Actuator

APF-ACT

APADANA PETRO FARAYAND

Knowledge is our difference

Apadana Petro Farayand is able to design and manufacture high-quality pneumatic actuators required in the oil and gas industry.

Introduction

The function of an actuator is to adjust the position of the valve to ensure correct control of the process fluid. The valve position may be only "open" or "closed", as in the case of isolating valves, or in any intermediate position for control valves. To operate effectively the actuator must be sufficiently powerful to produce a positive, accurate and quick response to a control signal. In the event of signal failure, the actuator may be required to return the valve to a predetermined position or to hold its current position. It is therefore important to specify the correct type and size of actuator in order to meet the demands of the process, reliability and economy.

An actuator applies a linear force or a rotary torque to a valve element. Some linear actuators can have the linear motion translated into rotary motion.

Actuator selection

When selecting an actuator, many factors must be considered including:

compatibility with the valve design to be used

- power supply for actuator
    - pneumatic
    - hydraulic
    - electric
    - combined system
- single or double acting
- control signal for actuator
    - pneumatic analogue
    - electric analogue
    - electric digital
    - analogue/digital combination
- force or torque required
- speed of operation
    - slow
    - fast
    - variable
- power required to achieve force/torque and speed
- stiffness of actuator
- fail-safe operation of actuator
    - fail-lock
    - open
    - close

- accessories and options required
    - handwheel
    - local powered operation
    - positioner
    - booster
    - remote indication
    - ESD override facilities
    - damping facilities
- ambient operating conditions
    - electrically hazardous
    - air-borne contamination/corrosion
    - water hazards
    - temperature extremes, including sunlight
    - humidity
    - biological attack
    - vibration, external and valve generated
    - seismic consideration
- serviceability by local staff and reliability
- initial purchase and installation costs
- operating and maintenance cost

A thorough knowledge and understanding of the process to be controlled and its requirements is essential if the correct choice of actuator is to be made. It is not possible to give general advice on the selection of actuators.

Force/torque required in valve operation

The forces and torques to be overcome in a valve are the result of a number of interacting factors which depend upon the actual operating conditions. Unless the valve is balanced, the predominant force is that created by the pressure drop across the valve, which is normally calculated for the valve in the closed position, although the forces can increase dramatically due to the effect of the fluid flowing through the valve.

Types of actuators

As shut-off valves form part of an SIS, it is necessary to operate the valve by means of an actuator. These actuators are normally fail safe fluid power type and typical examples of these are:

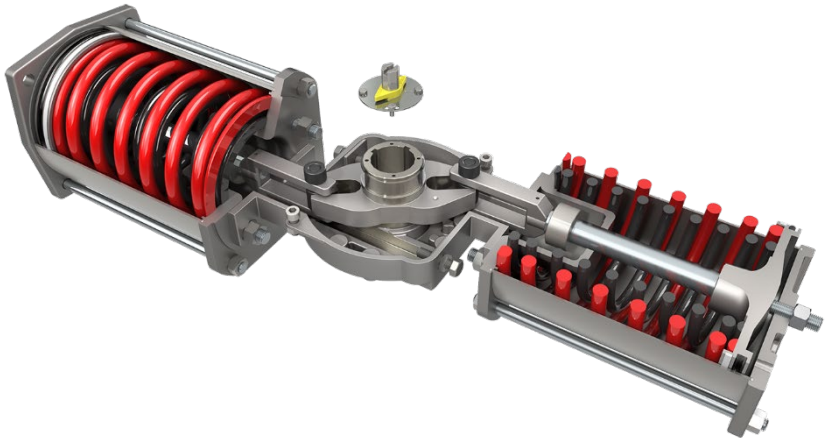
- Pneumatic cylinder actuator
- Hydraulic cylinder actuator
- Electro-hydraulic actuator

In addition to the fluid type, actuators also vary in the manner in which the energy is stored to operate the valve on demand as follows:

- Single-acting cylinder or spring return: Energy is stored by means of a compressed spring
- Double-acting cylinder: Energy is stored using a volume of compressed fluid

Very common and good types of actuators are the scotch yoke types. Apadana Petro Farayand safety shut off valves are normally equipped with the pneumatic double acting scotch yoke type actuators, though the other types are also available upon request. The Scotch yoke is a mechanism for converting the linear motion of a slider into rotational motion or vice-versa. The piston or other reciprocating part is directly coupled to a sliding yoke with a slot that engages a pin on the rotating part. The shape of the motion of the piston is a pure sine wave over time given a constant rotational speed. When pneumatic or hydraulic pressure is applied to the piston, a linear force is generated. The force is applied to the yoke, through the power transfer pin, at a distance from the center of the output shaft. As the yoke moves in a rotary fashion, torque is generated at the output shaft to provide the turning force required to cycle a valve. Some advantages of Scotch Yoke mechanism are as below:

- Scotch yoke actuators provide powerful open and close torque outputs; this closely matches the required torque for practical valve operation.
- Compact design and size
- Extremely long cyclic life
- Adjustable center stopper for both open & close positions



Dampers

Dampers are sometimes called "snubbers". Large valves working with large pressure drops are subject to large hydrodynamic forces which may produce vibration in the valve stem or spindle. Vibration in a valve can be caused by turbulence and the shedding of eddies and cavitation. There are three ways of counteracting these vibrations:

- select a valve style which is not prone to turbulence/eddies and will not cavitate at the proposed operating conditions
- use an actuator of adequate size and as "stiff" as possible, usually this means choosing at least a double acting piston actuator, hydraulic or electric actuators and avoiding diaphragm actuators
- fit a damper

The damper can be compared to a competition style shock absorber fitted to a rally car; it works in both directions and is adjustable. The damper attenuates the valve stem velocity by using a restriction, or orifice, through which the air/oil is made to flow as the stem moves. The restrictor should be adjustable. Two typical applications of the use of dampers are feed water valves and steam reduction valves for large steam boiler systems.

Principle of operation scotch-yoke

There are some common mechanisms used to convert the linear motion to rotational motion (and vice versa), which among them, rack and pinion, crank and slider, scotch-yoke and power screw mechanisms are well known. In the Scotch-yoke mechanism, the piston or other reciprocating part is directly coupled to a sliding yoke with a slot that engages a pin on the rotating part. The shape of the motion of the piston is a pure sine wave over time given a constant rotational speed. When fluid pressure is applied to the piston, a linear force is generated. The force is applied to the yoke, through the power transfer pin, at a distance from the center of the output shaft. As the yoke moves in a rotary fashion, torque is generated at the output shaft to provide the turning force required to cycle a valve.

Advantage of scotch-yoke

The actuators provide increased torque at open and close position, this closely matches the required torque for practical valve operation.

- Increased torque at the open and close position
- Compact design and size
- Extremely long cyclic life
- Adjustable center stopper for both open & close positions

Main features

- Scotch-yoke mechanism generates powerful opening and closing torque outputs
- Steel fabricated frame provides rugged foundation of modular assemblies
- Chrome-plated side load bar with guide block for effective elimination of piston rod deflection
- Bronze bushing interfaces provide low friction support of sliding and rotating components
- Downstream high pressure shut down
- Downstream low pressure shut down
- Feeding line failure shut down
- Sensing line failure shut down
- Available range; 2-160 bar
- Available for ball, plug and butterfly valves
- Available as double / single acting actuator
- Actuator torque up to 14,000 Nm
- Open and close travel stops, ±5° min.

Actuator design requirements

1. The yoke shall be supported by high resistance chrome plated steel guide bar along every position of travel, so that no side force is transmitted to the valve stem.

2. The yoke housing shall be fabricated from carbon steel for maximum strength. Sliding blocks and yoke bushings shall be in bronze. Other internal parts of the mechanism are permanently coated to prevent corrosion. Additional protection is assured by the inside grease, which provides reduced friction and high efficiency.

3. The piston and cylinder shall be fabricated from carbon steel. The cylinder shall be electro-less nickel plated, for maximum corrosion protection and low operating friction. Cylinder execution shall be with external tie rods for easy maintenance.

4. The actuator shall be equipped with externally adjustable travel stops, which provide a minimum of 4 degrees rotation adjustment at each end of travel. These stops shall be sufficient to absorb the maximum torque output of the actuator at the maximum rated pressure.

5. The actuator shall be suitable for direct mounting to the valve without changing the standard top works of the valve and shall have the capability to be mounted or removed from the valve, when the valve is in service.

6. The actuator shall be sized to stroke the valve throughout the entire operating pressure range and additionally shall provide a safety factor over the valve torque requirement at the minimum pipeline pressure, while the actuator power pressure is also the minimum pipeline operating pressure.

7. It is understood that the actuator max operating torque must be higher than the maximum valve torque. The safety factor shall be at least equal to the safety factor recommended by the valve manufacturer. For critical service applications, the safety factor shall be minimum of 30%.

8. Being the minimum pressure the most critical situation, it is understood that the safety factor ratio of actuator torque output to valve torque requirement will increases as the pipeline operating pressure increases. The actuator vendor must state in his proposal the considered valve torque requirement and the calculated output torque at the minimum design pressure.

Principle of operation

1. The actuator shall be powered from sweet, dry natural gas direct from the pipeline. Pipeline pressure may vary from location to location, not exceeding 101 barg (corresponding to the rating of class 600 ANSI).

2. The minimum allowable line pressure for the actuator is normally 10 bar.

3. Only if specifically required by the customer or engineering a torque limitation can be provided. The use of pressure regulator or torque limit device is allowed and can be fully integrated with the actuator control system.

Tubing and fittings

1. The pneumatic tubing and fittings shall be 316 stainless steel.

2. The tubing shall be sized to assure the required stroking time and will not be less than 6 mm OD.

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