Digitalisation and AI – new possibilities for automating process valves

The automation of process valves has been a long-established practice. Depending on the particular industry requirements and the application, either electric or pneumatic actuators are used. There are many different concepts for the automation of actuators, even within the same technology. When using pneumatic actuator technology, for example, the actuators can be activated by individual valves or valve terminals, depending on the type of system. Both concepts have advantages that you can utilise for your specific requirements. Digitalisation is a much discussed topic at the moment, also with regard to actuator technology for process valves. The following section shows the new opportunities that digitalisation opens up and the advantages it offers for industrial production, and it outlines the first cases in which artificial intelligence (AI) is used in this application area.

Automation concepts for process valves

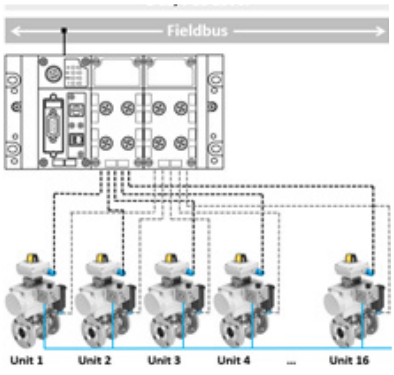
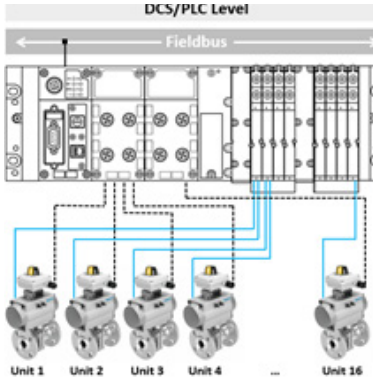


Fig.1: Actuation via single valves or valve terminals



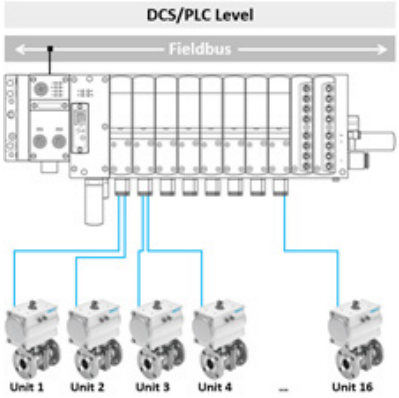


Fig. 2: Actuation via the digital Festo Motion Terminal

Established actuator concepts (Fig. 1) for pneumatic actuators include activation using single valves and using valve terminals. Single valves have advantages, e.g. when automating large systems. The advantages of valve terminals are their com-pact design and the option of integrating additional functions, their cost-effectiveness by saving on binary outputs, and their capability to diagnose the component itself, as well as the process. However, digitalisation opens up completely new opportunities that can contribute to savings in all phases of the life cycle of systems. One such component is the digital Motion Terminal VTEM (Fig. 2).

In recent years, devices that enable a wide variety of functions to be used on a standardised hardware (HW) platform have established themselves on the market. A prominent example of this is the smartphone. This concept of separating the HW and the user software – so-called motion apps – was applied to the VTEM. A valve terminal was equipped with additional sensors and so the disciplines of mechanics, electronics and software were integrated. Up to 50 different pneumatic applications can then be implemented on the standard HW via apps. This thus eliminates the contradiction between standardisation and flexibility. New apps can also be added, such as for end position detection for on/off process valves, thus eliminating the need for traditional limit switches or sensor boxes for end position detection.

Reduced compressed air consumption – with the ECO Drive app

In the planning phase, every pneumatic actuator is designed with a higher torque or force than would be necessary for the actual working stroke. This safety factor varies by up to half the torque or force required depending on the planner/operator. This is particularly noticeable in the compressed air consumption of systems in continuous operation. The ECO Drive motion app is able to pare down the increased compressed air consumption caused by the safety factor and the actuator size and re-duce the pressure in the actuator to the minimum required for the application. This means that less compressed air is used. Experience has shown that energy savings of up to 50% are possible. This is particularly interesting for applications with continuous compressed air consumption, such as systems that fill cement into bags. A further advantage is that no intervention in higher-level controllers is required and no additional communication is generated on the bus systems, since the app and its functions are processed decentrally.

Saves time and money: actuator specific leakage diagnostics

Identifying leaks in day-to-day operations normally takes a considerable amount of time. If production cannot be stopped, the app for diagnosing leaks offers many benefits.

It enables faults to be detected rapidly as the leaks can be actuator-related and thus accurately located. Laborious troubleshooting in partially extended net-works is no longer necessary, and the elimination of leaks can start immediately. In normal system operation, a certain number of switching cycles can be specified individually; when the specified number is reached, a test for possible leaks is carried out.

Flexibility and precision: the presetting of travel time

In some industries, the duration of a working stroke is hugely important. With the app “presetting of travel time”, the duration can initially be set digitally, i.e. the travel time is not defined by adjusting restrictors, but simply by entering the duration, for example in seconds, using this app. The VTEM is then initialised independently and changes the pressure build-up in the actuator so that the required time is achieved.

A further advantage of this app is that the travel time is continuously monitored during operation. As soon as the switching times change during the course of the product lifecycle, for example due to increased friction because of wear, the system automatically adapts the values so that the specified duration can be reached again. This can be referred to as semi-autonomous.

The advantages are as follows: reduced commissioning effort through automated learning and avoidance of manual restrictor adjustments, reduced effort required for conversions and autonomous adjustment of the process parameters in the event of deviations from specified parameters.

Controlling pneumatic actuators – new possibilities with AI

There are various possibilities for activating pneumatic actuators. In addition to integrating the positioner directly in the actuator itself (Fig. 3), the positioner can also be mounted on the linear actuator (Fig. 4).

Which variant is used will depend on the operational requirements. Thanks to the displacement encoder integrated in the actuator there is no need for external attachments for position detection. This significantly reduces calibration and maintenance costs, especially in applications in extreme environmental conditions.

Fig. 3: Linear actuator with integrated positioner

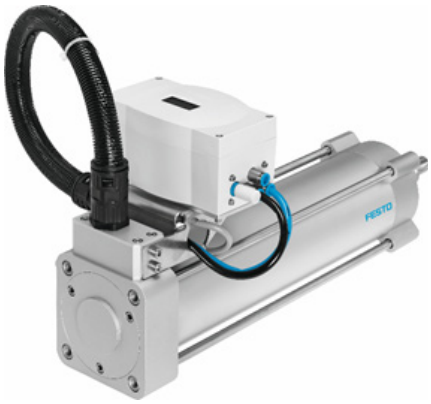


Fig. 4: Linear actuator with external positioner

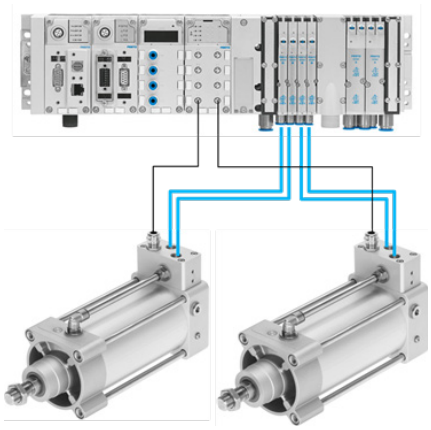


Fig. 5: Controlling linear actuators using a decentralised control unit

Figure 5 shows another control option. Here, the positioning function is not carried out at/in the actuator itself, but in a decentralised control unit. This also allows process engineering modules, e.g. a flotation cell (Fig. 6) for separating copper from ore, to be completely controlled.

This option has several advantages. In addition to the lower investment costs, the demands on the quality of the compressed air can also be lower. Furthermore, the actuator can achieve faster travel times. And, when provided with the appropriate extensions, this variant also offers the option of switching the actuator and thus the valve in the event of a power failure or if the control system is not yet functional. This option is especially interesting in places when the power supply is not particularly reliable.

Fig. 6: Pneumatic actuators in flotation cells must withstand harsh external influences. AI helps to identify potential problems early on.

Another advantage of digitalisation in actuator technology is the possibility of realising machine learning algorithms decentrally – on edge. Decentralised monitoring of actuator characteristics, such as pressure in the actuator chambers, travel speeds and their temporal correlation, not only enables the parameters of the actuator itself to be analysed, but also allows anomalies in the technical process to be detected. On the one hand, this forms the basis for implementing predictive maintenance concepts. And on the other, the data analyses can be used to determine the potential for optimising the production process. A particular advantage is that anomalies can be detected without additional programming in the module controller. The algorithms are taught in based on a database representing normal production, allowing them to independently detect deviations in the production process or in the performance of the actuators. Imminent problems can thus to be detected at an early stage and unplanned system downtimes caused by a fault can be avoided.