0.20 to 0.70 for gases, and steam. Best results occur between value of 0.4 and 06. Beta ratio refers to the ratio of the orifice bore to the internal pipe diameters



(Fig 1)

(**450** beveled edges are often used to minimize Friction resistance to flowing fluid)

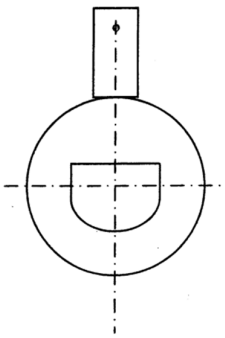

(Fig 2)

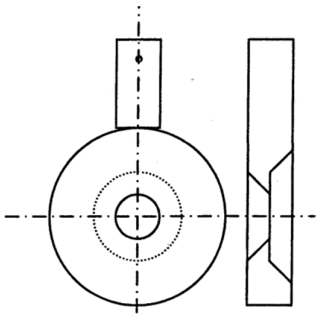
Eccentric:

The eccentric orifice plate has a hole eccentric. Use full for measuringcontaining solids, oil containing water and wet steam. Eccentric plates can be used either flange or vena contracta taps, but the tap must be at **1 800 or 900 to the eccentric opening.** ' Eccentric orifices have the bore offset from center toMinimize problems in services of solids-containing materials.

Segmental:

The segmental orifice place has the hole in the form segment used for colloidal and slurry flow measurement. For best accuracy, the tap location should be 1800 from the center of tangency. Segmental orifices provide another version of plates useful for solids containing materials.


(Fig 3)


(Fig 4)

Quadrant Edge:

It common use in Europe and are particularly useful for pipe sizes less1 than 2 inchs. Quadrant edge orifices produce a relatively constant coefficient of discharge for services with low Reynolds numbers in the range from 100,000 down to 5,000.

5. **How do you identify an orifice in the pipe line?**

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

6. Why is the orifice tab provided?

The orifice tab is provided due to the following reasons.

Indication of an orifice plate in a line.
The orifice diameter is marked on it.
The material of the orifice plate.
The tag no. ofthe orifice plate.
The mark the inlet of an orifice.

Advantages and Disadvantages of Orifice Plates

High differential pressure generated
Exhaustive data available
Low puhase price and installation cost
Easy replacement

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

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.

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

Themarking is always done H. P. side ofthe orifice tab which gives an indication ofthe H. P. side.

9. **How do you calibrate a D. P. transmitter?**

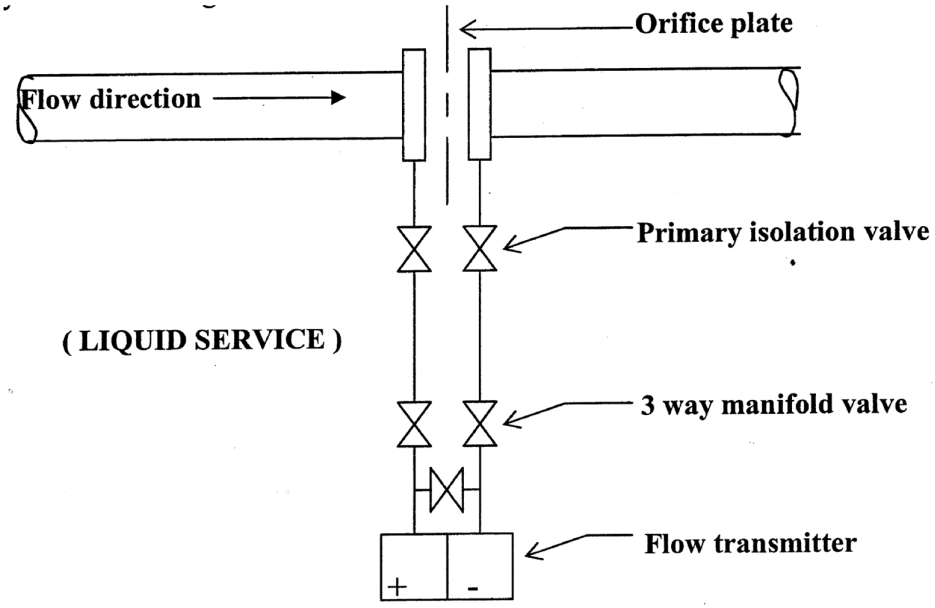
The following steps are to be taken which calibrating:
1 . Adjust zero of the Tx'r.
2. Static pressure test : Give equal pressure on both sides of the transmitter. Zero should not shift. If it is
shifting carry out static alignment.
3 . Vacuum test : Apply equal vacuum to both the sides. The zero should not shift.
4. Calibration Procedure:
. Give 20 psi air or 24Vdc supply to the transmitter.
. Vent the L.P. side to atmosphere.
. Connect output of the Instrument to a standard test gauge or Multimeter and adjust zero.
5. Apply required pressure to high pressure side of the transmitter and adjust the span.
6. Adjust zero again if necessary.

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

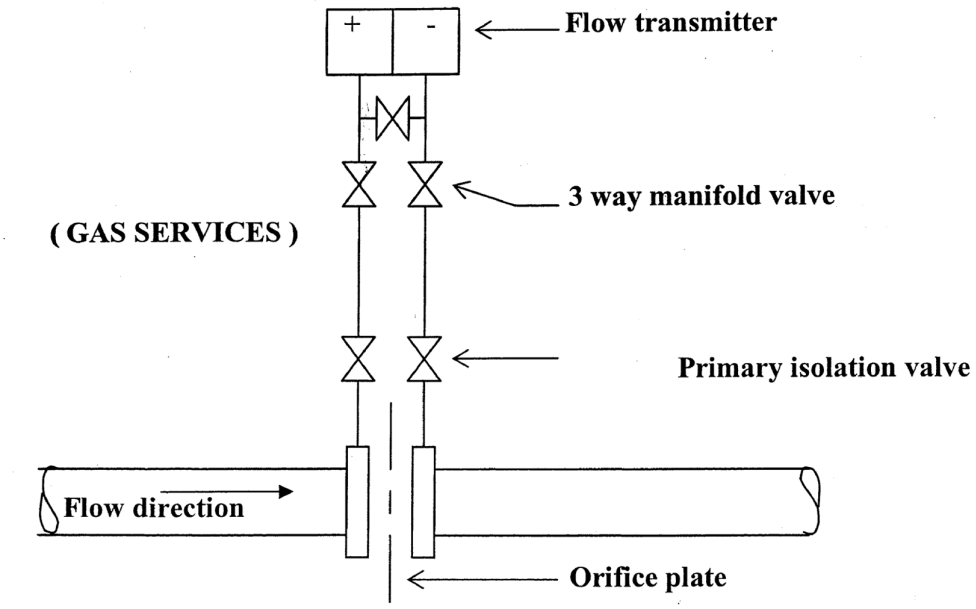
Glycol.

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

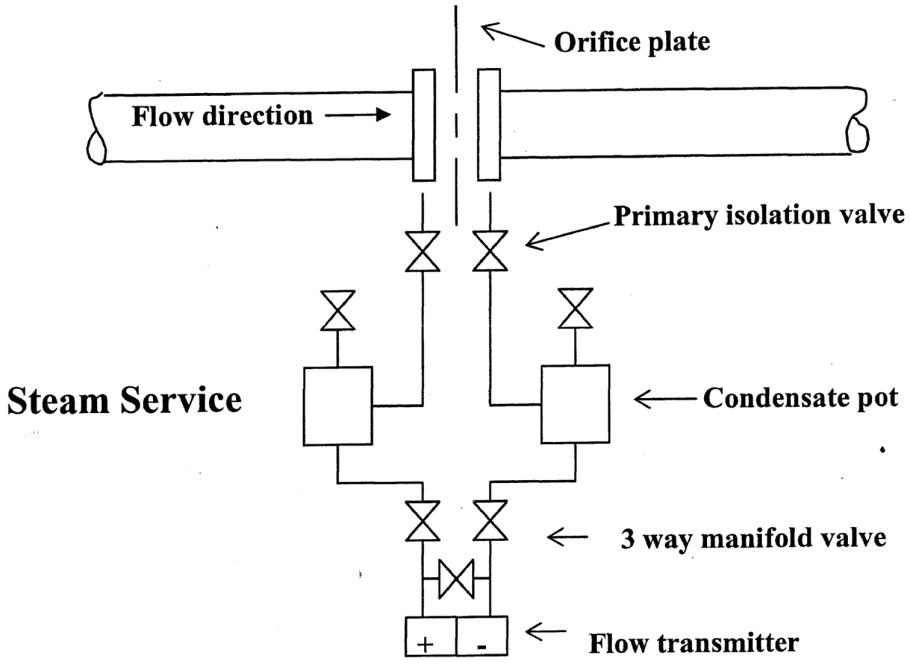
Liquid lines : On liquid lines the transmitter is mounted below the orifice plate because liquids have a property of self draining.



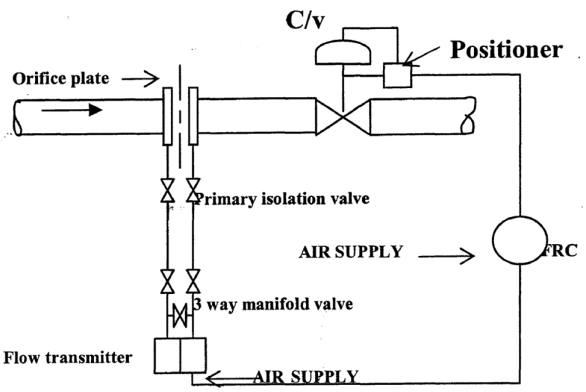
Gas Service :On gas service the transmitter is mounted above the orifice plate because Gases have a property of self venting and secondly condensate formation.



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



12. Draw and explain any flow control loop?



PNEUMATIC)
(FLOW CONTROL LOOP)

13. **An operator tells you that flow indication is more, How would you start checking?**
First flushing the transmitter.

Flush both the impulse lines.

Adjust the zero by equalizing ifnecessary.

If still the indication is more then Check L.P. side for choke.

If that is clean then Check the leaks on L.P side.

If not Calibrate the transmitter.

14. How do you do a zero check on a D.P. transmitter?
Close one ofthe valve either H.P. or L.P. open the equalizing valve. The O/P should read zero.

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

The procedure for glycol filling is:

Close the primary isolation valves.

Open the vent on the seal pots.

Drain theused glycol if present.

Connect a hand pump on L.P. side while filling the H.P. side with glycol.

Keep the equalizer valve open.

Keep the L.P. side valve closed.

Start pumping and fill glycol. .

Same repeat for L.P. side by connecting pump to H.P. side, keeping equalizer open and H.P. isolation valve closed.

Close the seal pot vent valves.

Close equalizer valve.

Open both the primary isolation valves.

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

$$\frac{Q1}{Q2} = \frac{\sqrt{\Delta P1}}{\sqrt{\Delta P2}}$$

Q1 = Old flow(factor)
Q2 = New flow(factor)
$\sqrt{\Delta P1}$ = Old range
$\sqrt{\Delta P2}$ = New range

$$Q2 \times \sqrt{\Delta P1} = Q1 \times \sqrt{\Delta P2}$$

$$Q2 = \frac{Q1 \times \sqrt{\Delta P2}}{\sqrt{\Delta P1}}$$

$$\text{New factor} = \frac{\text{Old factor} \times \sqrt{\text{New range}}}{\sqrt{\text{Old range}}}$$

O/P % = Flow, I/P % = ΔP
$F = \sqrt{\Delta P}$ x 10 (or) O/P % = $\sqrt{I/P\%}$ X 10

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

Air is vented by opening the vent plugs on a liquid service transmitter. 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.

18. Why flow is measured in square root?

Flow varies directly as the square root of different pressure F = K square root of D/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.

19. What is absolute pressure?

Absolute pressure is the total pressure present in the system

Abs. pressure = Gauge pressure + Atm. pressure.

20. What is absolute zero pressure?

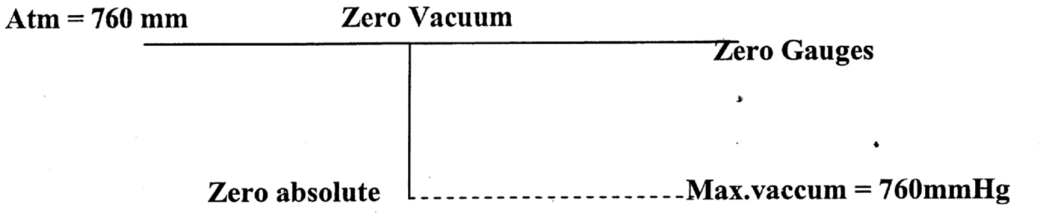
Absolute zero = 760 mm Hg Vacuum.

21. **What is the maximum Vacuum?**

The maximum Vacuum = 760 mm Hg.

22. What is Vacuum?

Any pressure below atmospheric pressure is vacuum.



23. What are the primary elements for measuring pressure?

The primary elements used for measuring pressure are:

- Bourdon tube.
- Diaphragm.
- Capsule.
- Bellows.
- Pressure Springs.

The above are known as elastic deformation pressure elements.

Type of Bourdon tubes.

- 'C'type.
- Spiral.
- 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-spanc stainless steel.
Bellows : Bellows is a one - piece, collapsible, seamless metallic unit with deep folds
Formed from very tin walled tubing.
Material used: Brass, phosphor bronze, stainless steel. Used for high Pressure.
Pre.spring: Pressure springs ofhelical or spiral shape used for measuring high pressures.

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

The procedure for calibration is as follows:

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

25. You are given a mercury manometer range 0 -760 mm ? A vacuum gauge reads 60 mm vacuum. The test nianometer reads *50* vacuum ? Which of the two in correct.

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

26. **Why is an inclined manometer used?**
It is used to extend the scale of the instrument. Because the manometer is at an angle to the vertical.

27. What is the principle of a pressure gauge?
Pressure works on Hooks law.
Principle : "Measuring the stress in an elastic medium"

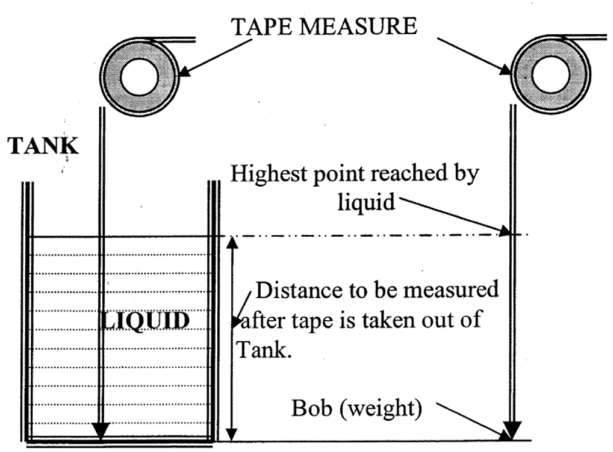
28. Draw and explain a pressure gauge ? What is the used of a Hair spring?
The parts of a pressure gauge are:
1. 'C' type Bourdon tube.
2. Connecting link.
3 . Sector gear.
4. Pinion gear.
5. Hair Spring.
6. Pointer.
7. Dial.

Uses of Hair Spring : Hair spring serves two purposes namely
. To avoid backlash error (eliminate any play into linkages).
. It serves as a controlling torque.

LEVEL

29. Briefly explain the different methods of level measurement?
There are two ways ofmeasuring level:
1 . Direct
2. Indirect

1 . **Direct level measurement:**
(a) Bob and tape:
A bob weight and measuring Tape provide the most simple And direct method of Measuring liquid level.

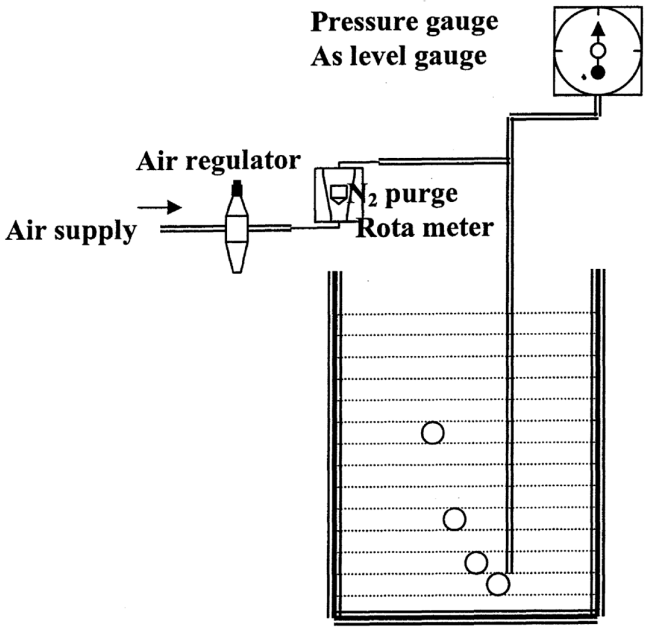


This consists of a graduated glass tube mounted on the side of the vessel. As the level of the liquid in the vessel change, so does the level ofthe liquid in the glass tube.

Indirect level measurement:

(A) 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 ofpressure which can be measured by a gauge.

(B) Purge system:
In this method a pipe is installed vertically with the open and at zero level. The other end of the pipe is connected to a regulated air r 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 cab be seen slowly leaving the open end ofthe pipe.



The air pressure to the bubbler pipe is minutely in Excess ofthe liquid pressure in the vessel, so that Air pressure indicated is a measure of the level in the tank.

The method above is 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.

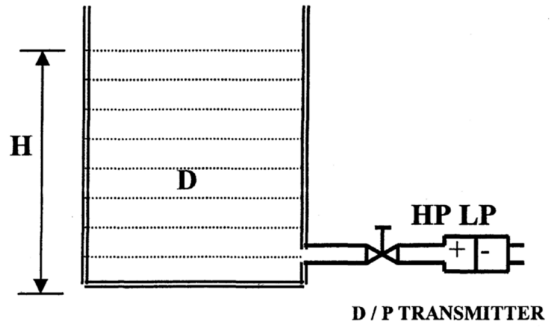
(c) Differential pressure meter:
Connections are made at the vessel top and bottom, and to the two columns of the D.P. meter. The top connection is made to the L.P. column of the transmitter and the bottom to H.P. column of the transmitter. The difference in pressure in the vessel is balanced out, since 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.

(d) 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 in 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.

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

The bottom connection of the vessel is connected to high pressure side of the transmitter.
Different Pressure = H X D



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

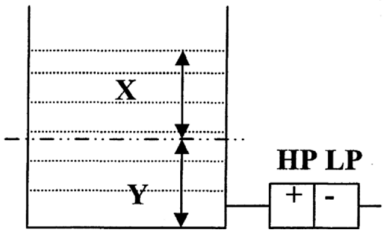
31. How is D.P. transmitter applied to a close tank?

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

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

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.

SPAN = (X) (Sp. Graf)
ZERO SUPPRESSION = (Y) (Sp.Grav)

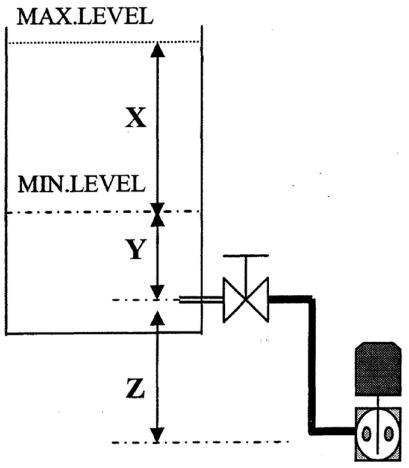


33. How is DY transmitter applied to a close tank & open tank with Dry leg?

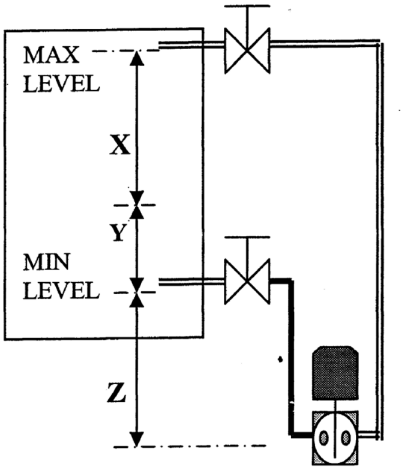
Span = (X) (GL)
Hw at minimum level = (Z) (Gs) + (Y) (GL)
Hw at maximum level = (Z) (Gs) + (**X** + Y) (GL)

Where:
G_L Specific gravity of tank liquid.
G_s = Specific gravity of seal liquid.
H_w Equivalent head of water.
X, Y&Z are shown in fig.

Open tank



Close tank with dry leg



Example:

Open tank with X = 300 inches
Y = 50 inches
Z =10 inches
GL= 0.8
G= 0.9
Span = (300) (0.8) = 240 inches

H_w at minimum level = (1 0) (0.9) + (50) (0.8) = 49 inches
H_w at maximum level = (1 0) (0.9) + (50 + 300) (0.8) = 289 inches Calibrated range = to 289 inches head of water

DEFINITION OF INSTRUMENT RANGE AND SPAN

Range	Defined in IEC 60902 as follows: The region ofvalues between the lower and upper limits of the quantity under consideration.
Span	It is expressed by stating the lower and upper limits (e.g. minus 1 to 10 bars (ga)). Defined in JEC 60902 as follows: The algebraic difference between the upper and lower limit values of a given range. It is expressed as a figure and unit ofmeasurement (e.g. 8 bars).
LRL	Lower Range Limit; the lowest quantity that a device is designed to measure.
URL	Upper Range Limit; the highest quantity that a device is designed to measure.
Instrument range	The region in which the instrument is designed to operate. It is a physical capability ofthe device. The region limits are expressed by stating the LRL and URL.
Instrument minimum span Instrument maximum span	The maximum distance between the URV and LRV for which the instrument is designed. It is a physical limitation ofthe device.
LRV	Lower Range Value; the lowest quantity that a device is adjusted to measure.
URV	Upper Range Value; the highest quantity that a device is adjusted to measure.
Adjusted range	The measurement region. It is expressed by stating the LRV and URV.
Adjusted span	The distance between the URV and LRV.

Example: A differential pressure transmitter is used to measure the level in a vessel, using a wet reference leg. 0% levelcorresponds with a differential pressure of -800 mbar and 1 00% level with -1 00 mbar. The catalogue ofthe selectedtransmitter lists -1800/+1 800 mbar for LRL and URL respectively and span limits of 300 to I 800 mbar, so:

Instrument range	= -1800 to +1800 mbar
Instrument minimum/maximum span	= 300 / 1 800 mbar respectively;
LRV I URV	= -800 I -1 00 mbar respectively;
Adjusted range	= -800 to -100 mbar.
Adjusted span	= 700 mbar.

NOTE: ‘Adjusted’ range and ‘adjusted’ span are frequently referred to as ‘calibrated’ range and ‘calibrated’ span. This term is however only correct, if a calibration facility is used to setthe LRV and URV. For intelligent measuring devices, thesupplier is usually calibrating the device atthe LRL/URL and the user is setting the required LRV and URV by remote communication.

SELECTION OF RANGES

The accuracy (2.8) and adjusted range ofan instrument should be selected to cover the operating window (2.1), which includes applicable abnormal operation and alternative operating modes. Unless otherwise stated,'the normal design value should lie between *50%* and *75%* ofthe adjusted range .

NOTE: For certain applications it might not be possible to combine all normal and abnormal operating conditions in one measurement at the required accuracy. In such cases, a case-by-case analysis should disclose whether additional instruments are required or the accuracy requirements and/or operating window may be relaxed. It might be acceptable to present measured values during some of the abnormal operating cases at a lower accuracy or it might be justifiable for the measurement not to produce a sensible signal under some of the abnormal process conditions during start-up, commissioning, regeneration, emergency conditions and the like.

IPF transmitters should have the same instrument range, adjusted range and accuracy as corresponding process transmitters in order to facilitate measurement comparison. For details and exceptions, see DEP 32.80. 10. lO-Gen. Trip settings should lie between 10% and 90% ofthe adjusted range.

The LRV should be selected so that the displayed result represents the zero or sub-zero value ofthe process variable (e.g. 0-150tons/day, 0-100% level, 0-10 bar (ga), -1/+3 bar (ga), 0-500 °C, -50/+50 °C etc.). Elevated zero's (100-300 tons/day, 100-200 °C) should be avoided.

Close tank with wet leg:

Span = (X) (GL)

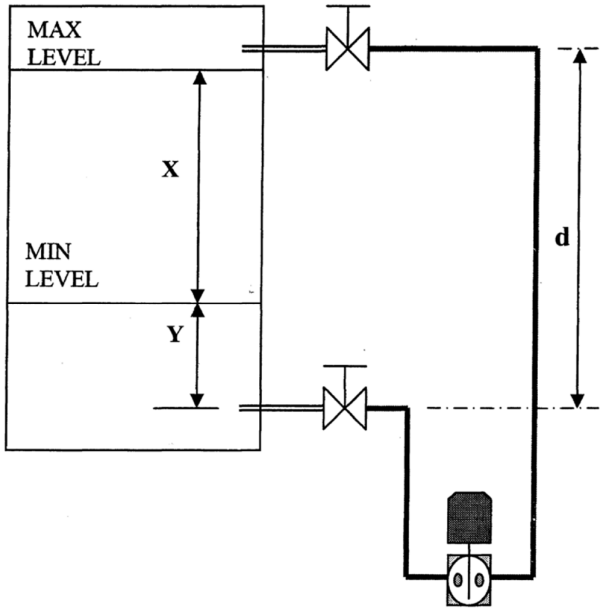
Hw at minimum level = (Y) (GL) — (d)(Gs)

Hw at maximum level = (X + Y) (GL) — (d) (G)

Where: GL Specific gravity of tank liquid Gs Specific gravity of tank liquid

Hw Equivalent head of water

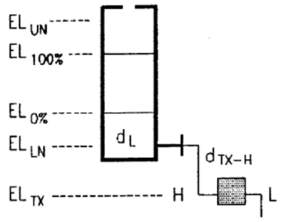
X, Y And Z are shown in fig.



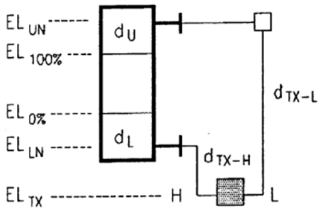
Example

x = 300 inches
Y =*50* inches
d = 500 inches

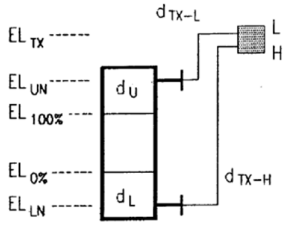
GL= 0.8
G=0.9
Span =(300)(0.8) = 240 inches
Hw minimum level = (*50*) (0.8). - (500) (0.9) = - 4 1 0 inches
Hw maximum level = (300 + 50) (0.8) — (500) (0.9) = - 1 70 inches
Calibrated range = - 410 to —170 inches head of water.
(minus sings indicate that the higher pressure is applied to the low pressure side of the transmitter)



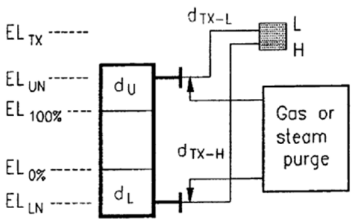
Arrangement–1:
Open equipment;
No reference leg;
Term T–1 = 0;
Term T–4 = 0.



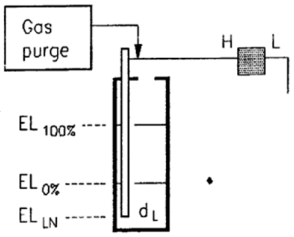
Arrangement–2:
Closed equipment;
Wet reference leg.



Arrangement–3:
Closed equipment;
Dry reference leg;
Self purging.



Arrangement–4:
Closed equipment;
Dry reference leg;
External gas or steam purging (entry point near equipment nozzles).



Arrangement–5:
Open equipment;
No reference leg;
External gas purging (entry point near purge pipe);
Terms T–1/3/4 = 0.

The universal formulae for calculating the lower and upper range values of any differential pressure type level measurement are:

Lower range value in mbar:

$$9.81 * 10^{-5} * \{ \underbrace{(EL_{UN} - EL_{0\%}) * d_U}_{\text{Term T–1}} + \underbrace{(EL_{0\%} - EL_{LN}) * d_L}_{\text{Term T–2}} + \underbrace{(EL_{LN} - EL_{TX}) * d_{TX-H}}_{\text{Term T–3}} - \underbrace{(EL_{UN} - EL_{TX}) * d_{TX-L}}_{\text{Term T–4}} \}$$

Upper range value in mbar:

$$9.81 * 10^{-5} * \{ \underbrace{(EL_{UN} - EL_{100\%}) * d_U}_{\text{Term T–1}} + \underbrace{(EL_{100\%} - EL_{LN}) * d_L}_{\text{Term T–2}} + \underbrace{(EL_{LN} - EL_{TX}) * d_{TX-H}}_{\text{Term T–3}} - \underbrace{(EL_{UN} - EL_{TX}) * d_{TX-L}}_{\text{Term T–4}} \}$$

34. What is purge level system?

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 *A* 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 he seen slowly leaving the open end of the pipe. The gage then measures the air pressure needed to over come the pressure of the liquid.

Delta P=HXD

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

35. **Explain the working of a leveltrol.**

The leveltrol is used for measuring level ofliquids 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 ofliquid displaced by the body".

The leveltrol basically consists ofthe following:

DISPLACER: It is 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.

Motions take of from Torque tube.

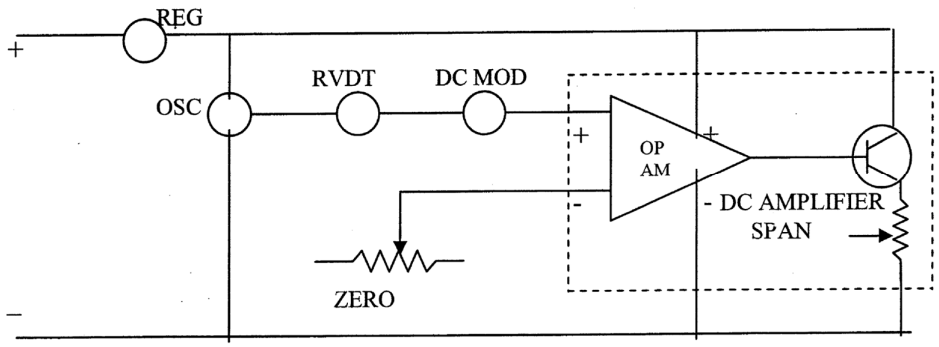
Means of reverse control action.

Adjustment for specific gravity.

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

6. CONTROL SETTING UNIT: Provides motions of varying the set point.

36. Explain **the working an electronic leveltrol.**



ELECTRONIC LEVEL TROL

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.

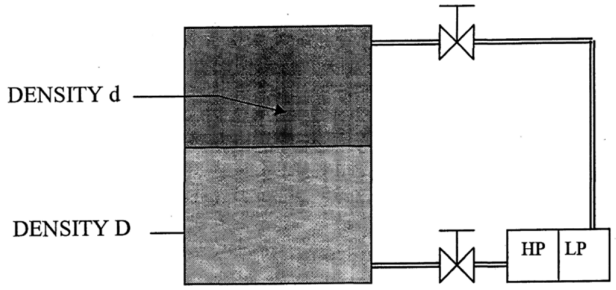
37. How will you reverse an action of the leveltrol?

The reversing are 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.

38. What is interface level? How do you calculate it?

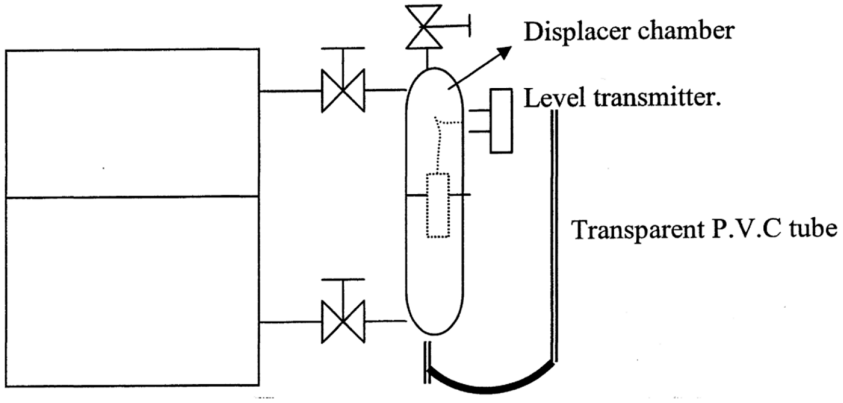
When a vessel is filled with two liquids of two different specific gravities the level measurement refers to as interface level.

DP = H (D - d)



On a level set the difference oftwo specific gravities.

39. **How will you calibrate a leveltrol in the field?**



Calculation #1 If the calibrating liquid is water: Process Liquid Density / 1* Displacer height = mm of H2O.

Calculation # 2 If the calibrating liquid is other liquid: Process Liquid Density / Calibrating liquid density * Displacer height = mm of H20. (Calibrating liquid height in mm).

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 ofthe top flange.
5. Adjust the specific gravity or span adjustment (Electronic Level).
6. Fill it up to *50 %,* check linearity.

40. How will you calibrate on interface level control.?

On an interface leveltrol there are two liquid of two different specific gravities.

1 . The level will be zero when it is full of lighter liquid.
Zero % level = H X d.
H = Displacer length
d = Specific gravity oflighter liquid.
2 The level will be 100 % when it is full of heavier liquid.

100 %level=HX 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.

Displacer length: L in mm

Density Low : dl in Kg I 1

Density High : DH in Kg I 1

$$Y = L^{*}\left(\frac{dh}{100}X + \left(1 - \frac{X}{100}\right)^{*} dl\right)$$

41. How will you apply wt. test calibration to a leveltrol.

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.

3 For Span : V = rr

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.
S 5 To check linearity apply average ofthe two weights.

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

The output will be maximum.

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

The output will be minimum.

44. What is the used of Suppression and elevation?

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.

45. What are the limitations of leveltrol?

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

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

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.

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

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.

48. Explain the working of an Enraf level gauge?

The Enraf precise level gauge are based on servo powered null-balance technique. A displacer serves as a continuous level sensing element.

Principle:

A displacer with a relative density higher than that of the product to be measured, is suspended from a stainless steel wire B, that is attached to a measuring drum. A two phase servo meter controlled by a capacitive balance system winds or unwinds the measuring wire until the tension in the weighing springs is in balance with the weight of the displacer partly immersed in the liquid. The sensing system in principle measures the two capacitance formed by the moving center sensing rod E provided with two capacitor platesand the side plates. In balance position the capacitances are of equal value. A level variation will a difference in buoyancy of the displacer. The center sensing rod will move in the direction of one of the sidecapacitor plates. This causes a difference in value of these capacitances. By an electronic circuit this change is detected and integrated. During the rotation of the servo motor the cam driven transmitter continuously change the voltage pattern to a remote indicator of which the receiver motor drives a counter indicating level variation.

TEMPERATURE

49. What are the different methods of temperature measurement? Explain.

The different methods oftemperature measurement are:

1 . Mechanical 2. Electrical.

Mechanical methods:

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 isheated the mercury expands much more than the glass and is therefore forced to rise up in the tubing A scaleis 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 withits thickens.

3. Pressure Spring Thermometers: There are four classes ofpressure spring thermometers.

1 . Liquid filled = class 1

2. Vapor pressure = class 2

3 . Gas filled — class 3

4. Mercury filled = class 4

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 controllingmechanisms 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 helical are matched in volume so that variation in temperature at the instrument case and along

the capillary tubing produces equal motion from both helical. 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/P2 = T1/T2

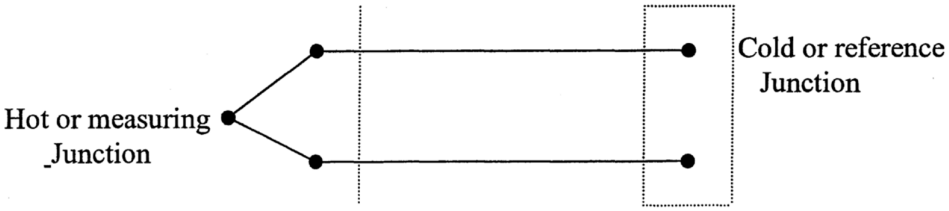
The system is filled under high pressure. The increase pressure for each degree of temperature rise is therefore greater than if the filling pressure were low. Nitrogen the gas most after used for such systems, because it chemically insert and possesses a favorable coefficient thermal expansion.

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 charge is small; at higher temperature the vapor pressure change is much greater.

Electrical method of temperature measurement:

1 . Thermocouples: It is temperature measurement device .its works on principal of SEE. BACK EFFECT.According this when two dissimilar metal wires joined at their ends. Between the two junction theelectromotive force is produced.



Type TIC	Positive wire & color	Negative wire & color	Range °F
J	Iron & White	Constantan & Red	-300 to 1400
K	Chrome! & Yellow	Alumel & Red	-300 to2300
E	Chromel & Purple	Constantan & Red	-300 tol 600
T	Copper & Blue	Constantan & Red	-300 to 650
R	Platinum and 10%Rhodium & Black	Platinum & Red	32 to 2700
S	Platinum and 13%Rhodium & Black	Platinum & Red	32 to 2700

Resistance — Temperature Detectors (RTD): .

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

PRINCIPLE: "Resistance increases as temperature increase"

Rt.=Ro(1+αt)

Rt. = Resistance of Temperature to measured. Ro. = Resistance ofzero temperature.

A = Co. offofthermal (expansion).

t = Temperature to be measured.

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

Types ofmaterial used: (1) Platinum (2) Nickel

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

Calculation of Resistance or Pt 100.

Ro. =100

X for platinum = 0.00385 /^{o}C.

To calculate Resistance at 1 00'c.

R100= 100[1+(38.5x 104x 100)]

= 100+(100 x0.385)

R100 = 138.5

Resistance at 100'C = 138.5

50. What is Pt 100 mean?

PtlOO means 100 OHMS at O'C for a platinum resistance bulb.

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

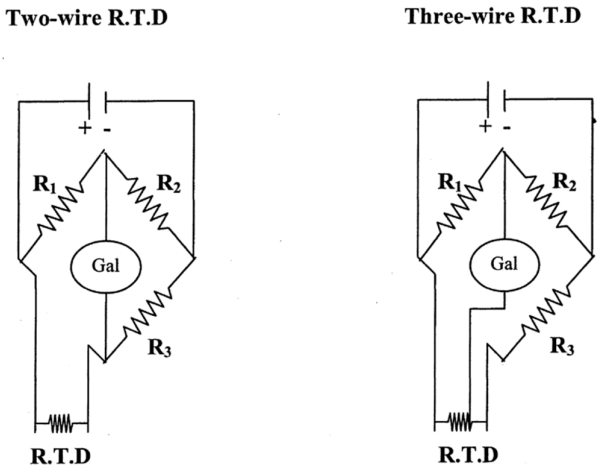
Two wire R .T .D. system:

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

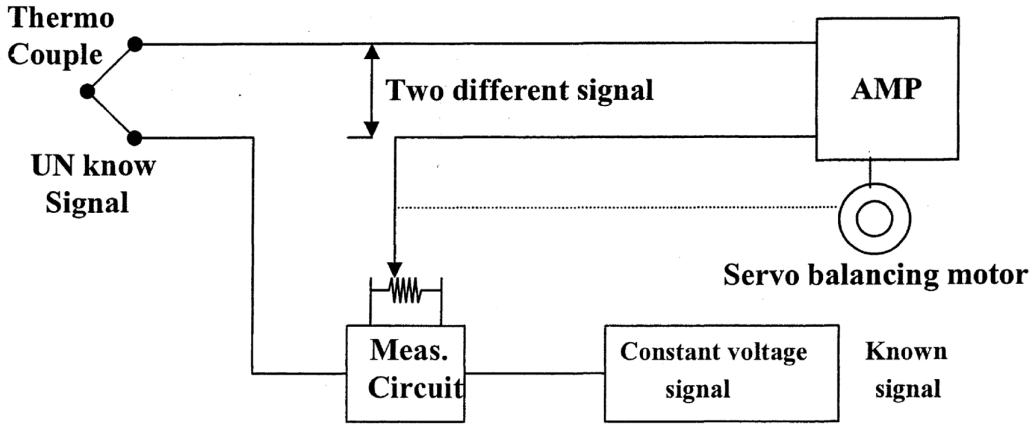
Three wire System:

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

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



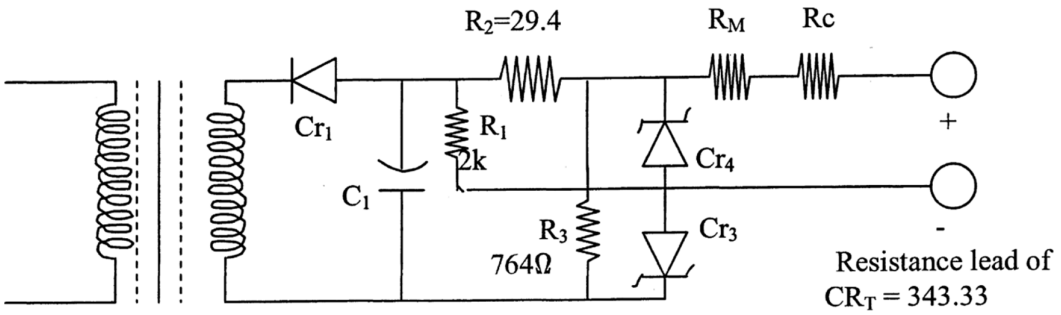
52. Draw a potentiometer temp. Measuring circuits and explain its?



OPERATION:

The input to the instrument is a measurement of some in the processes using a sensing element (such as thermocouple) 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 potentiometer 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 feedbackvoltage and the input voltage is balance out. An error signal equal to zero results (null point) the balancing(servo motor is be longer driven).

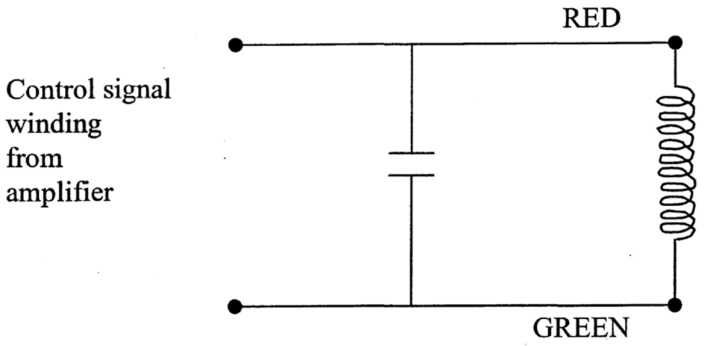
53. What is the constant voltage unit?



The constant voltage circuit consists of a rectifier, CR, a filter capacitor Cl , followed by two stages of zener regulation. Abridge configuration is provided to lamp line voltage regulation zener CR3, Ri 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.

54. Explain the working of a balancing motor.

Signal in control winding appears as Ω Ω Ω Ω due tank circuit formed by winding and capacitor of amp. board.



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

-ye signal : Leads 90' from line dueto 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.

55. What is burnout feature ? Explain.

Burnout provides the warning feature of driving indicator the end of scale if the input circuit should open. 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 1 0 M Downscale burnout : R value 2.2 M

57. Why is a converter used in a temp. recorder?

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

58. Why are Thermowells used?

Jn numerous application it is neither desirable nor practical to expose a temperature sensor directly to aprocess material. Wells are therefore used to protect against damage corrosion, erosion, abrasion and highpressure processes. A thermowell is also useful in protecting a sensor from physical damage during handlingand 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’.

59. How will you calibrate a temp. recorder using a potentiometer ?

Connect the potentiometer output to the input oftemp. recorder.

1 . Connect the (+ve) to the (+ve) and (-ye) to the (-ye).

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.. Findout 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 ofthe potentiometer to the thermocouple.

2. The 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 corn input millivolts measured. Find out from the chart for the corresponding temperature.

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

The sensing element used for measuring very low temperature is R. T. D.(Resistance Temperature Detector)

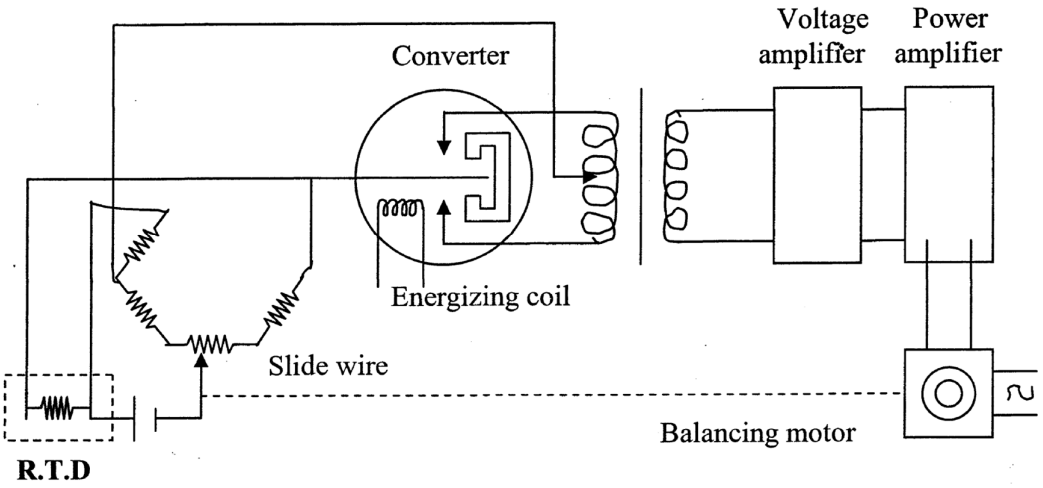
61. What are skin temperature thermocouples?

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.

63. What is the difference the a wheatstone bridge and a potentiometer?

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.

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

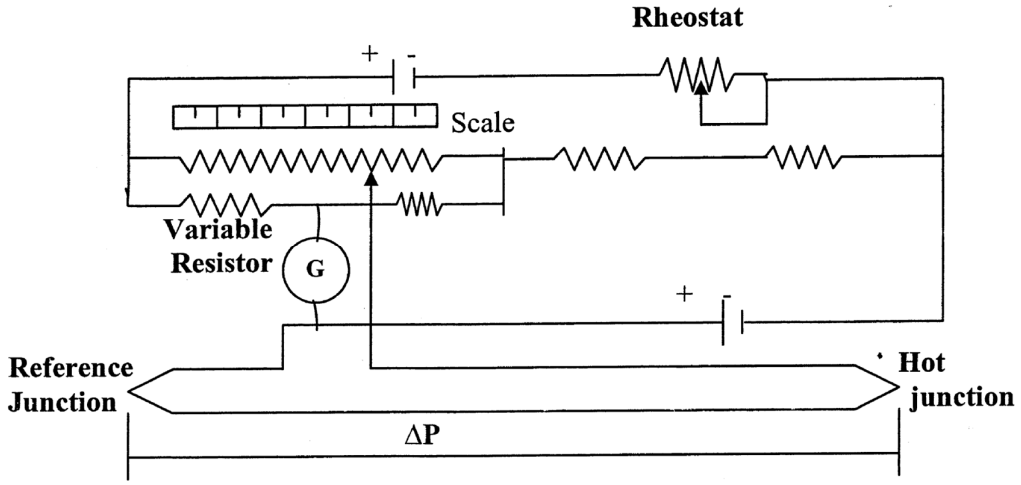


In a balance wheatstone bridge resistance thermometer a resistance bulb is connected into one branch of d.c. bridge circuit; in another branch is a variable resistance in the form of a calibrated slidewire. Variations in temp. ofthe measured medium cause a change in resistance ofthe bulb and a consequent 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 poweramplifier 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.

65. How is automatic Reference junction compensation carried out in temp? Recorders?



For automatic reference junction compensation a variable nickel resister 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.

CONTROL SYSTEMS

66. Explain the application of proportional integral and derivative action? Proportional control only :

Proportional control only attempts to return a measurement to the set point after a load upset has occurred. How ever 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. Proportional plus 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 plus reset plus 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.

Use : On temperature controls.

67. What is difference gap control?

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 isdesirable only to prevent a tank from flooding or drying. When a measured variable exceeds the upper gapthe control valve will open fully or be closed fully. Similarly when it exceeds the lower gap it will open orclose fully.

68. Where is on off control used?

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 are conditioning systems.

69. What is reset-wind up?

When reset action is applied in controllers where the measurement is away from the set point for long periods the rest may drive the output to its maximum resulting in rest wind up. When the process starts again the output will no come off its maximum until the measurement crosses the so point causing large overshoots. This problem can be avoided by including anti-reset wind up circuit which eliminates the problemof output saturation.

70. Why is reset called integral and Rate derivative?

Reset is called integral because of the mathematical relationship to the output.Rate is called derivative because

$$Oi = f\int_{t=o}^{t=i} e\,(dt) + O_0 \qquad Oi = r\,(de/dt) + O_0$$

r = is the rate time

O_i = is the Output at any given time

O_O = is the output at time zero or zero error.

e = is the error signal

t = is time.

f = is the reset rate in respects per minute.

71. Explain tuning of controllers.

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 Ku 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.

Process reaction curve:

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

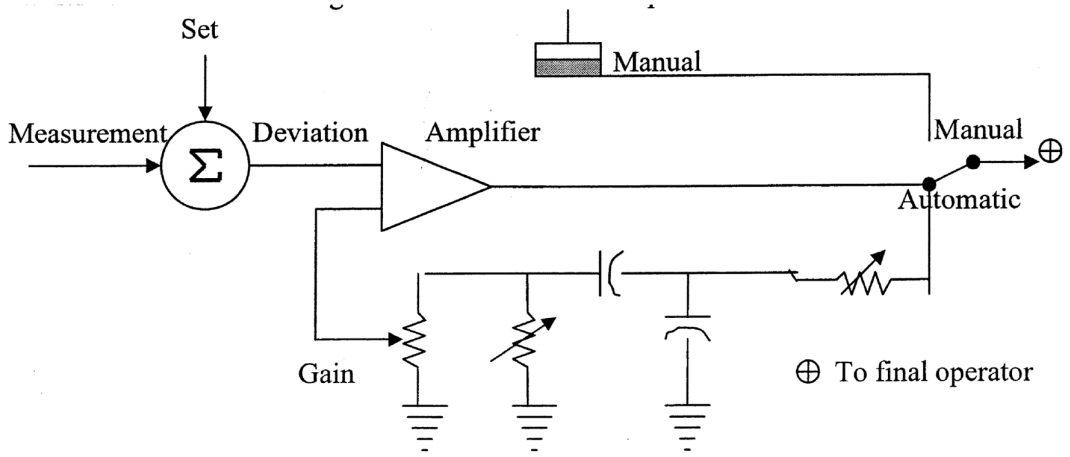
5. With controller on manual, impose a step changes in the output of controller, which is an signal to value.

6. Record the response of controlled variable.

7. Return the controller output to its previous value and return the controller to auto operation.

72. Explain the working of an electronic P.I.D. controller.

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 lO-50 mA signal for actuation of final operators.



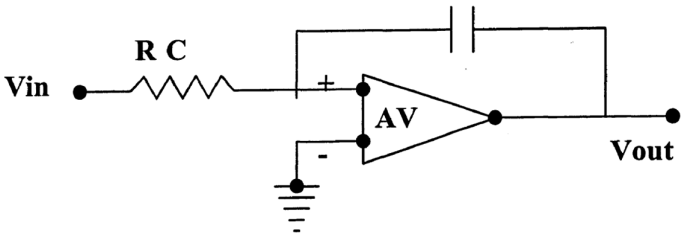
Proportional action: It is a obtained by adjusting the magnitude of feed back signal. An increase in negative feed back means less effective gain and thus a broader proportional band.

Reset actions: It is obtained by charging the reset capacitor at a rate determined by the value of reset resister. The reset resister is variable, and constitutes reset adjustment.

Derivative action: The connection of a derivativecapacitor 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 resister. This resister is variable and constitutes derivative adjustment.

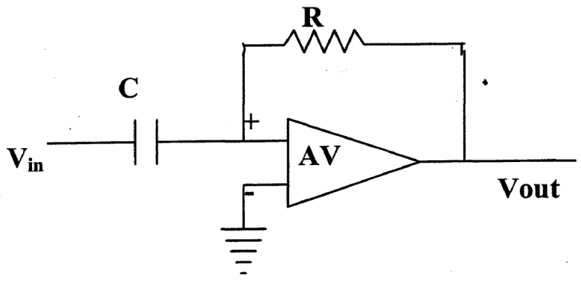
73. What is an analogue integrator and an analogue differentiator?

Analog integrator:



$$V_0 = \frac{-1}{RC} \int V_{in} dt$$

Analog differentiator:



$$V_0 = -RC \frac{d}{dt} V_{in}$$

74. What is an anti reset wind up?

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.

75. What are De-saturators ?

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.

76. What is the effect of weep hole on calculation of orifice bore?

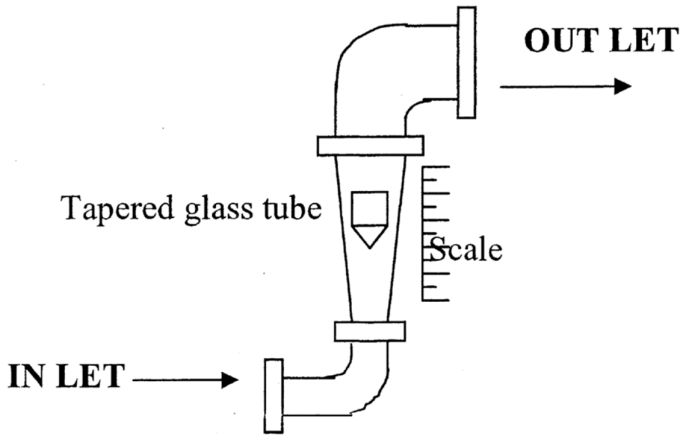
$$d = dm\left\{1 + 0.55\left(\frac{dh}{(dm)^2}\right)\right\}$$

where: dm = Measured diameter of orifice.

dh = Drain hole diameter.

d = Corrected diameter orifice size.

77. Explain the working of Rotameter?



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.

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

The transmitter output stance 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 takes 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.

78. Explain the working of a magnetic meter.

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 toa 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.

79. Explain the working of a turbine meter.

Turbine meters consist of a straight flow tube within which a turbine or fan is free to rotate, about its axis which is fixed along the center line of the tube. Straightening vanes upstream of the turbine minimizes possible rotational components of fluid flow. In most units a magnetic pick-up system senses the rotation of the rotor through the tube wall. The turbine meter is a flow rate device, since the rotor speed is directly proportional to flow rate. The output is usually in the form of electrical pulses from the magnetic pick-up with a frequency proportional to flow rate. Turbine meter are primarily applied to measurement of clean and non-corrosive hydrocarbons.

80. Explain the working of a Pitot tube.

The pitot tube measures the velocity at point in the conduct. If quantity rate measurement is desired, it must be calculated from the ratio of average velocity to the velocity at the point of measurement.

Principle : If a tube is placed with its open and facing into a stream of fluid, then the fluid impinging on the open end will be brought to rest, and the kinetic energy converted to pressure energy. This the pressure built up in the tube will be greater than that in the free stream by the impact pressure or pressure produced by loss of kinetic energy. The increase in pressure will depend upon the square of the velocity of the stream. The difference is measured between the pressure in the tube and static pressure of the stream. The static pressure is measured by a tapping in the wall of the main or by a tapping incorporated in the pitot static tube itself. The difference between the pressure in the tube and static pressure will be a measure of the impact pressure and therefore of the velocity of the stream oil.

81. Where is the integral orifice used?

Integral orifice is used to measure small flow rates. It is mounted directly on the secondary device. The integral orifice diameter varies between 0.020 inch and 0.250 inch diameter. The integral orifice finds considerable use in laboratory and pitot plants.

Calculation of flow rate : $\mathbf{Qn / Fc = Ks \ x \ Cwi \ x \ Fa \ x \ Fm \ x \ \sqrt{Gp / Ge} , \ \sqrt{hw}}$

82.Explain the working of a target meter.

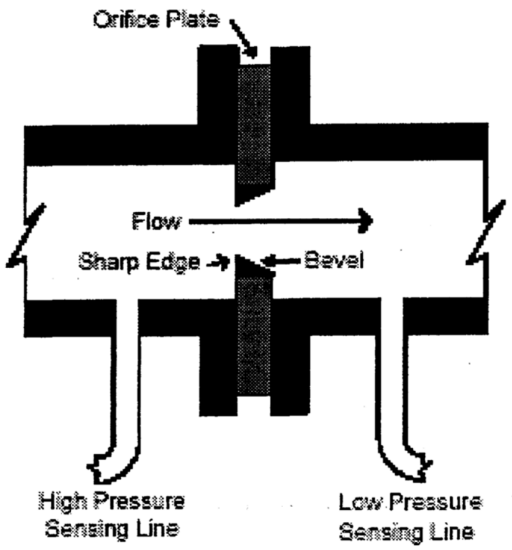
The target meter combines in a single unit both a primary element and a force balance flow rate transmitter. A circular disc (or target) supported concentrically in the pipe carrying the flowing fluid results in an annular orifice configuration. Pressure difference developed by the fluid flow through this annular orifice produces a force on target proportional to the square of the flow rate. This force is carried out of the pipe through a rod passing through a diaphragm seal, and is measured by a pneumatic or electronic force balance system identical with the mechanism ofthe force balance D.P. cell. The advantages ofthe target meter lies primarily in its single unit construction the primary device and responsive mechanism in a single structure. This eliminates the diff. pressure fluid connections in most heads meters. This is particularly used for sticky and dirty material which may plug up differential connections and for liquids which require elevated temperatures to avoid solidification, this elimination ofliquid connection is useful.

$$F = \left(\frac{Wm}{Cst \ \ Fa \ \ Fm \ \ Fc \ \ \sqrt{rf}} \right)^2$$

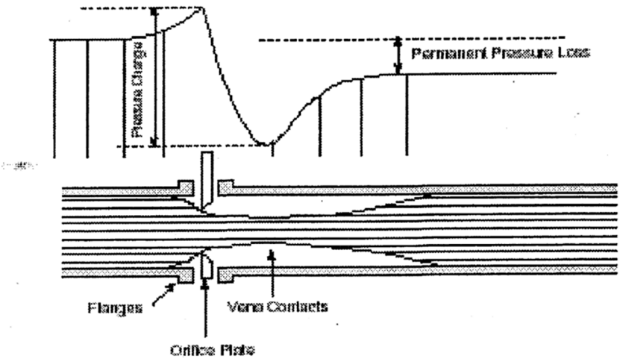
83. Where is a quadrant orifice used?

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

84. What are types of taps used for orifices?

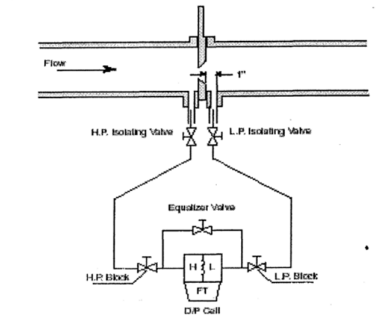


A Typical Orifice Plate



Orifice Plate Installation with Pressure Profile

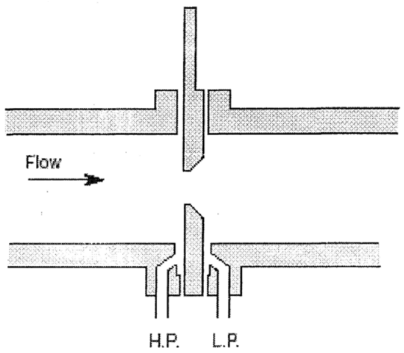
1. Flange taps:



Orifice Plate with Flange Taps and Three Valve Manifold

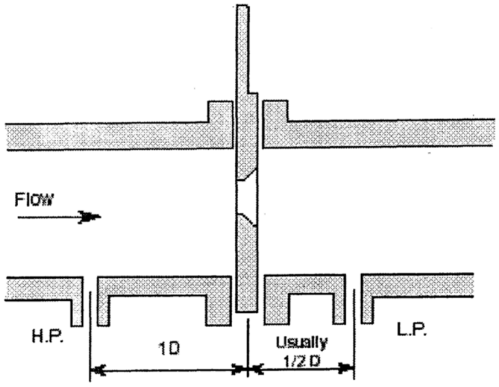
This is most commonly used on pipe sizes of 2 inches or larger. They are located in the orifice flange 2 inch from upstream and 1 inch downstream from the faces 0 orifice plate.

2. Corner taps:



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

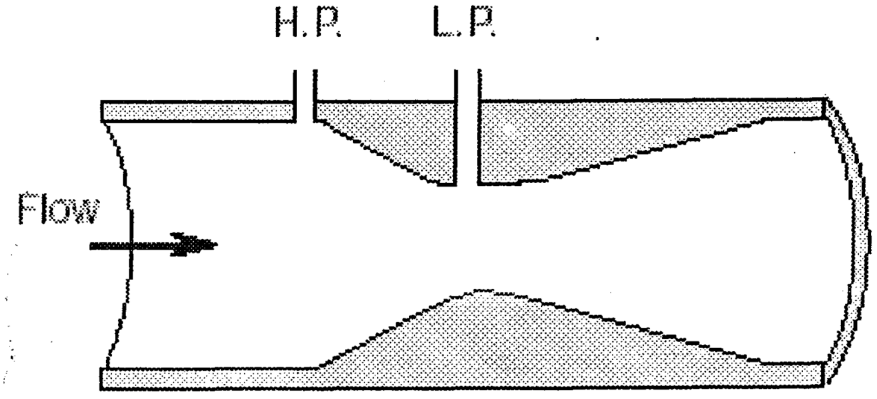
3. Ven contracta taps located at 1 pipe diameter upstream and at point of minimum pressure downstream. There are mostly widely used for measurement of steam.Radius taps are located 1 pipe diameter upstream and 1/2 pipe diameter downstream for the inlet face of the orifice are a close approximation to vena contracta taps upto 0.72 d/D.



4. Full flow taps:
Face flow taps are located at 2'/ pipe diameter upstream and B pipe diameter downstream. Full flow taps at 2'/2 and B pipe diameter have the same advantage as vena contracta or radius taps.

Venturi Tubes

For applications where high permanent pressure loss is not tolerable, a venturi tube (Figure) can be used. Because of its gradually curved inlet and outlet cones, almost no permanent pressure drop occurs. This design also minimizes wear and plugging by allowing the flow to sweep suspended solids through without obstruction.



However a Venturi tube does have disadvantages:

Calculated calibration figures are less accurate than for orifice plates. For greater accuracy, each individual Venturi tube has to be flow calibrated by passing known flows through the Venturi and recording the resulting differential pressures.

The differential pressure generated by a venturi tube is lower than for an orifice plate and, therefore, a high sensitivity flow transmitter is needed.

It is more bulky and more expensive.

As a side note; one application of the Venturi tube is the measurement of flow in the primary heat transport system. Together with the temperature change across these fuel channels, thermal power of the reactor can be calculated.

85. What is Reynolds number?

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.

$$R = \frac{v D \rho}{\mu}$$

V = velocity
D = inside diameter of pipe
p =fluid density
μ = viscosity

For most applications in practical flow measurement the Reynolds number is taken to be sufficient criterion of dynamic similarly. The magnitude of Reynolds number not only indicates whether the flow is laminar orturbulent 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.

86. How would you choose differential range?

The most common diff. range for liquid measurement is 0-100" H20. 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 up to 400" and a decrease down up to 20" by merely changing range tubes or range adjustments.

87. What is positive Displacement meters ?

principle: The principle of measurement is that as thc,iquid 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 apointer 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. OvalGeartype.

88. Why are two plugs provided on a D.P transmitter?

1 .The top plug is a vent plug for venting the air entrapped inside the cell.

2.The bottom plug is a drain plug for draining the liquid accumulated inside the cell.

CONTROL VALVES

89. What is a control valves?

A control valve is the final control element, which directly changes the valve of the manipulated variable bychanging 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 positionof the valve plug inside the body. The plug is connected to the operator by a stem, which slides through astuffing box. The air signal from the controller is applied above the diaphragm. The increasing air signalfrom the controller is applied above the diaphragm. An increasing air signal will push the operator stemdownwards against the force exerted by the spring on the diaphragm plate. The valve is adjusted in such away that the plug starts moving when 3 psi is applied to the diaphragm and touches the seat when 15 psi isapplied to the diaphragm. Thus an increase in air pressure wjll close the valve. Hence the home “Air toClose”. Another type is “Air to open”, such that 3 psi on the diaphragm the value is closed and 15 psi airsignal it in fully open.

90. What are the different types of control valves?

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:

1 . Globe valves single or double seated.

2. Angle valves.

3. Butterfly valves.

4. Three way valves.

91. What is the use of single seated valve?

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

92. What is the use of double seated valve?

In double seated valves the upward and downward forces on the plug due to reduction of fluid pressure ai 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.

93. What is Cv of a valve?

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.

$Cv = Q (\Delta P/G)$

Where: Cv = Valve co-efficient

Q = Volumetric flow rate (gallons/ minute)

ΔP = Pressure drop across the valve in psi.

G = Specific gravity of flowing fluid.

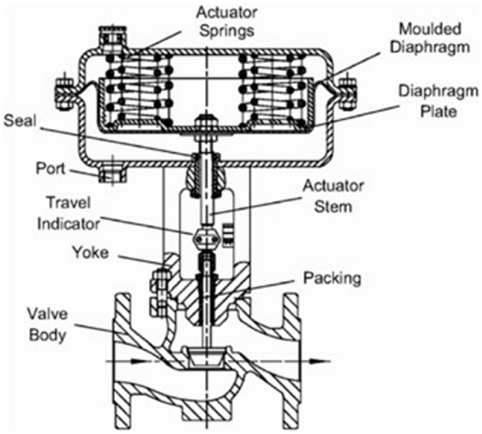
The valve coefficient Cv is proportional to the area ‘A’ between the plug and valve seat measured perpendicularly to the direction of flow.

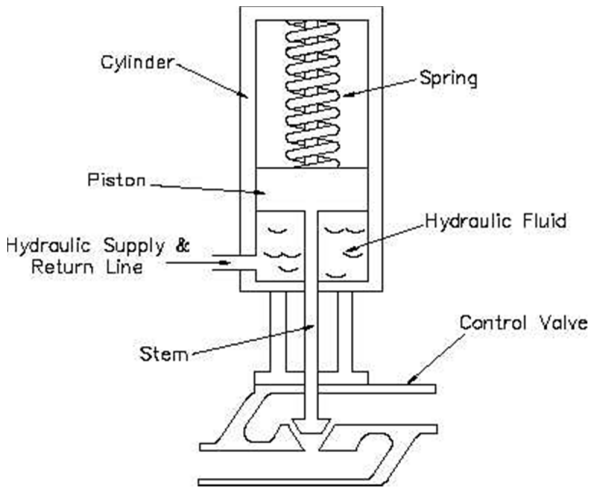
94. What are the different types of actuators?

The different types of actuators are:

1 . Diaphragm Operated.

2. Piston Operated.





95. What types of bonnets would you use of high temp. and very low temp.?

High temperature: Bonnets are provided with radiation fins to prevent glad packing from getting damaged.On very low temperature: Extended bonnets are used to prevent gland packing from getting freezed.

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

While the control valve is in line or in service, it has to be by passed and secondly the line to be depressurized and drained.

97. What is the use of a valve positioner?

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.

7. Reversing valve operation.

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

A by pass on a positioner cannot be used when:

1 . Split Range operation.

2. Reverse Acting Positioner.

3 . Valve bench set not standard.

99. What is the use of butterfly valves?

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.

100. What is the use of three way valves?

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

101. What are the different types of plugs?

The different types ofplugs 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 offbalance area.

Contoured plug:

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

102. What is a cage valve?

A cage valve uses a piston with piston ring seal attached to the sing1e 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.

103. What are the advantages of Camfiex valves ?

Camfiex valves are intermediates between globe valve and butterfly valve. The plug rotates 60’ for fullopening.

Advantages:

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 Temperature.

3. Variations in flow.

4. Light weight.

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

The link serves as the feed back to the value. 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.

105. What is the use of booster relays ?

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.

106. What is the use of Angle valves?

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.

107. What are the different valve characteristic?

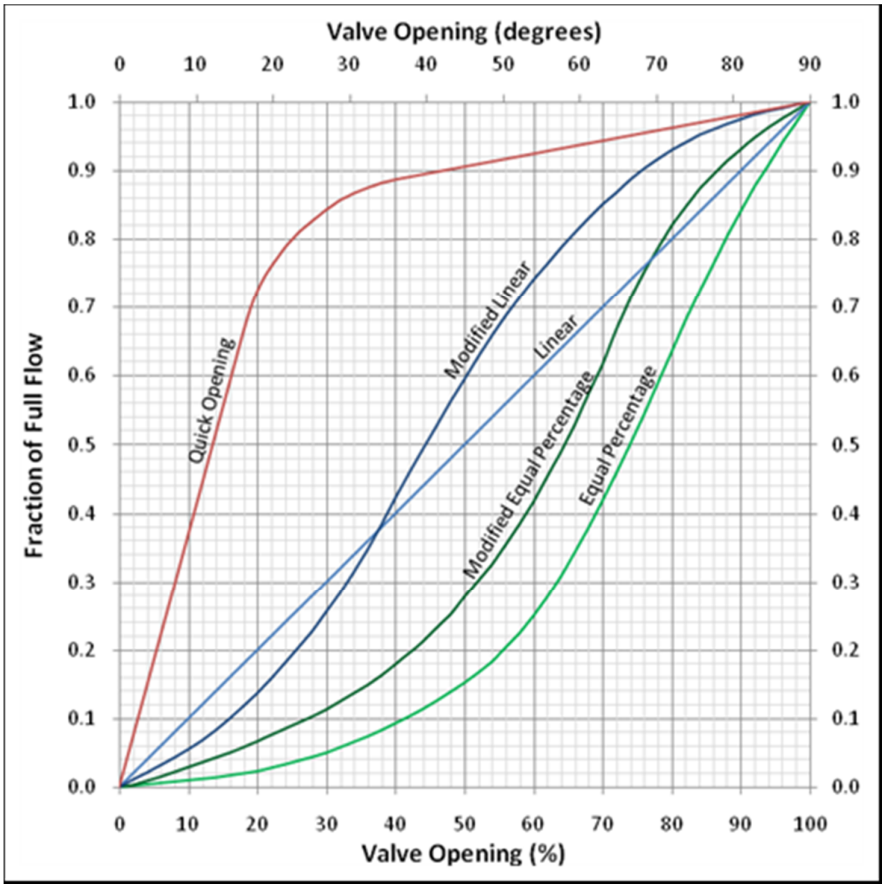
The different types of valve characteristic are:

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

1.Linear: The valve opening to flow rate is a linear curve

2.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. ..

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



108. What is a solenoid valve ? Where it is used?

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:

Normally open Normally Close

USE : It is used for safety purpose.

109. How will you change the valve characteristics with positioner?

The positioner contains different types of came in it. selection of the proper cams in it.By selection of the proper cam the valve opening characteristics can be changed.

11O.How will you change the action of a control valve?

1 . If the control valve is without bottom cap. The actuator needs to be changed.

2. Ifbottom cap is provided.

a) Disconnect the stem from the actuator stem.

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.

0 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.

111. How will you select the control valve characteristics?

The graphic display of flow various lift shows then the Desired or inherent characteristic is changed by variations pressure drop. This occurs as the process changes from condition where most of pressure drop takes place at the control valve is a condition where most of the pressure drop is generally distributed through rest of the system.

% Flow : This variation in where most of the total drop take place is one of the most important aspects is choosing the proper valve characteristics for give process.

Flow control : Normally Equal percentage valve is used.

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

Temp. Control : Normally equal percentage valve is used.

Liquid Level Control : Normally linear valve is used.

Basically in selecting a valve characteristic two important point 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

112. What is the effect of pipe reducers on valve capacity?

When control valves are mounted between pipe reducers, there is a decrease in the actual valve capacity. The reducers create an additional pressure drop in the system by acting as contractions of enlargements in series with the valve.

Metric formula: for inlet and outlet reduces.

$$R = \sqrt{1 - 1.5\left(1 - \frac{d_2}{D_2}\right)^2 \frac{Cv^2}{0.04d_2}}$$

For outlet reducer only or inlet reducer with entrance angle less than 40 inches.

$$R^2 = \sqrt{1 - 1.5\left(1 - \frac{d_2}{D_2}\right)^2 \frac{Cv^2}{0.04d_2}}$$

d = valve size mm. D = line size mm. Cv = required valve co-efficient.

To compensate for reducer losses at sub-critical flow, divide Cv calculated by R.

113. An operator tells you that a control valve in a stuck ? How will you start checking?

1 . First of all get the control valve is passed from operation.

2. Check the lingual to the diaphragm of the control valve.

3 . Disconnect it possible the actuator stem from the control valve stem.

4. Stroke the actuator and check whether the actuator operates or not. It not then the diaphragm may be punctured.

5. Ifthe 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 w/shop.

114. Where is an Air to close and Air to open control valves used ?

Air to close:

1 . Reflux lines.

2. Cooling water lines.

3 . Safety Relief services.

Air to open:

1 . Feed lines.

2. Steam Service.

115. Why does control valve operate at 15 psi?

On higher pressure the actuator sizes becomes bigger in area. The actual force produced by the actuator.

Force = Pressure x Area.

= 15psi xArea, If Area= 15”

Force produced = 15 psi x 25 in^2 = 375 pounds.

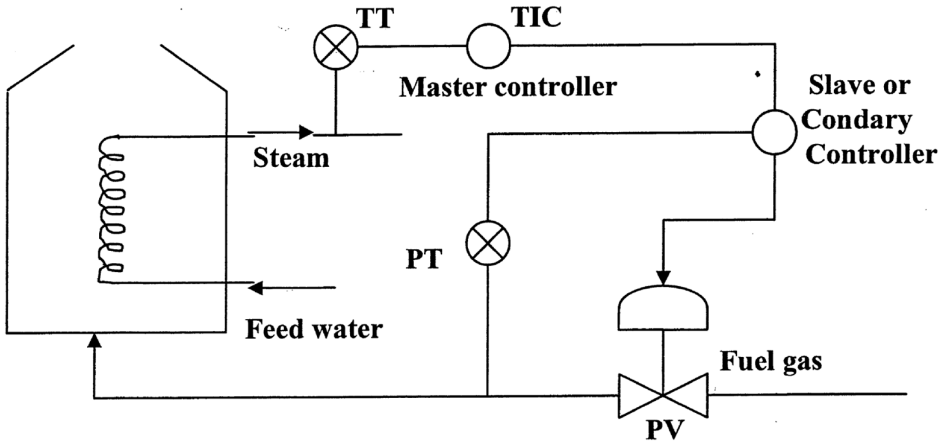
Actual force acting on a control valve = 375 pounds.

116. Explain Cascade Control system with a diagram. What would happier if a single controller were used?

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

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 is turn operates the valve. The reqd. temp. is set on theTIC.



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 responds 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.

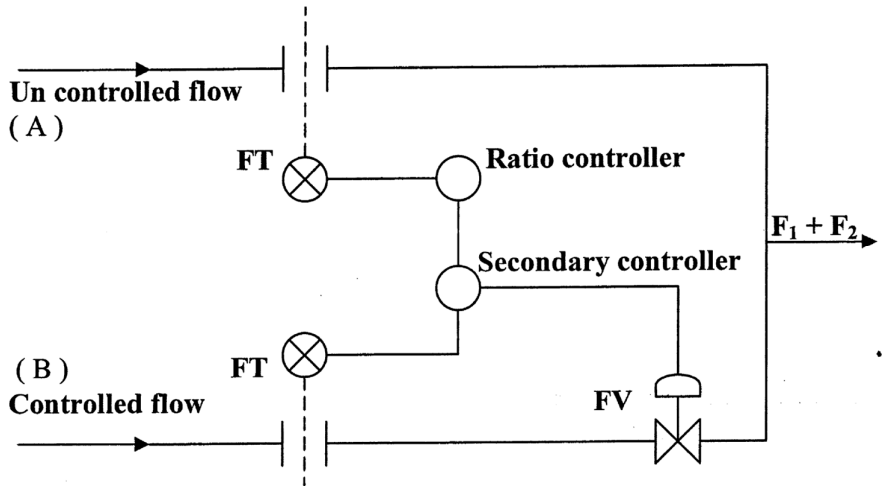
117. Explain ratio control system.

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 0 a ratio control system the secondary flow is hold in some proportion to a primary uncontrollable flow.

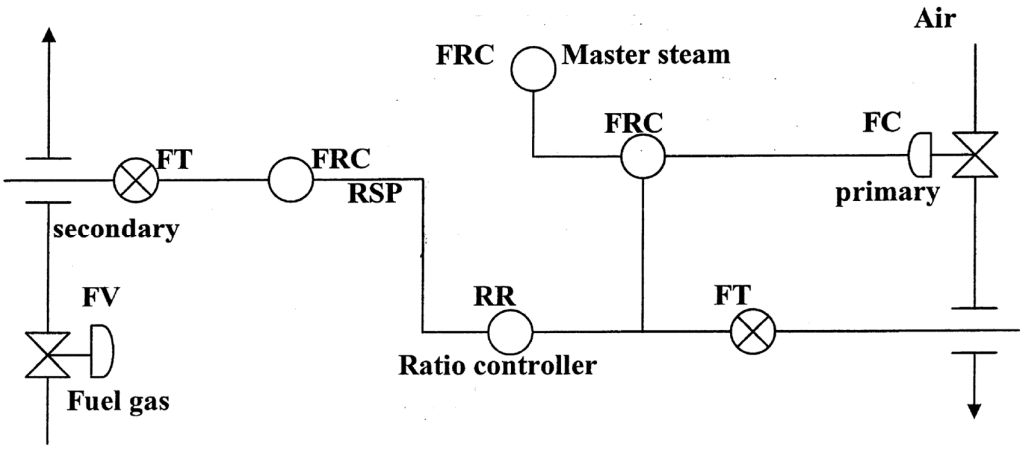
If we assume that the output of primary transmitter is A, and the output of the secondary transmitter is B, And that multiplication factor of the ratio relay is K, then for equilibrium conditions which means set valve is equal to measured valve, we find the following relation:

KA-B=O

or B/A = K, where ‘K’ is the ratio setting of the relay.



118. Explain fuel to air ratio control of furnaces.



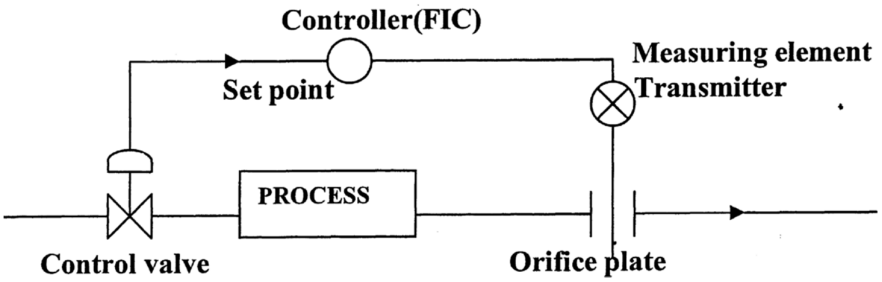
119. What is Furnace Draft control ?

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 " H20) negative pressure of the top of furnace.

120. What is feed back control ? What is feed forward control ? Discuss its application?

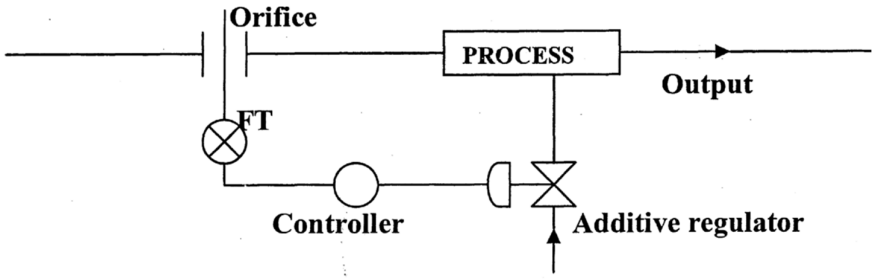
Feed back control involves the detection ofthe controlled variable and counteracting ofcharges its it's value relative to set point, by adjustment of a manipulated variable. This mode of control necessities that the disturbance variable must affect the controlled variable itself before correction

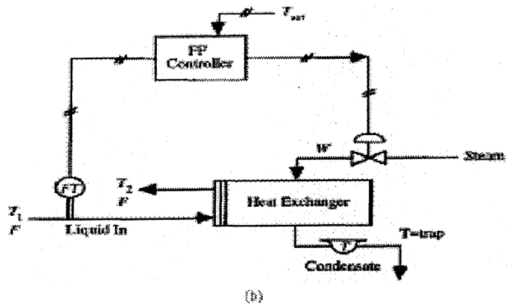
can take place. Hence the term 'feedback' can imply a correction 'back' in terms of time, a correction that should have taken place earlier when the disturbance occurred.

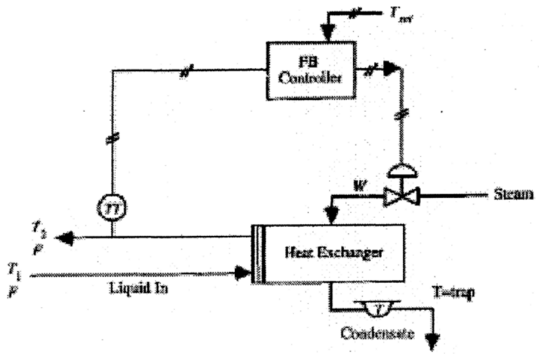


Feed forward control system is a system in which corrective action is based on measurement of disturbances inputs into the process. This mode of control responds to a disturbance such that is instantly compensates for that error which the disturbance would have otherwise caused in the controlled variable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

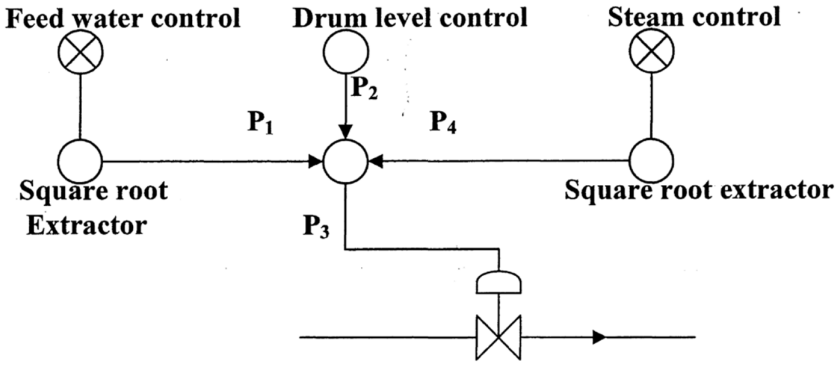






In feed forward control no difference between the desired result and actual result need exist before corrective action is taken in feed back control a difference must exist. Hence, open loop or feed forward control is capable of perfect control, but feed back is not. Due to economic impartibility of 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 properlychoose the type of feed back controller for a particular process application, two factors time and gain must be considered.

121. Explain three element feed water control system?



Computing equation:

$P_3=R\ (P_2- P_1- K) + P_4+K_a$

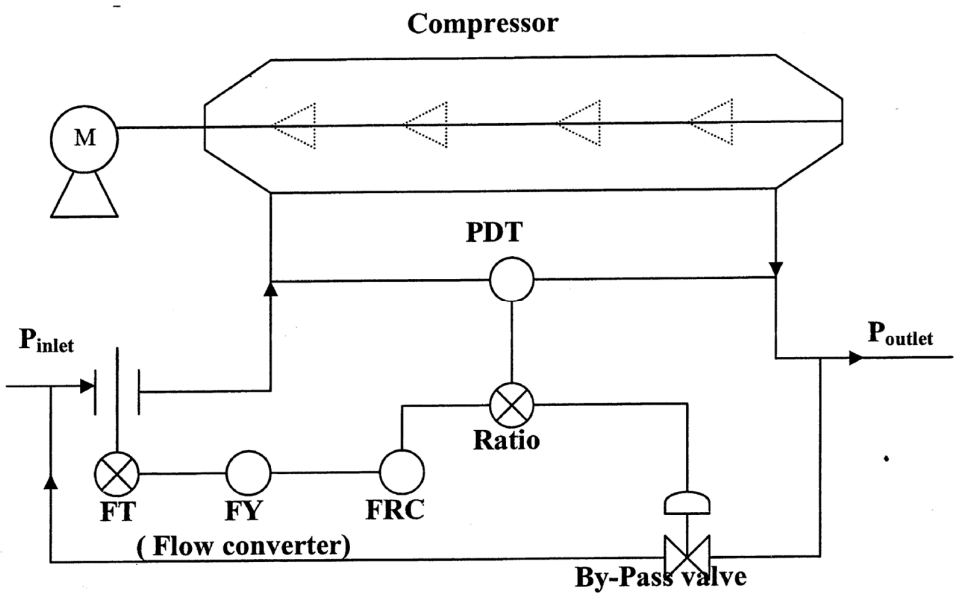
P_3 = Output.

P_1, P_2& P_4 = Input

K_1 = Adjustable suppression.

K_a = Adj.Bias.

122. Explain Anti-surge control?



This method of surge control uses the ratio of compressor pressure rise to inlet flow rate to set the flow in by-bass loop. When the suction pressure drops and discharge shoots up, the compressor starts surging. The PDT senses this and gives the signal to the FRC which will open the by-pass valve.

123. What is Surge?

Surge occurs in a turbo compressor when discharge head cannot be sustained at the available suction flow.Surge occurs at specific combinations of head and flow, as defined by the compressor manufacturer'sperformance curves. One or more ofthe following can result from surge:

Unstable operation

Partial or total flow reversal through the compressor

Disrupted process

Mechanical damage to the compressor

Surge is usually accompanied by the following:

Increase in discharge temperature

Reduction in discharge pressure

Increase in vibration

Sharp rise in inlet temperature dependent on the volume flow at the suction.

Avoiding Surge

In the gas compressor section(Figure 4), surge can be avoided by recycling a controlled portion of the discharge flow back to the suction through a recycle valve. Recycling raises the suction pressure

and lowers the discharge pressure, which increases flow and moves the operation away from surge. Raising speed also moves the compressor away from surge. This is a temporary solution because it also raises Pd and lowers Ps, which tends to drive the machine back towards surge. In the air compressor section (Figure), a blowoff valve is used to vent the compressor discharge to atmosphere. This does not affect the suction conditions, but it reduces discharge pressure and increases flow, which moves the operating point away from surge.

This method of surge control uses the ratio of compressor pressure rise to inlet flow rate to set the flow in by-bass loop. When the suction pressure drops and discharge shoots up, the compressor starts surging.

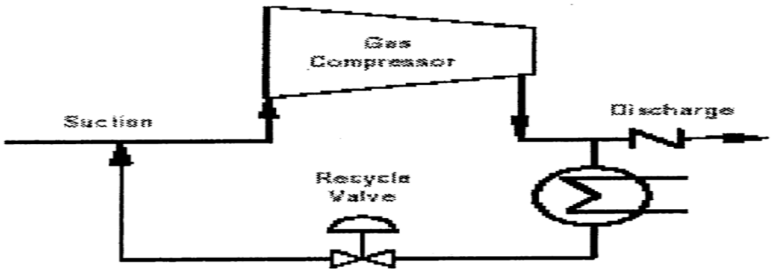


Figure 4
Gas Compressor Anti-Surge Valve

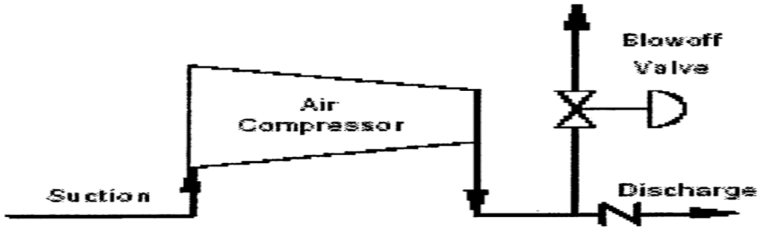


Figure 5
Air Compressor Anti-Surge Valve

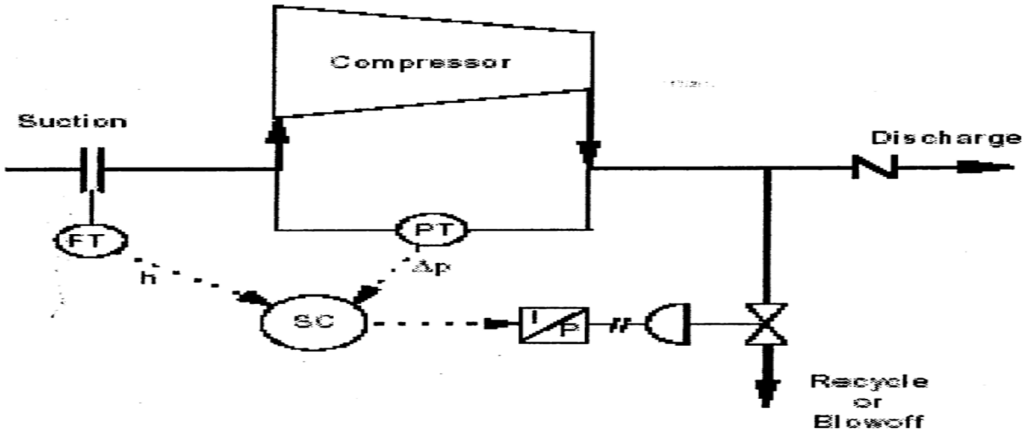


Figure 8
Pressure Rise Method

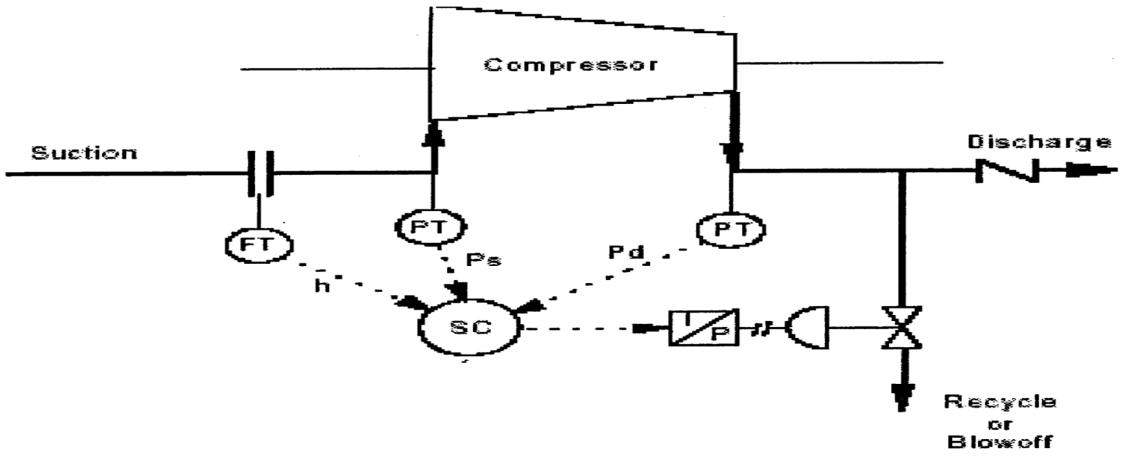


Figure 9
Pressure Ratio Method

124. 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.

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

125. What is force balance and motions balance principle?

FORCE BALANCE PRINCIPLE:

“A controller which generates and output signal by opposing torque’s”.

The input force is applied on the input bellows which novas the beam. This crackles 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 expands the bellows, there by moving the nozzle upward. The nozzle will move untill motion (almost) ecfuals the input (baffle) motion.

Advantages of force Balance :

1 . Moving parts are fever.

2. Baffle movement is negligible.

3. Frictional losses are less.

126. Define spectroscopy.

Spectroscopy is the measurement and interpretation of radiationemitted,scattered or absorbed by different atoms,molecules& other chemical species.

127. Chromatography.

Chromatography is defined as the physical and chemical method of separation between various components of a mixture into pure fractions or bands of eachcomponent.

128. How PH of a solution is measured &give the Nernst equation?

PH is measured by electro chemical cell , consist of two electrodes ¾_Measuring Electrode ¾_Reference ElectrodeMeasuring electrode is sensitive to hydrogen ions &Ref: Electrode is notsensitive to hydrogen ions.The PH is calculated by Nernst eqn: which is given as

E=E0 +2.303RT/F[PcH] ,

wherePcH is the PH value deviation from 7.
R is the gas constant
T is the absolute temperature
F is the Faradays constant.

129. Define Thermal Conductivity of a gas?

Thermal Conductivity of a gas is defined as the quantity of heat (in calories) transferred in unit time (seconds) in a gas between two surface 1 cm2 in area when the temperature difference the surfaces is 1ºC.

130. Define Humidity.

It is basically moisture content in air or it is the quantity of water vapour retained by gas.

131. Define Viscosity.

It is a measure of fluidity of the system. Many fluids undergo continuous deformation with the application of shearing stress.

132. What are the disadvantages of pitot tube?

They can become plugged with sediment and that the pressure difference sensed may not be large enough to give the desired accuracy for the flow rate under consideration.

133. List the advantages of the orifice plate

used in wide range of pipe sizes
used with pressure differential device.
Available in many materials

134. List the disadvantages of the orifice plate

high permanent pressure loss
reduces the use in slurry services
accuracy depends on the care during installation.
It has the square root characteristics.

135. Explain the principle of turbine flow meter

when the liquid enter through inlet, due to the inflow, shaft rotates which cuts the magnetic pickup, and produces the voltage which is proportional to inflow of water.

136. List the disadvantages of glass Rotameter

subject to breakage
It must mounted vertically
It limited to low temperature
Less accuracy
If pressure is greater than 35 kg/cm3 tube get damage

137. list the advantages of electromagnetic flow meter?

It can handle slurries & corrosive fluids
It has low pressure drop
It can be used as bi-directional meter
Available in large pipe size & capacities

138. Explain the principle of vortex flow meter

it is based on vortex sheding which occurs when a gas or liquid flows around a non stream

lined objects. When fluid flows pass an obstucle, boundary layers of slow moving fluid are formedalong the outer surface of the obstucle and the flow is unable to follow contours of the obstucle of itsdownstream side.

139. Why do we need mathematical modeling of process?

The physical equipment of the chemical process we want to control havenot been constructed. Consequently we cannot experiment to determine how theprocess reacts to various inputs and therefore we cannot design the appropriatecontrol system. If the process equipment needs to be available for experimentationthe procedure is costly. Therefore we need a simple description of how the process
reacts to various inputs, and this is what the mathematical models can provide tothe control designer.

140. Distinguish between continuous process and batch process.

A process in which the materials or work flows more or less continuouslythrough a plant apparatus while being treated is termed as continuous process. Theproblem of continuous process is due to load changes.
A process in which the materials or work are stationary at one physicallocation while being treated is termed as batch process.

141. Define proportional band.

Proportional band is defined as the change in input of proportionalcontroller mode required to produce a full-scale change in output

142. Define offset.

It is the steady state deviation (error) resulting from a change in value ofload variable.

143. Define integral (reset) windup?

The over charging in the presence of a continuous error of the integralcapacitor which must discharge through a long time constant discharge path andwhich prevents a quick return to the desired control point.

144. Define cascade control.

Cascade control is defined as a control system composed of two loopswhere the set point of one loop (the inner loop) is the output of the controller ofthe other loop (the outer loop)

145. What is split-range control?

To control A single process output can be controlled by co-coordinating theactions of several manipulated variables all of which have same effect oncontrolled output. Such systems are called split-range control systems.

146. What is the need of I/P converter in a control system?

In some process loop the controller is electronic and the final controlelement is electronic one. To interconnect these two we need a device that shouldlinearly converts electric current in to gas pressure (4-20mA-315 psi). such deviceis called I/P converter.

147. What is meant by cavitations in control valve?

When a liquid enters a valve and the static pressure at the vena contractadrops to less than the fluid vapor pressure and the recovering to above fluid vapourpressure, this pressure recovery causes an implosion or collapse of the vapourbubbles formed at the vena contracta. This condition is called cavitation.

148. Why calibration of instrument is important?

The calibration of all instruments is important since it affords theopportunity to check the instrument against a known standard and subsequently toerrors in accuracy.

149. Write notes on LVDT

It is the linear variable differential transformer which is used to translatethe linear motion into electrical signals. It consists of a single primarywinding and 2 secondary winding.

DEFINITION

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 c 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.

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.

ACCURACY:

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 resultingresponse.

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 ofthe 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.

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.

POSITIONING ACTION:

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

DERIVATIVE ACTION:

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 continuos 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 ofthe effect ofproportional 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 value produced by rate action compared with proportional position action for the same rate of change of actual measurement in both cases.

Alternating Current Abbreviation ac. Electric current whose flow alternates in direction. The number of times the current changes direction in one second is called the frequency. The normal waveform of ac is sinusoidal.

Alumel Trade name for an alloy ofnickel with up to 5% aluminium, manganese and silicon, used with chromel in K-type thermocouples.

Ampere Abbreviation A . SI unit of electric current.

Amplifier A circuit that produces a larger output power, voltage or current than was applied at its input.

Amplitude The size or magnitude of a signal.

Analogue-to-Digital (A/D) Converter Converts an analogue signal (such as a voltage signal from a temperature sensor) into a digital signal suitable for input to a computer.

Anti-Alias Filter An anti-alias (or anti-aliasing) filter allows through the lower frequency components of a

signal but stops higher frequencies, in either the signal or noise, from introducing distortion. Anti-alias filters are specified according to the sampling rate of the system and there must be one filter per input signal.

Backbone The major multi-channel link in a network, from which smaller links branch off.
Background Noise Extraneous signals that might be confused with the required measurement.

Baud The rate of data transmission in serial data communications, approximately equal to one bit per second.

Chromel An alloy of nickel with about 10% chromium, used with Alumel in K-type thermocouples.

Constantan An alloy of4O% nickel and 60% copper, with a high volume resistivity and almost negligible temperature coefficient. Used with copper in T-type thermocouples.

Current Current is Qften used to transmit signals in noisy environments because it is much less affected by environmental noise pick-up. Before AID conversion the current signals are usually turned into voltage

signals by a current-sensing resistor.

Differential Inputs Reduce noisepicked up by the signal leads. For each input signal there are two signal wires. A third connector allows the signals to be referenced to ground. The measurement is the difference in voltage between the two wires: any voltage common to both wires is removed.

Digital-to-Analogue (DIA) Converter Used to produce analogue output signals. These may be control signals or synthesised waveforms.

Electromotive Force (em!) Difference of potential produced by sources of electrical energy which can be used to drive currents through external circuits. Unit is the volt.

Endurance limit In fatigue testing, the number of cycles which may be withstood without failure at a particular level of stress.

EIA Electronic Industries Association.

Ethernet A local area network to which you can connect data acquisition devices.

E-Type Thermocouple Chromel-constantan thermocouple with a temperature rangeof 0-800 °C.

FIFO buffer A first in, first out, store. The first value placed in the buffer (queue) is the first value subsequently read.

Filtering Attenuates components of a signal that are undesired: reduces noise errors in a signal. Frequency Measured in hertz (cycles per second), rate of repetition of changes.

Frequency Counter Counts digital pulses over a defined gate time. A typical gate time is between 0. 1 and 10 seconds.

Front panel The front surface of a unit, generally containing switches and indicator lights. Gain Amplification of a circuit.

GPIB General Purpose Interface Bus. Also known as IEEE-488 bus. The GPTB standard was designed to connect several instruments to computers for data acquisition and control. Data can be transferred over GPIB at 200 000 bytes per second, over distances of2 meters.

Ground See earth. •

Hertz (Hz) Cycles per second unit of frequency.

Human machine interface (hmi) Also known as man machine interface. The communication between the computer system and the people who use it.

IEEE-488 Bus See GPTB

Integration Time An integrating AID converter measures an input voltage by allowing it to charge a capacitor for a defined period. The integration averages the input signal over the integration time, whIch if chosen appropriately will average over a complete mains cycle thereby helping to reduce mains frequency interference.

Isolation Two circuits are isolated when there is no direct electrical connection between them.

Isolation to Earth or System A high transient voltage at one input may damage not only the input circuit, but the rest of the data acquisition hardware, and, by propagating through the signal conditioning and AID circuits, eventually damage the computer system as well. You can prevent this type of damage by isolating the input from the earth of the data acquisition and computer hardware.

Isolation Between Inputs A transient at an input can also propagate to other equipment connected to that input. This is prevented by providing isolation between inputs.

J-Type Thermocouple Iron-constantan thermocouple with a temperature range of 0 to 750 °C.

K-Type Thermocouple Chromel-Alumel thermocouple with a temperature range of-200 to 1200 °C.

N-Type Thermocouple Nicrosil-Nisil thermocouple with a temperature range of-200 to 1200 °C.

Resolution The resolution of an AID or D/A converter is the number of steps the range of the converter is divided into. The resolution is usually expressed as bits (n) and the number of steps is 2’ (2 to the power n), so a converter with a 12-bit resolution divides its range into 212 or 4096 steps. In this case a 0-10 volt range will be resolved to 0.25 millivolts.

Rins Root mean square. The square root of the sum of the squares of a set of quantities divided by the total number of quantities. Used when monitoring ac (alternating current) signals. Many power supplies, for example, issue an ac signal. This needs to be converted to a dc (direct current) signal for the PC interface. The solution is a signal conditioning input that produces a dc signal proportional to the rms of the amplitude of the input signal. The rms operation means the reading will always be positive.

Settling Time When an output voltage swings full-scale through the range of the D/A converter, the settling time tells how long it will take for the output to settle to its new value.

Signal Conditioning Makes a signal suitable for input to an analogue-to-digital converter. For example, a signal may be filtered to remove noise, or amplified to meet the range of the AID converter.

Simultaneous Sampling When all analogue signals are read simultaneously. This. is achieved by providing each input with its own A/D converter, and initiating sampling from a single clock. It ensures that there is no reduction in sampling rate when more signals are connected.

Slew Rate The maximum rate of change of an output signal.

Strain Gauge A device which experiences a change in resistance when it is stretched or strained.

. Thermistor A temperature sensor. The name comes from thermal resistor. It comprises a mixture of certain

oxides with finely divided copper, of which the resistance is very sensitive to change of temperature. Thermocouple Popular temperature sensor because of its low cost, versatility and ruggedness. Consists of two different metals joined together, making a continuous circuit. When one junction has a different temperature from the other an electromotive force (voltage) occurs. There are several types of thermocouples, constructed from different metals and with differing temperature ranges and accuracies.

Transducer A device which converts a physical quantity into an electrical signal. Examples include thermocouples and photocells.

Transient A short surge of current or voltage, often occurring before steady-state conditions have become established.

T-Type Thermocouple Copper-constantan thermocouple with a temperature range of -200 to 400 °C.