MODULE TITLE : CONTROL SYSTEMS AND AUTOMATION

TOPIC TITLE : CONTROL DEVICES AND SYSTEMS

LESSON 2 : VALVE POSITIONERS AND VALVE SIZING

CSA - 4 - 2

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INTRODUCTION

In many control applications the need for accurate response and positioning of the valve opening dictates the use of valve positioners. This lesson describes the construction and operation of valve positioners and also deals with the "sizing" of control valves.

YOUR AIMS

On completion of this lesson you should be able to:

- state the reasons for using a valve positioner
- sketch and explain the operation of a typical valve positioner
- explain how reverse action and split range operation is achieved in a valve positioner
- define flow coefficient and explain its use in determining the sizes of control valves on liquid duties
- explain how noise, flashing and cavitation are created in control valves
- describe the problems they cause and how their effects can be minimised.

REASONS FOR USING A VALVE POSITIONER

In order to achieve good control it is essential that the valve stem of a control valve moves easily, quickly and accurately in response to any change in the controller signal. The main causes of inaccurate positioning of the stem and poor response times are:

- frictional forces acting on the valve stem
- long pneumatic signal transmission lines and large volume actuators
- forces arising from the process fluid acting on the valve plug.

These effects can be overcome or reduced by employing strategies as described below.

- The selection of suitable gland packing and a good lubrication schedule can reduce valve stem friction.
- The provision of a large area actuator will increase the activating force and facilitate valve movement. However, a larger actuator also introduces an additional capacity lag which must be taken into consideration.
- The use of volume boosters, electrical signals and transducers reduce the problems associated with 'capacity lags' caused by long pneumatic signal transmission lines.
- The force acting on a valve plug is proportional to the product of the process pressure and the area of the plug. This force may be reduced, but not eliminated, by fitting a pressure balanced valve. However, such valves, which are double seated, tend to be large and expensive.

An effective method of improving valve performance involves the employment of a **valve positioner**. Essentially, this forms a high gain closed loop system centred on the control valve. The positioner can be designed as an integral part of the valve actuator or can be mounted directly on the valve itself.

A valve positioner accurately monitors the actual valve stem position, compares it to the desired position as indicated by the signal from the controller, then adjusts the valve actuator pressure accordingly. FIGURE 1(a) shows the schematic arrangement of a valve positioner which is mounted directly on a control valve. FIGURE 1(b) shows the valve positioner and control valve represented in block diagram form.

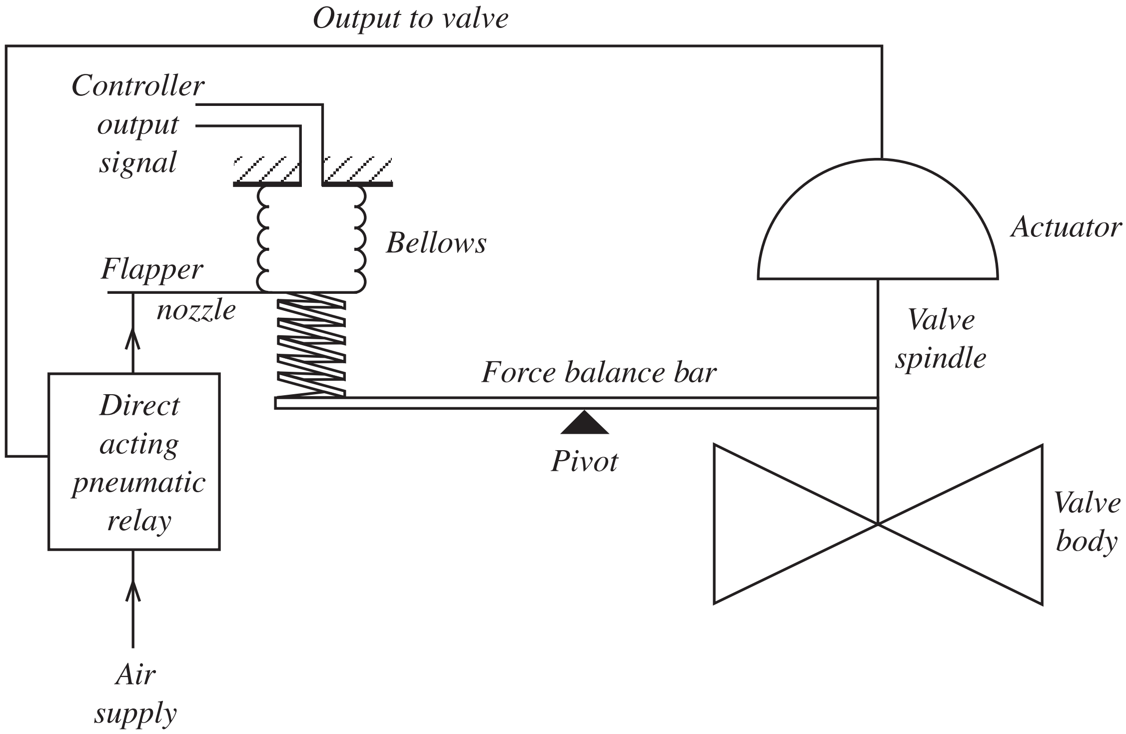

FIG. 1(a)

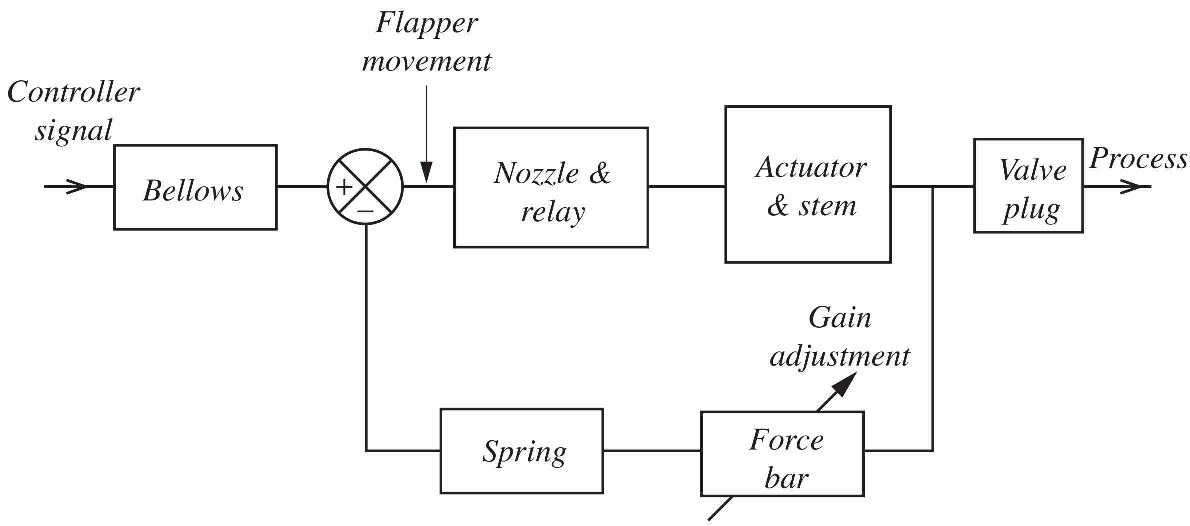

FIG. 1(b)

OPERATION OF THE VALVE POSITIONER

An increase in controller signal expands the bellows, compresses the spring and pushes the flapper onto the nozzle. This increases the nozzle back-pressure and hence the output pressure from the relay. This output pressure is fed to the valve actuator which moves the valve stem downwards.

The downward movement of the valve stem is fed back to the valve positioner by means of the force balance bar, which pivots clockwise and further compresses the spring. The compressed spring tends to lift the flapper away from the nozzle, causing the nozzle back-pressure to fall and reduce the amplified output of the relay.

This activity continues until a point of equilibrium is reached and the actual position of the valve stem matches the desired position, as indicated by the input signal from the controller.

The employment of *feedback* is the key to rapid and precise valve positioning. Insufficient valve movement, caused, for example, by excessive stem friction, will result in reduced spring compression and flapper 'lift'. The relay output pressure will remain high, allowing an increase in actuator pressure sufficient to re-position the valve.

Alternatively, excessive valve movement will produce an increase in spring compression and flapper 'lift', resulting in a reduced actuator pressure.

The gain of the valve positioner, which is the relationship between valve stem travel and the change in controller input signal, can easily be varied by moving the pivot point of the force balance bar. This allows the valve positioner to be adapted to different types of control valve involving different ranges of stem travel.

Cam-Type Valve Positioner

A cam-type valve positioner employs a contoured cam to transmit movement of the valve stem to the flapper mechanism, and carries out the same function as the positioner already described. Refer to FIGURE 2 overleaf as you read the explanation of its operation.

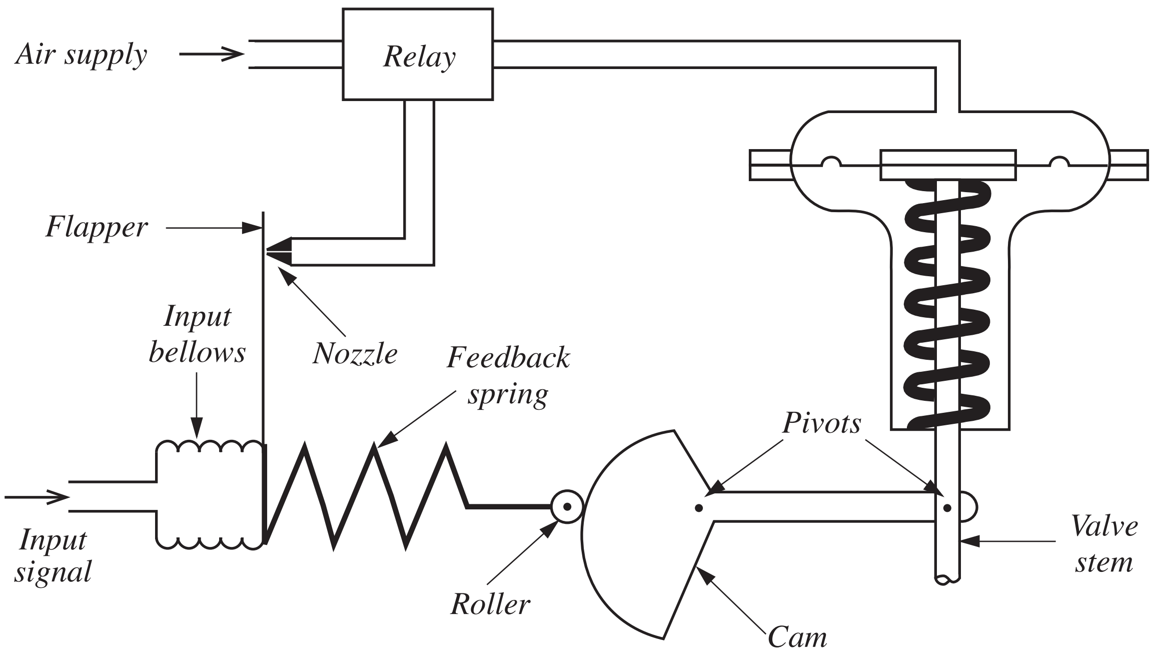

FIG. 2

Operation of the Cam-Type Valve Positioner

The cam, which forms an essential part of the feedback mechanism, can be designed to have a profile which will produce a required feedback relationship.

The amount of feedback determines the gain of the positioner, and hence governs the relationship between the controller output signal and the valve stem movement. If the cam is non-linear, the relationship between the controller input signal and the controlled flow will also be non-linear.

Hence, by reshaping the cam it is possible to change the apparent inherent flow characteristics of a control valve. For example, a valve positioner can be used to convert a 'linear' valve to one having equal percentage flow characteristics.

CONTROL VALVE FAIL SAFE OPERATION

In selecting a control valve for a particular application, the parameters which must be considered include those listed below.

- The force available from the actuator to position the valve.
- The size of the valve body.
- The materials of construction and the fluid being regulated.
- The flow characteristics required.
- The effect on the plant and process fluid of an air supply failure.

We have already referred to the spring of a control valve returning the valve to a rest position, which is described as the **fail safe** position.

A valve which is designed to fail in the **open** position is called an "open air failure valve" (OAF valve). In certain situations the terms "air to close" (ATC) or air fail valve open (AFVO) are used.

A valve which is designed to fail in the **closed** position is called a "closed air failure valve" (CAF valve). In certain situations the terms "air to open" (ATO) or air fail valve closed (AFVC) are used.

Selection of the correct air failure action, appropriate to the particular process, is essential to address safety issues.

FIGURE 3 shows part of a process in which a reaction vessel fluid is being heated by means of a steam coil. Let's look at this process to see why selection of the correct air failure action is important.

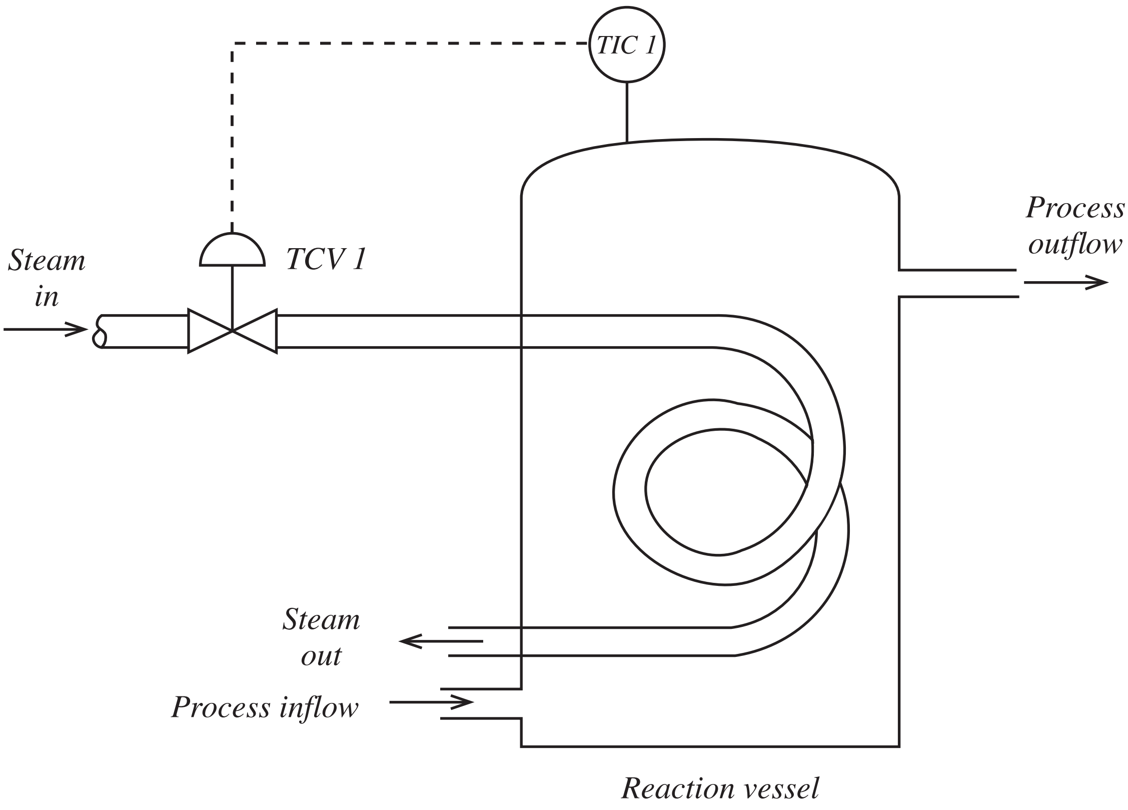

FIG. 3

Valve TCV regulates the flow of steam and is activated by the controlling instrument, TIC. If a fault develops and the instrument air supply fails, TCV can come to rest in either the open or closed position.

If the valve fails in the open position, the steam will continue to heat the process fluid within the vessel, which might result in the fluid reaching a dangerously high temperature and or pressure, resulting in possible damage to the process equipment.

Alternatively, if an air supply failure sets the valve in the closed position, the steam supply is shut off, causing the process fluid to cool down.

Can we conclude that the fail safe position for the steam valve is the closed position?

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The above conclusion is acceptable if the avoidance of overheating of the process fluid is the overriding safety criterion. However, if there is a danger of the fluid solidifying at ambient temperature, it may be necessary to opt for an open air failure valve.

Before a valve specification can be concluded, therefore, it is important to consider the characteristics of the process fluid in the context of the operation of the plant.

FIGURE 4 shows two methods of controlling the level of water within a tank by means of a control valve.

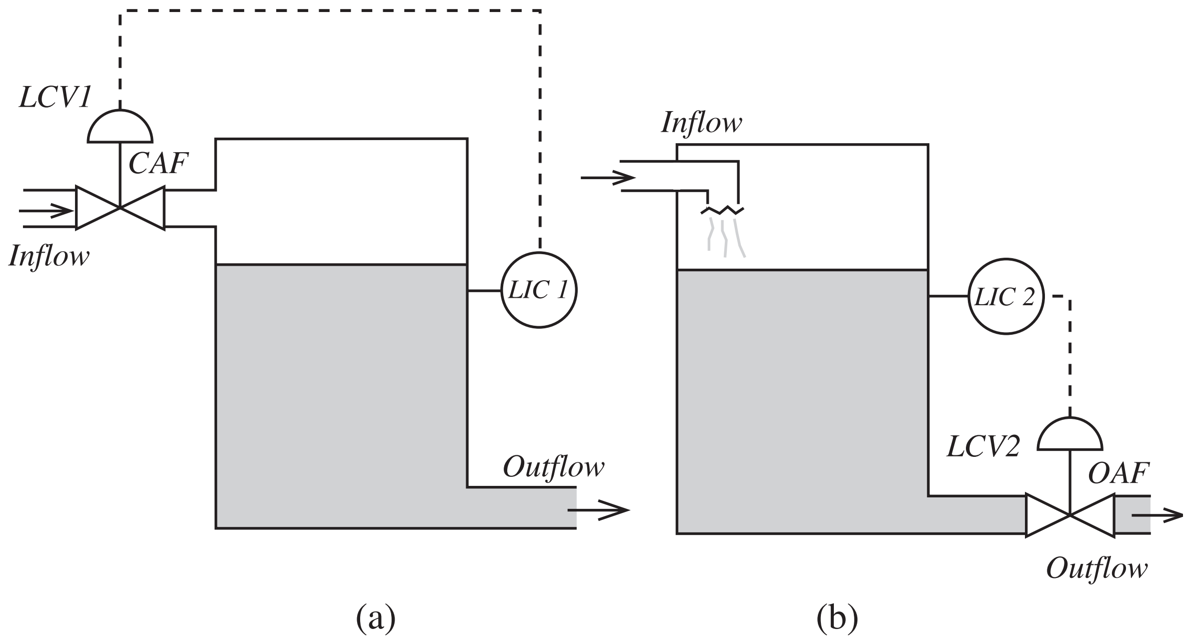

FIG. 4

In FIGURE 4(a) the required level is maintained by controlling the inflow to the tank. A fall in level due to an increase in demand at the outflow will be detected by controller LIC 1 causing the valve LCV 1 to open.

In FIGURE 4(b), a fall in level due to a reduction in the inflow will be detected by LIC 2 causing valve LCV 2 to close. Thus, although both control strategies maintain the fluid level in the tank. one causes a valve to open and the other causes a valve to close.

If the main safety criterion is the avoidance of tank overflow, LCV 1 will need to be a CAF type of valve and LCV 2 will need to be an OAF type

At this stage, it is worth again emphasising the importance of correct valve selection in achieving the safe operation of a process plant.

VALVE ACTION CONFIGURATION

There are many configurations of spring diaphragm actuator, employing different methods of achieving the same fail safe result. FIGURE 5 shows a selection of configurations.

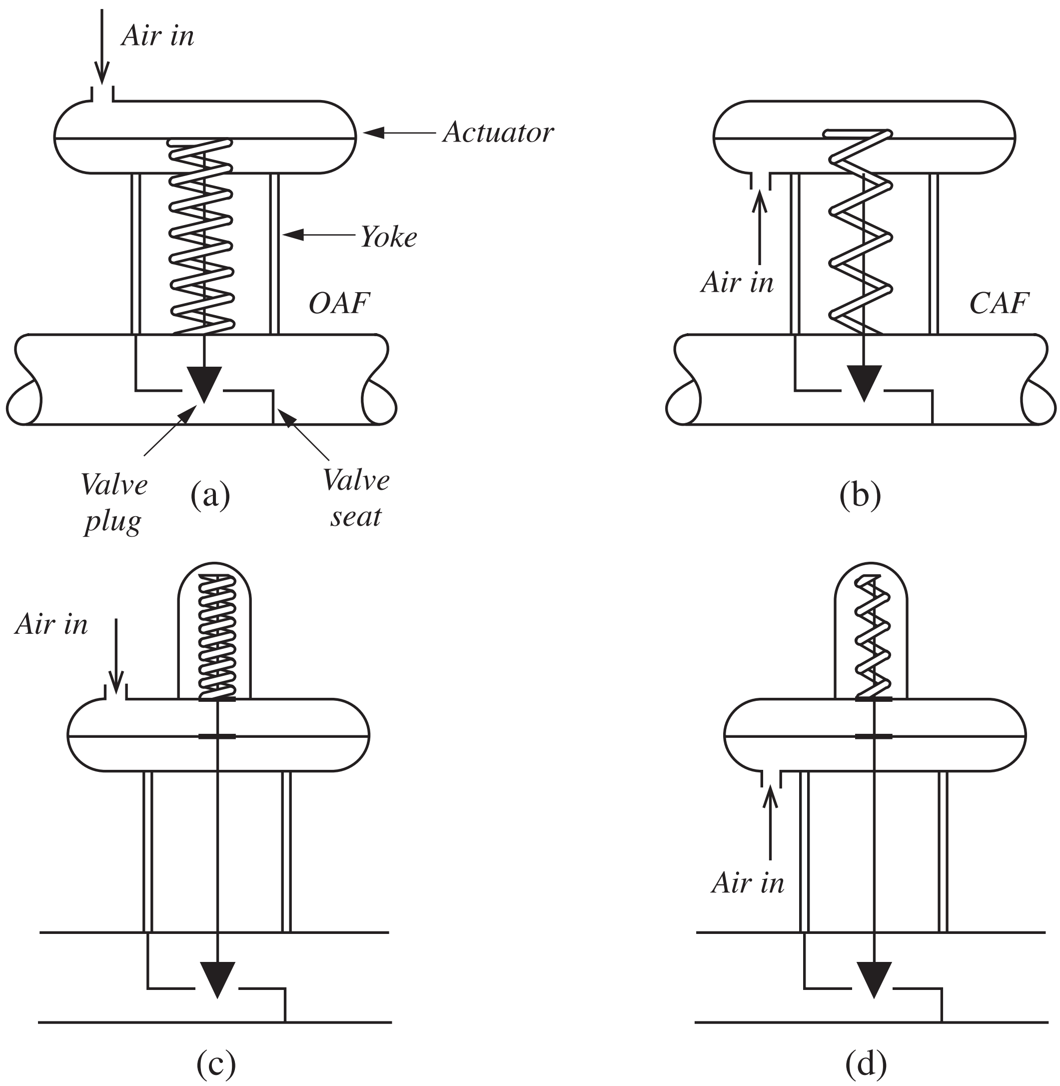

FIG. 5

The 'rest position' of the valve plug shown in FIGURE 5(a) is *off the seat*. As air is applied, the diaphragm and valve stem move downwards compressing the spring and closing the valve. Failure of the air supply causes the spring to expand, lifting the plug from its seat.

The 'rest position' of the valve plug shown in FIGURE 5(b) is *on the seat*. As air is applied, the diaphragm and the valve stem rise, extending the spring and opening the valve. Removal of the air supply causes the spring to contract and force the plug onto its seat.

See if you can describe the operation of the valve actuators illustrated in FIGURE 5(c) and 5(d), and designate them as OAF or CAF.

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The valve shown in FIGURE 5(c) operates on the OAF principle. The diaphragm pushes down the stem, closing the valve and compressing the spring. Removal of the air pressure allows the stem to lift and the plug to rise from its seat.

FIGURE 5(d) illustrates a CAF type valve. Air lifts the diaphragm causing extension of the return spring and opening the valve. Removal of the air pressure allows the spring to force the valve plug back onto its seat.

In many designs the valve body construction allows the valve action to be reversed. For example, the design shown in FIGURE 6 permits reversal of the valve plug and seat to reverse the OAF and CAF valve actions.

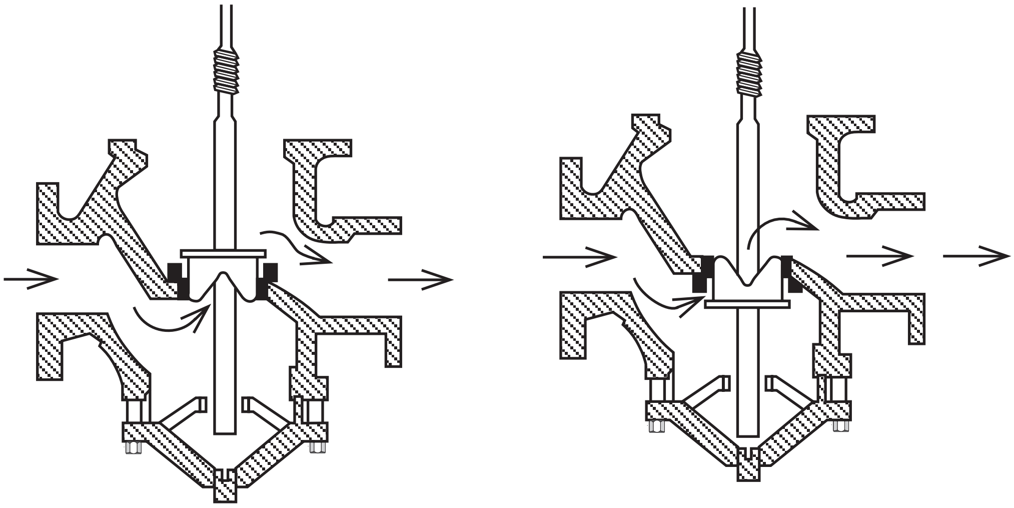

FIG. 6

VARIABLE GAIN FACILITY

Most valve positioners are designed to have a variable 'gain' facility. In the case of force balance positioners, this is achieved by either moving the pivot point or by changing the position of the nozzle.

The provision of this variable gain facility meets two particular requirements:

- the need for amplified control signals to meet certain valve operational specifications

- to facilitate 'split range' operation.

Split Range Operation

Split range operation is employed to enable a single controller to operate two control valves. The requirement of the system shown in FIGURE 7 is for controller TIC to maintain a constant temperature in the reaction vessel.

This is achieved by governing the action of valves TCV 1A and TCV 1B which control the flow of steam and cooling water into the vessel.

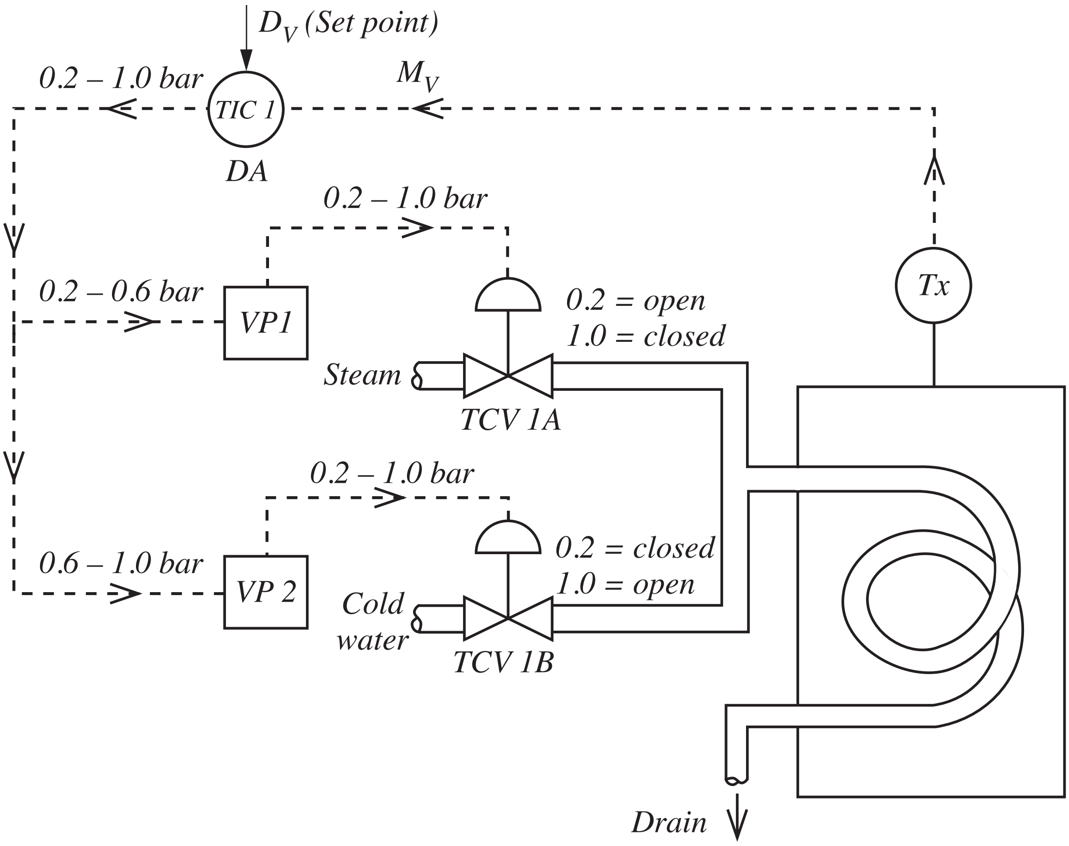

FIG. 7

The output of the temperature controller is a standard 0.2 → 1.0 bar signal. The valve positioners have been calibrated to give the following input/output relationships.

VP 1 A 0.2 to 1.0 bar output is achieved from a 0.2 to 0.6 bar input signal to the valve positioner. For input signals exceeding 0.6 bar the output remains at 1.0 bar. Hence, the steam control valve, although a standard 0.2 to 1.0 bar control valve, achieves its full stroke when the controller output signal changes from 0.2 to 0.6 bar.

VP 2 This valve positioner is set up so that an output of 0.2 to 1.0 bar is achieved for a valve positioner input signal of 0.6 to 1.0 bar. The net result is that the cold water valve achieves its full stroke over a controller output signal range of 0.6 to 1.0 bar.

The system operates in the following manner.

- If the measured value of the process temperature is exactly at the desired value, the controller output will be 0.6 bar, which represents a 50% bias output. This means that the output of VP 1 will be 1.0 bar and the steam valve will be closed. The output of VP 2 will be 0.2 bar which means that the cold water valve will also be closed. These valve states are correct for the stated conditions because there is no heating or cooling requirement.

- If the process temperature rises above the desired value, the controller output will exceed 0.6 bar. This will not affect the position of the steam valve, but positioner VP2 will respond to give an increased output and open the cold water valve. This action will, of course, reduce the process fluid temperature.

- If the process temperature drops below the desired value the controller output will fall below 0.6 bar. The water valve will remain closed but VP 1 will come into operation to open the steam valve and raise the process fluid temperature.

Note that when split range valves are employed, only one valve is in operation at any particular time. The obvious exception to this occurs when the controller output is 0.6 bar, putting both control valves into the closed position.

Advantages of using a Valve Positioner

- An increased pressure is supplied to the valve actuator, thereby ensuring the following outcomes:

  (a) the valve always reaches its correct position corresponding to the applied input signal

  (b) compensation for the effect of valve stem friction is achieved

  (c) any high process line pressures affecting the actuator are overcome.

- The use of a cam permits variation of the control signal/flow characteristic relationship.

- Faster positioning with less overshoot is achieved.

- Split range control valves can be used.

- Control valves of different operating ranges can be used.

- Reverse or direct valve action can be employed in order to change the "apparent action" of a valve while retaining the original air failure action.

We now need to consider how the size of a control valve is determined.

It is extremely important to select a valve of the correct size. A valve which is too small to deliver the required flow will probably need to be replaced at a later date. A valve which is too large for its application incurs unnecessary expense and will provide inferior control.

Despite careful selection of the correct controller and correct calibration of the instrument system, effective process control will be difficult to achieve using incorrectly sized valves.

The correct sizing of a control valve should ensure the selection of a valve capable of passing a desired maximum flow. The flow through a control valve, which can be regarded as a restriction, is given by the expression:

$$Q = \frac{A_1 A_2}{\sqrt{(A_1 - A_2)}} \times \sqrt{\frac{2\Delta p}{\rho}}$$

where, Q = flow rate
Δp = differential pressure across the restriction
ρ = fluid density
A_1 = area of pipe
A_2 = area of restriction.

Representing all other constants by the single constant C, the relationship can be expressed in the following form:

$$Q = C\sqrt{\frac{\Delta p}{\rho}}$$

The value of C can be determined experimentally. Normally, the constant C is represented by C_v which is termed the valve flow coefficient. Hence, the expression becomes:

$$Q = C_v\sqrt{\frac{\Delta p}{\rho}}$$

or $$C_v = Q\sqrt{\frac{\rho}{\Delta p}}$$

British Standards (*Industrial-process control valves* BS EN 60534-2-1) defines a valve's flow coefficient for when the liquid is water as:

> *The volume flow of water through a valve measured in cubic metres per hour with a pressure drop of 1 bar across the valve and at a water temperature in the range of 5°C to 40° C.*

As the liquid is water and the temperature range is small we can assume that density (ρ) is constant and we can incorporate it into the constant. We can thus use the above definition to define a new valve flow coefficient for water (K_v) as:

$$K_v = Q\sqrt{\frac{\Delta p_{K_v}}{\Delta p}}$$

where: Q is the volumetric flow through the valve in cubic metres per hour
Δp is the measured differential pressure drop across the valve in bar
Δp_{K_v} is the pressure loss of 1 bar.

Determine the units of K_V.

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Since $K_v = Q\sqrt{\dfrac{\Delta p_{K_v}}{\Delta p}}$ the term inside the square root is dimensionless, and thus K_v has the same units as Q, namely $m^3\ h^{-1}$.

If a liquid other than water is used to determine the flow coefficient, then the equation needs to take account of the different densities of the water and the new liquid, and can be modified to:

$$K_v = Q\sqrt{\left(\frac{\Delta p_{K_v}}{\Delta p}\right) \times \frac{\rho}{\rho_w}}$$

$$\text{OR} \qquad K_v = Q\sqrt{\left(\frac{1}{\Delta p}\right) \times RD}$$

where: Δp is the measured differential pressure drop across the valve in bar

ρ is the density of the liquid in kg m^{-3}

ρ_w is the density of water in kg m^{-3}

RD is the relative density of the liquid $= \dfrac{\rho}{\rho_w}$

Δp_{K_v} has been replaced by 1 bar.

Thus, if we know the value of K_v, then the volumetric flow through a valve can be found by transforming this equation to make Q the subject, i.e.

$$Q = K_v \sqrt{\frac{\Delta p}{RD}}$$

Alternative flow coefficient C_v

K_v is the metric value of valve flow coefficient. The United States still uses flow coefficients based upon the US gallon (0.833 of the imperial gallon) and pressure measured in pounds per square inch (p.s.i.). Such is the prevalence of US instrumentation that British Standards actually define an alternative flow coefficient in 'US' units. When defined as such, the flow coefficient is given the symbol C_v.

The US valve flow coefficient C_v is therefore defined as:

The volume flow in US gallons per minute through the valve with a pressure drop of 1 p.s.i. across the valve and at a water temperature in the range of 40°F to 100°F.

Using this definition, C_v is given by:

$$C_v = Q\sqrt{\frac{\Delta p_{C_v}}{\Delta p}}$$

where, Q is the volumetric flow through the valve in US gallons per minute
Δp is the measured differential pressure drop across the valve in p.s.i.
Δp_{C_v} is the pressure loss of 1 p.s.i.

C_v will have units of US gallons per minute.

(These alternative definitions of flow coefficients reveal why the standard has had to define the parameters Δp_{K_v} and Δp_{C_v} so that they have the different values of 1 bar and 1 p.s.i. respectively.)

Installed Conditions

In a practical industrial application the installed flow performance of a valve can be greatly affected by:

- the type of valve
- the presence of other fittings such as reducers and trims
- the piping arrangements surrounding the valve.

BS EN 60534-2-1 allows for the modifying effects of valve type, fixtures and piping in installed conditions by including correction factors in the design equations. For example, the equations can be modified by using correction factors F_d and F_P (valve design and piping geometry factors respectively). The application of these factors is quite complex and will not be pursued any further in this lesson. For more information, refer to the standard.

On another practical point, the differential pressure across a valve varies with where the two measuring points are made along the pipework. FIGURE 8 shows the BS recommended tapping points on the pipeline at which the differential pressure measurements should be made. For a pipe of diameter D, the upstream measurement point should be made at a distance of $2D$ from the flange of the valve and the downstream measurement point should be made at a distance of $6D$.

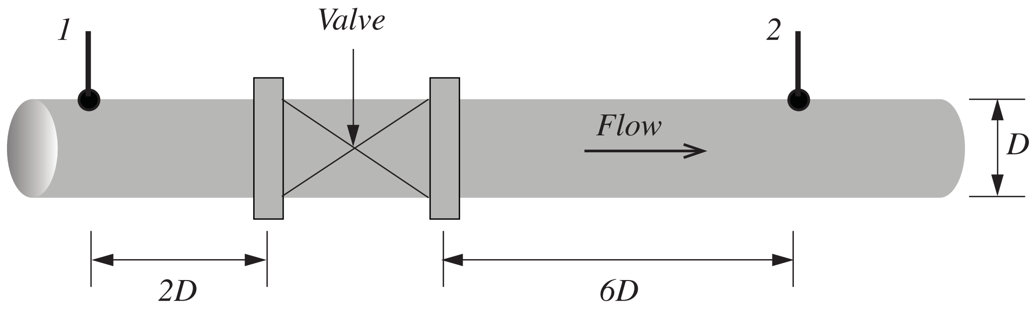


FIG. 8

VALVE SIZING FOR LIQUID FLOW

Knowing the value of K_v, we can refer to manufacturers' tables to determine the valve size required. TABLE 1 shows a typical set of manufacturer's empirical data for a particular type of valve, relating valve size to flow coefficient. Many valve manufacturers also produce charts and web-based software to aid in valve sizing.

Valve nominal size (dia)		*Flow co-efficient*	
mm	*inches*	K_V	C_V
6	$\frac{1}{4}$	0.70	0.81
10	$\frac{3}{8}$	1.45	1.68
15	$\frac{1}{2}$	2.75	3.19
20	$\frac{3}{4}$	5.85	6.79
25	1	11.1	12.88
40	$1\frac{1}{2}$	24.2	28.07
50	2	41.3	47.91
60	$2\frac{1}{2}$	60.1	69.72
75	3	86.1	99.88
100	4	142	164.72

TABLE 1

We can determine the K_v value of a valve when given the required flow rate Q (in $m^3\ h^{-1}$), the relative density RD of the process liquid and the pressure drop Δp across the valve in bar.

All of the above equations are valid when:

- the flow is turbulent
- the nominal diameter of the valve is matched to that of the pipe
- cavitation or flashing does not occur.

The equations have to be modified however, if the flow is laminar or if cavitation or flashing occur.

Example 1

When a valve passes a water flow of 1 litre per second the pressure drop across it is 0.5 bar. Calculate the K_v of the valve.

Solution

$$Q = 1 \text{ litre s}^{-1} = \frac{3600}{1000} \text{ m}^3 \text{ h}^{-1}$$

$$K_v = Q\sqrt{\frac{RD}{\Delta p}} = \frac{3600}{1000}\sqrt{\frac{1}{0.5}}$$

$$K_v = 5.1$$

RANGEABILITY AND TURNDOWN RATIO

It is impossible for a control valve to maintain control over a process fluid whilst the valve stem is at an extreme point of its travel. The term **rangeability**, as applied to a control valve, is the ratio of the maximum controllable flow to the minimum controllable flow, and is indicative of the range over which the inherent characteristics of the valve are maintained.

In most applications, control valves do not normally function at their maximum rated flow conditions. The *normal rated flow* is, in practice, about 70% of the maximum rated flow rate. *Turndown ratio* is the ratio of normal rated flow rate to the minimum controllable flow rate.

Noise

Control valves handling fluids, especially at high flow rates and pressures, are often subject to 'noise' production. This unwanted 'noise' is produced as a result of the random pressure fluctuations within the valve body and/or the impingement of fluid on valve components. It may be loud enough to present a health hazard, or it may possess a resonant frequency, leading to vibration within the valve trim and possible early failure of the valve.

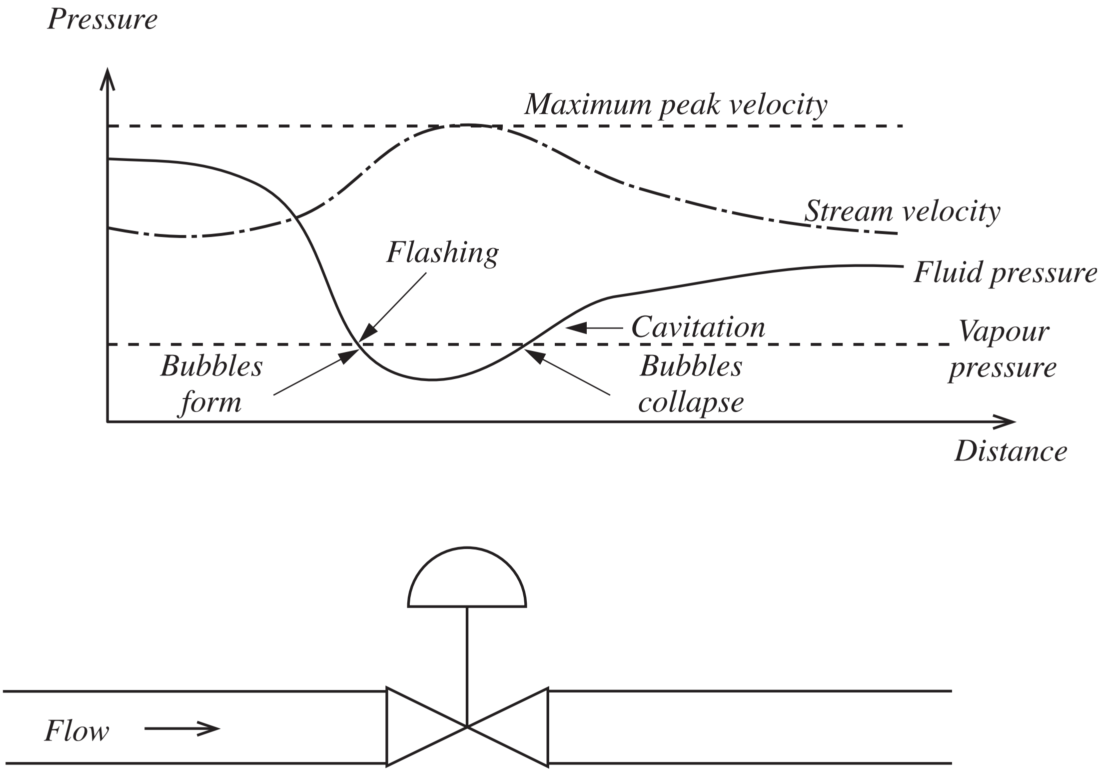
Flashing and Cavitation

If the pressure drop across a valve is too great, the downstream pressure of the fluid might fall below the vapour pressure of the liquid. In such circumstances some of the liquid will vaporise, producing a phenomenon known as **flashing** as illustrated in FIGURE 9.

The fluid passing through the valve becomes a mixture of vapour and liquid. The vapour is normally in the form of bubbles, which results in two undesirable effects.

- The calculated flow will be incorrect for the liquid and vapour mixture.

- **Cavitation** can result as the downstream pressure rises above the vapour pressure, causing the bubbles to collapse. The bubbles normally collapse on the valve trim or body or in the pipe, creating large localised pressures which cause rapid wear in addition to excess noise.



Flashing and Cavitation

FIG. 9

OVERCOMING THE PROBLEMS OF NOISE, FLASHING AND CAVITATION

Excessive 'noise' can cause damage to plant, personnel or equipment. Its effects can be reduced by fitting lagging and pipe silencers similar to those found on vehicles. These measures deal with most of the damaging frequencies, and reduce the effects of the noise problem. Care must be exercised when using pipe silencers as they tend to act as pressure reducers and fluid flow restrictors.

Cavitation is the end result of flashing caused by high pressure drops across the valve. Reducing the pressure drop, or increasing the inlet pressure to prevent the pressure falling below the vapour pressure, removes the risks of flashing and cavitation occurring. The inlet pressure may be increased by installing the valve at a lower location in the pipe system. If this is not possible then the use of an anti-cavitation trim as shown in FIGURE 10 is recommended.

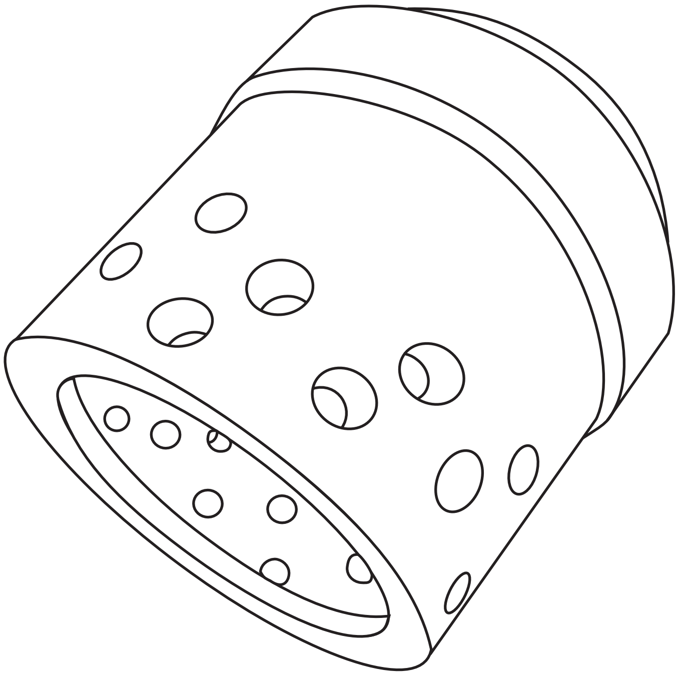


FIG. 10

This type of valve trim reduces the likelihood of flashing, cavitation and noise in the following ways.

- Division of the flow into several streams induces several smaller velocity peaks occurring at slightly different times. The maximum peak velocity is also reduced and, because the line pressure is maintained above the vapour pressure, flashing is prevented.

- The flow path through the small orifices reduces the potential energy of the fluid, leaving less energy available for noise conversion.

You should now be able to attempt the following Self-Assessment Questions.

NOTES

SELF-ASSESSMENT QUESTIONS

1. Complete FIGURE 11 by adding bellows, spring, relay flapper and nozzle in order to illustrate a valve to which is fitted a **reverse** acting valve positioner. Hint: FIGURE 1(a) shows a direct acting positioner.

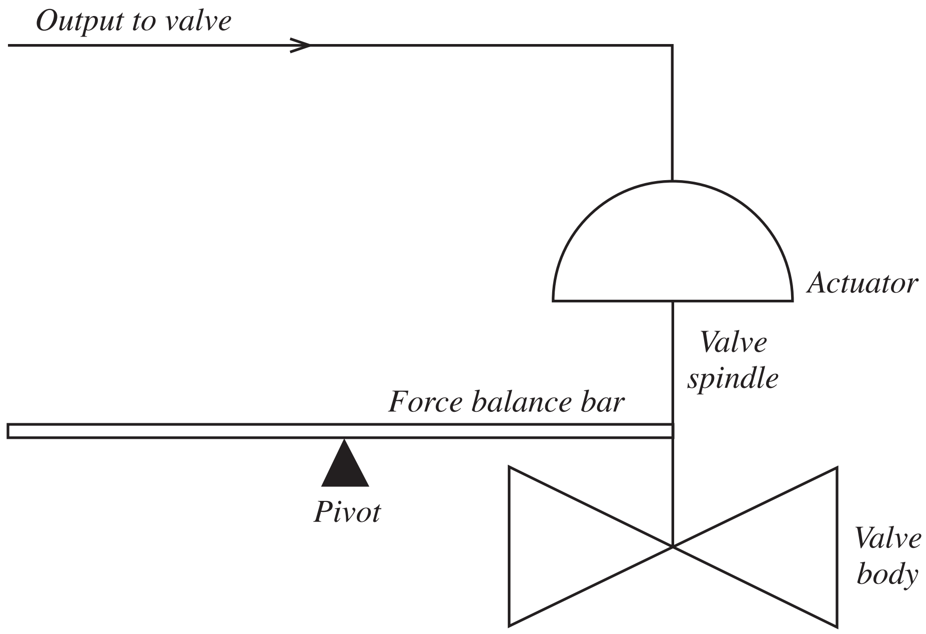


FIG. 11

2. The controller ANC shown in FIGURE 12 is a pH controller maintaining the pH of the process fluid to a predetermined value by means of acid or alkali injection.

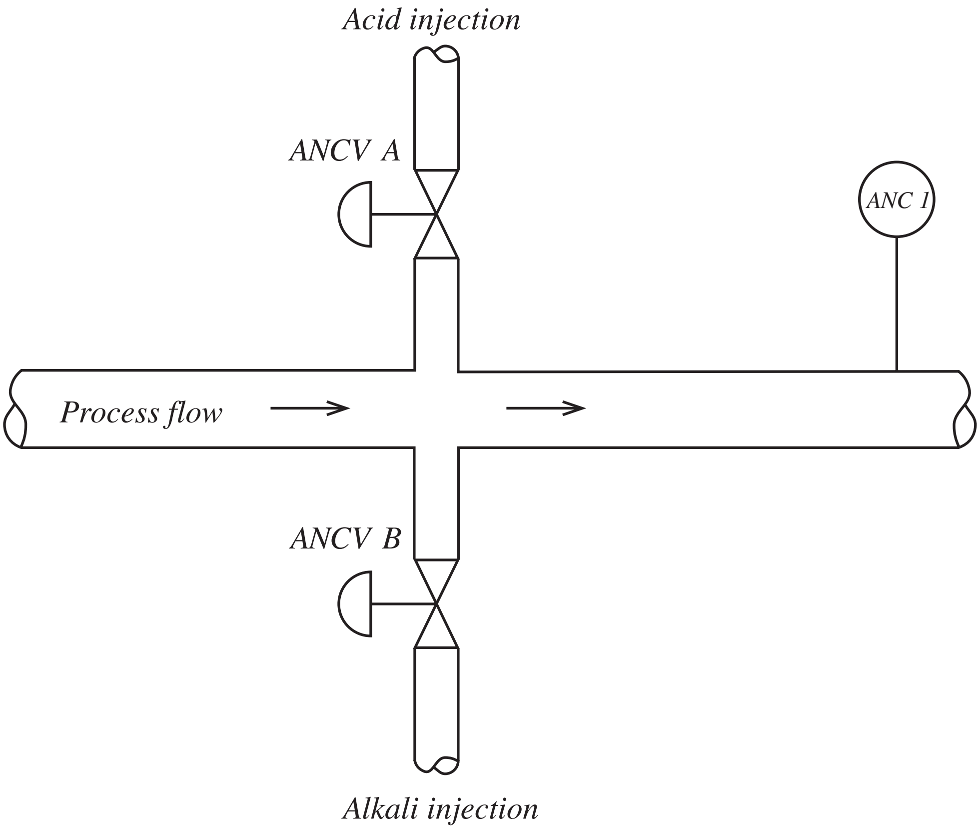


FIG. 12

The output of ANC is 0.2 bar when the process fluid is too alkaline and 1.0 bar when too acidic. Valves A and B both work on a standard 0.2 → 1.0 bar signal. Show the piping arrangement and stipulate the ranges of the valve positioners. Also state the fail safe position for each valve to ensure the process fluid remains acidic in the event of an Instrument Air Supply failure.

3. Determine the C_v value for a valve required to pass a maximum of 150 US gallons of ethyl alcohol per minute which has a relative density of 0.8, at a maximum pressure drop of 40 psi. Use TABLE 1 in the lesson to determine the required valve size.

ANSWERS TO SELF-ASSESSMENT QUESTIONS

1. Your diagram should be similar to that shown in FIGURE 13 below.

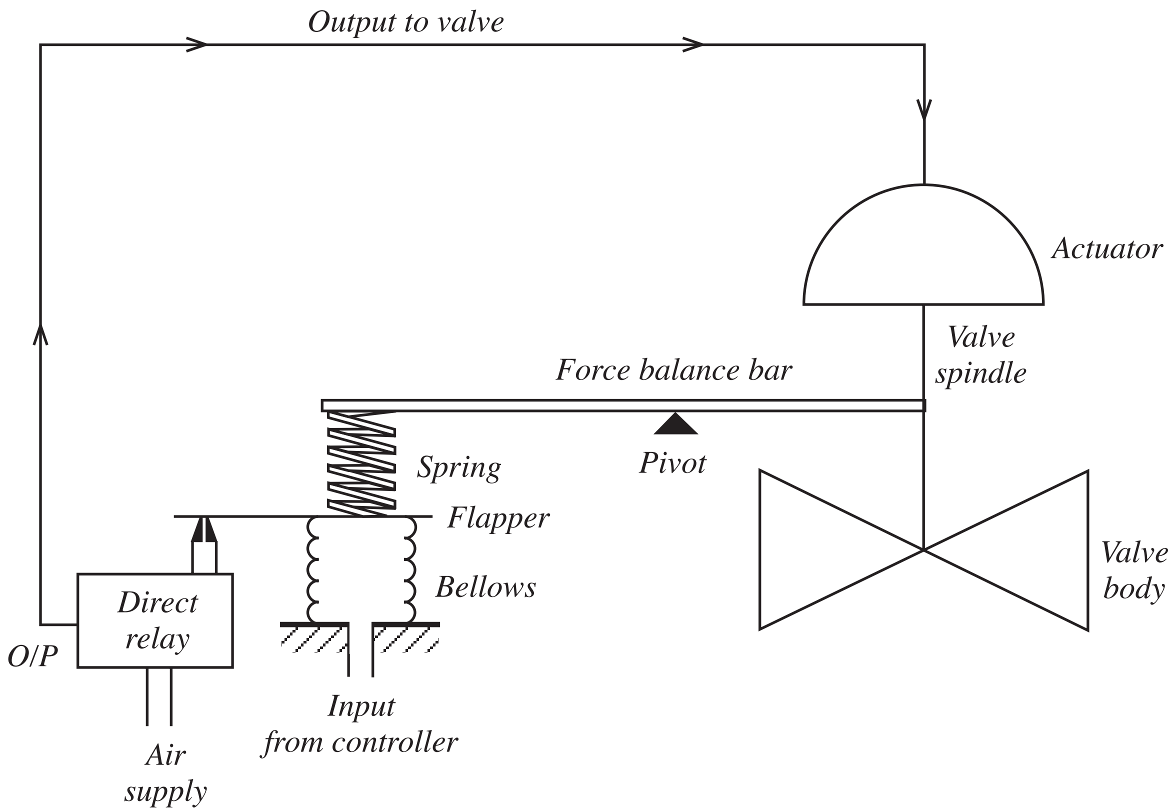


FIG. 13

2. If the process is to remain acidic when the air supply fails the alkali valve must close and the acid valve remain open. Thus the alkali valve should close on air failure and the acid valve should open on air failure, as shown in TABLE 2.

Acid valve	
Open	*0.2 bar*
Closed	*1.0 bar*

Alkali valve	
Open	*1.0 bar*
Closed	*0.2 bar*

TABLE 2

When the solution is neutral, we require neither the acid nor the alkali, so both valves must be closed for a controller output of 0.6 bar (mid point of air range).

If the solution is too acidic the controller output will be 1.0 bar and the alkali valve must be **open**. Thus the alkali valve positioner must operate a full stroke from closed at 0.6 bar to fully open at 1.0 bar. The positioner must, therefore, be direct acting.

If the solution is too alkaline the controller output will be 0.2 bar and the acid valve must be fully **open**. The valve positioner must, therefore, operate full stroke from closed at 0.6 bar to open at 0.2 bar. The positioner must, therefore, be direct acting.

The complete system is shown in FIGURE 14.

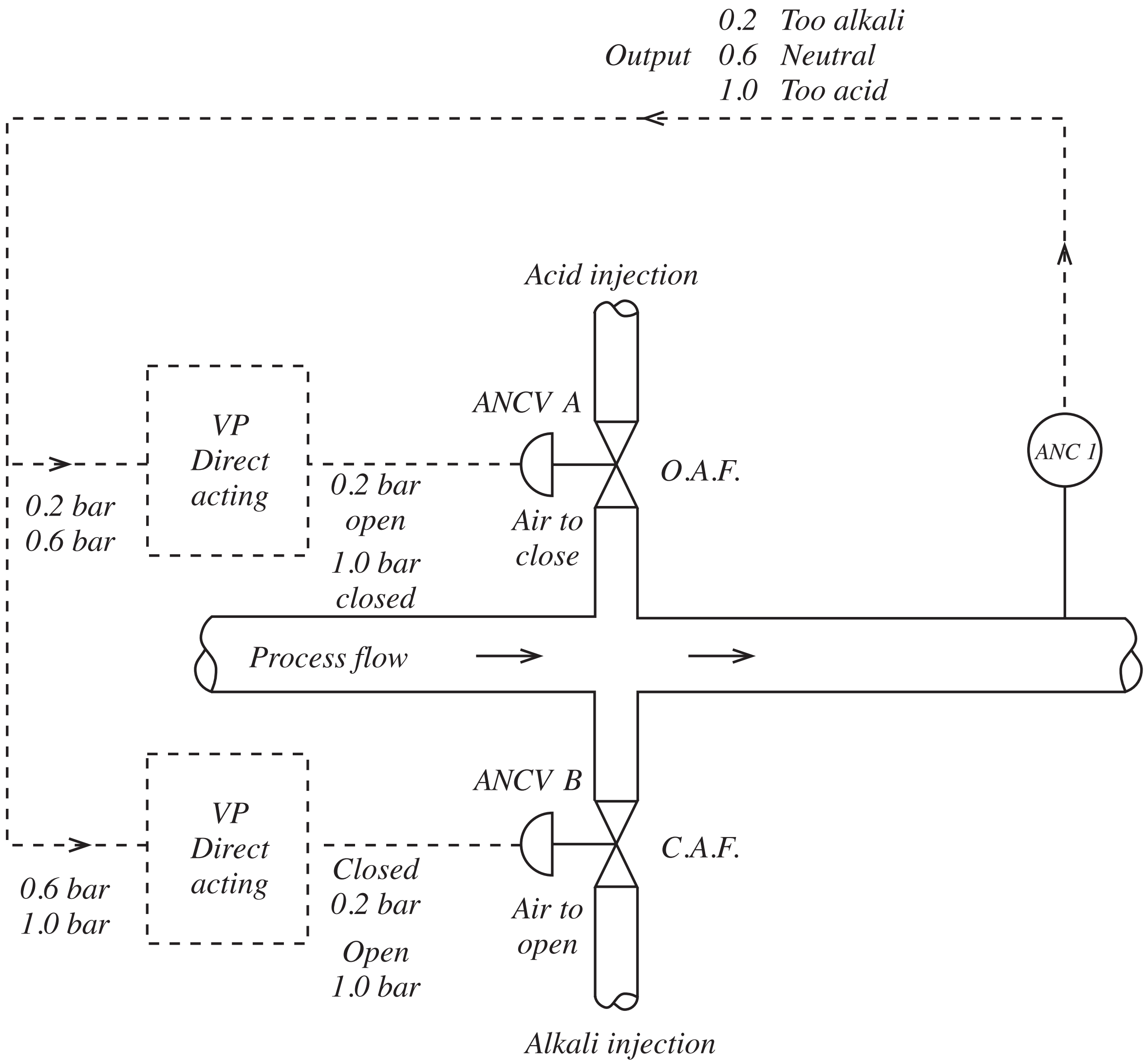

0.2 Too alkali
Output 0.6 Neutral
1.0 Too acid
Acid injection
ANCV A
VP
Direct
acting
0.2 bar
0.6 bar
0.2 bar
open
1.0 bar
closed
Air to
close
O.A.F.
ANC 1
Process flow
ANCV B
VP
Direct
acting
0.6 bar
1.0 bar
Closed
0.2 bar
Open
1.0 bar
Air to
open
C.A.F.
Alkali injection

FIG. 14

3.
$$C_v = Q\sqrt{\frac{RD}{\Delta p}}$$

$$C_v = 150\sqrt{\frac{0.8}{40}}$$

$$C_v = 21.2$$

where: C_v = valve coefficient
Q = required maximum flow rate (US gallons per minute)
RD = relative density (specific gravity)
Δp = pressure drop (p.s.i.).

To obtain a coefficient of this size would require a $1^1/2$ inch diameter control valve according to TABLE 1 as the 1 inch diameter valve is not big enough.

SUMMARY

A valve positioner ensures that the valve stem is positioned accurately and rapidly.

Valve positioners can be either reverse or direct acting.

The gain of a valve positioner can be adjusted to achieve split range operation. Split range operation occurs when different ranges of the output from a controller control different valves via individual valve positioners. The valve positioners are calibrated so that they are actuated by different sub-ranges of the controller signal.

The spring location in a control valve determines the position the valve stem assumes in the event of an air failure occurring. In conjunction with the arrangement of the valve trim, it determines whether the valve is Open Air Failure (OAF) or Close Air Failure (CAF).

The flow coefficient C_v is used in control valve sizing. By definition, the C_v has a value equal to 1.0 when a fully open valve will pass a flow rate of 1 US gall min^{-1} of water when a pressure drop of 1 psi occurs across the valve. The metric equivalent is K_v (1 m^3 h^{-1} when pressure drop is 1 bar).

Rapid flow of fluids through valves can cause problems due to noise and vibration. When large pressure drops occur across valves in liquid flow applications it is possible for "flashing" to occur. 'Flashing' occurs when a rapid reduction in pressure allows vapour bubbles to form within the liquid. When these bubbles collapse due to the extremely high local pressures that can be created, 'cavitation', which can lead to rapid erosion of valve internals, can result. The correct selection of valve trim can reduce the likelihood of these problems occurring.