

## **VALVE AUTOMATION**

### **What is Automation?**

**Automation** is the techniques and equipment used to achieve automatic operation or control.

Automation is an automatic operation and control of machinery or processes by devices, such as robots that can make and execute decisions without human intervention.

Automation is the great idea of industries. After introducing Automation the quality of the product is increased. The controlling logic and process methodology where has been taken care by automation systems.

### **What is Actuator?**

Actuator is a device that transforms or converts energy into motion.

Also applied as a force, an actuator usually is a mechanical apparatus that takes energy, normally constructed by air, electricity, or liquid and converts that into a specific kind of motion.

Actuators are a type of tool which is used to put something into automatic action.

### **Actuators for valves can be classified up several characteristics:**

#### **By the type of movement**

- Multi-turn
- Quarter-turn
- Linear

#### **By the energy source**

- Manual
- Electric: they can be driven by direct and alternate current.
- Pneumatic: they use pressured air or gas to create motion. They are widely used in the industry due to their low cost. In case of failure they are easy to diagnose or repair in field, rather than electric actuators.
- Hydraulic and Electro-Hydraulic

#### **Functionality**

- On/Off valve service
- Positioning to % open
- Modulating to control changes on flow conditions
- Emergency Shut Down (ESD)

#### **Other characteristics**

- Explosion-proof
- Safety integrity level (SIL)
- Enclosure: IP and NEMA

## **What is Valve Automation with Pneumatic Actuators?**

Pneumatic Actuators are energized by compressed air, or non-aggressive gas, this means that a pressure supply system is required to operate the actuators.

### Quarter Turn

Pneumatic Quarter Turn Actuators are mainly used for automation of Ball Valves, Butterfly Valves, Plug Valves and Dampers. The advantages for this type of Actuator are that they are less sensitive for intensive cycling than the Electric Actuators and also very reliable thanks to a minimum of moving parts. These actuators are more or less considered as maintenance-free.

Therefore these types of Actuators are the absolute most popular solution for process automation in all kinds of industries such as chemical, petrochemical, water treatment, oil and gas, off-shore, district heating, steel and metal, pulp & paper, food & brewery etc.

The Pneumatic Quarter Turn Actuators are available both as Double Acting and Single Acting with spring return.

### Dominating Designs

The two dominating designs are the Rack & Pinion design and the Scotch-Yoke design.

#### Rack & Pinion

Rack & pinion design actuators have pistons with Rack and a Drive shaft with Pinion giving a linear torque output over the 90° travel for double acting actuators. The single acting spring return actuators have a torque output that decrease at the end of the travel in both directions.

With a constant air supply flow capacity the turning speed of the shaft is constant over the full 90° travel. This can affect the service life of the actuator-valve package in a negative way because of hard acceleration and retardation in the end positions.

The rack & pinion design is mainly used for actuation of smaller valves.

#### Scotch-Yoke

Scotch-Yoke design has pistons with piston rollers aligning in the slot of the scotch-yoke connected to the drive shaft. The power transmission works as a variable lever over the 90° travel, starting with a long lever, in the mid position a short lever and in the end position a long lever.

This gives, for both double acting and single acting actuators, a high torque output at the end positions where most valves require higher operating torque.

With a constant air supply flow capacity the turning speed of the shaft is starting smoothly, then accelerating and at the end of the travel slowing down again. This favorable turning speed has a positive effect on the service life of the actuator-valve package.

Scotch-Yoke actuators are available with canted yoke and with symmetric yoke.

#### Canted Scotch-Yoke

Canted Scotch-Yoke gives a higher Break-away torque than end of travel torque and covers most butterfly valves and ball valves.

#### Symmetric Scotch-Yoke

Symmetric Scotch-Yoke gives same torque in both end positions and is used for plug valves and metal seated ball valves.

#### Double Acting

A Double Acting Pneumatic Actuator is pneumatically operated in both turning directions and will by loss of Air Supply Pressure stay in position. Depending of how the Solenoid Valve or the Positioner that Controls the Actuator is set up the actuator can set the valve into a decided end position Open or Closed by electrical signal failure.

#### Single Acting Spring Return

A Single Acting Pneumatic Actuator is pneumatically operated in one direction and by a spring return function in the other direction.

A spring return Actuator is normally used for applications where a Fail Safe function is required. The function can be Fail Close or Fail Open. This means that if there is a major air supply failure the safety function of the actuator will operate the Valve to the decided safety position by the spring return function.

#### Multi Turn

Multi Turn Pneumatic Actuators are used for Gate Valves, Globe Valves, Plug Valves, Dampers and other applications where multi turn function is required, for example quarter turn valves with reducing gear boxes. The multi turn pneumatic actuators are only available as double acting but can be equipped with air bottles for emergency operation in case of air supply failure.

#### Controlling and Signaling

Pneumatic Actuators are often fitted with control and signaling accessories as Limit Switch Boxes, Solenoid Valves and Positioners. The Actuators can be connected to almost any digital Control System or Monitoring system such as AS-Interface (ASI-bus), Profibus, Foundation Fieldbus, Interbus, Modbus, Device Net, HART-protocol, etc, etc, by the use of suitable Communication accessories.

#### Switch Box

Limit Switch boxes are used for position feed-back signaling of the end positions for on-off applications to monitor the actual valve positions in the process plants. This is required for safe operation of automatic controlled processes carried out by PLC-systems etc.

#### Solenoid Valve

Solenoid Valves are used for on-off applications where the valves are operated from fully closed to fully open position and no mid positions are required. The solenoid valves are available for many different control voltages and ingress protection grades such as IP65, IP67, IP68, NEMA 4 and NEMA6 and also for Hazardous areas where Explosion proof according to ATEX or NEMA 7 are required.

#### Positioner for Pneumatic Actuators

Positioners are used for Positioning, Control or Modulating applications where a defined valve position anywhere between fully open and fully closed valve is required. The positioning can be controlled by an Analogue input signal 4-20mA or by a Digital input signal.

The Positioners are used for all kinds of modulating such as flow control, temperature control, pressure control or mixture control in process plants. Positioners are available for use in Normal Zone and in Hazardous Zone where ATEX or NEMA 7 approvals are required. Smart Positioners are used for applications where closed control loops, diagnostics or bus-communication is required.

#### Mounting Kit

To assemble the actuators, pneumatic or electric on the valves, needs a Mounting Kits or Adaptor Kits. This is one of the most critical parts in the whole Valve and Actuator package since the performance of the package will never be better than the performance of the weakest link in the chain from the Actuator to the Valve. The machining tolerances of the mounting kit are of highest importance since too much play or poor alignment will affect the function and service life of the valve-actuator system.

#### Mounting

The mounting of actuator on valve should only be carried out by professionals. The sizing and the required function of the actuator must be checked to make sure that it is correctly sized and equipped to suit the actual valve applications requirements. The mounting kit must have the correct fit. It is important to set the valve and the actuator in same end position before mounting them together. Finally the tightening of the screws with the correct torque, test cycling and setting of the signaling unit is carried out. This all together gives a long and reliable function of the actuated valve.

### **What is Valve Automation with Electric Actuators?**

Electric actuators are energized by electric power supply. They are available for many different voltages with different ingress protection grades such as IP65, IP67, IP68, NEMA 4 and NEMA 6 and also with ATEX and NEMA 7 Approvals for use in Hazardous Zones.

The Electric Actuators can be connected to almost any digital control system or monitoring system such as AS-Interface (ASI-bus), Profibus, Foundation Fieldbus, Interbus, Modbus, Device Net, HART-protocol, etc. by the use of suitable communication accessories.

#### Electric Quarter Turn Actuators

Electric Quarter Turn Actuators are mainly used for automation of Ball Valves, Butterfly Valves, Plug Valves and Dampers.

#### Electric Multi Turn Actuators

Electric Multi Turn Actuators are used for Gate Valves, Globe Valves, Plug Valves, Dampers and other applications where multi turn function is required.

#### Fail Safe Electric Actuators

Most electric Actuators have no integrated fail safe function but can be equipped with battery packs for fail safe function. On the market are also some fail safe systems with spring return function available even if most of them are equipped with electro-mechanical release mechanisms which are not too reliable after longer use because of dirt, corrosion and aged lubricants. A more safe solution for this is the Electro Hydraulic Fail Safe Actuators which are using a similar spring return system as the pneumatic actuators where no release mechanism is required. These kinds of actuators are to be seen as electric actuators with spring return.

#### Duty Cycles

The On-Off Duty electric actuators are sensitive for high intensity cycling. Therefore when modulating is required it is very important to choose an actuator with a maximum Modulating Duty intensity that corresponds to the requirements for the specific application.

#### Controlling and Signaling

Single Phase Electric Actuators are normally controlled by a 3-position switch function for Open-Stop-Close function.

Three Phase Electric Actuators must be controlled by Starter Relays since phase inverting is necessary to for changing the directions of a three phase motor.

#### Limit Switches

The Electric Actuators are often equipped with potential free limit switches for signaling to PLC controllers where the motor voltage of the actuator is not possible to use as feed back signal.

#### Local Control

For Local Control of the electric actuators a control unit is required, such units have a key selector switch for Local/Remote selection and a 3-position control knob for Open-Stop-Close control.

#### Positioner for Electric Actuators

For modulating applications with Electric Actuator a Positioner is required. The Positioners are available in most various designs, starting with the simplest for a 4-20 mA input signal only. If required there are optional feed-back signal transmitters available with or without relays.

A basic rule is that the higher the resolution of the positioning and the feed back signal, the higher the price is.

The best Positioners for electric quarter turn actuators can perform 450 points of resolution for a 90° turning angle. These Positioners are equipped with dynamic braking control features and also adaptive control by continuously monitoring and compensating for actuator backlash, motor coast and load changes to eliminate Positioner dead band. Moreover these Positioners have built in advanced safety features as stall detection and duty cycle protection for the actuator to ensure that no overloading occurs.