

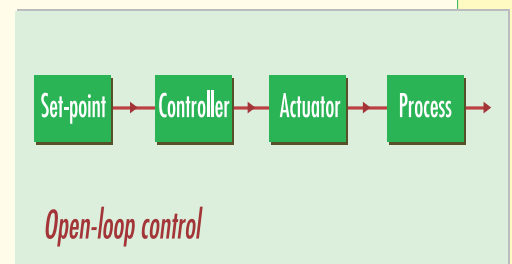
CONTROL SYSTEMS

In many machines and plants, physical variables (temperature, pressure, force, displacement etc.) must reach a predetermined (desired) value (e.g. the position of a carrier on a machine-tool) independent of parasitic influence from outside. To this intent, two interconnected operations must be assured: comparison and adjustment. The required cycle of operation takes place in a so-called control loop whereby a difference is made between an open loop and a closed loop.

OPEN-LOOP CONTROL

An example for an open control loop is a heating radiator in which the supply of warm water and, thus, the temperature is "controlled" or – more precisely – adjusted with a valve. As soon as the room temperature rises, the valve must be closed by hand. As soon as the room temperature drops, the valve must be opened by hand, i.e. the rise and fall of the temperature are not controlled automatically. It is an open-loop control system with no feedback, i.e. there is no control loop connecting the output of the system to the input of the system.

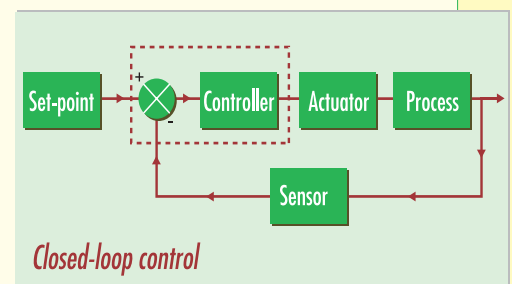
The use of special methods and equipment to influence cycles of operation and processes is what is generally understood by control. A control system is in place when a process is influenced in relation to a desired (requested) state without consideration of the observed (measured) state. A particular characteristic for controlling is the open sequence of actions via the individual transfer element or the control.



CLOSED-LOOP CONTROL

In a closed-loop, the predetermined (desired) value is constantly compared to the actual value. DIN standard 19226 defines the terms "Control and Adjustment" as follows: "Control and adjustment is an operation in which a physical variable (e.g. temperature, pressure etc.) is continuously measured and compared to a previously specified value of the variable with the aim of matching the two. The resulting closed sequence of actions occurs in a closed loop, the closed-control loop."

At the example of temperature regulation in a heating radiator, the actual temperature is measured with a temperature sensor and compared to the predetermined (desired) value. As soon as there is a difference between the desired value and the measured value, a signal is transmitted to the valve to open (if the temperature has fallen below the specified value) or to close (if the temperature has risen above the specified value). This means that the temperature is held at the predetermined (desired) value (i.e. it is fully stabilised) irrespective of any outside conditions (parasitic influence).



INTRODUCTION TO CONTROL TECHNOLOGY

CONTROL METHODS

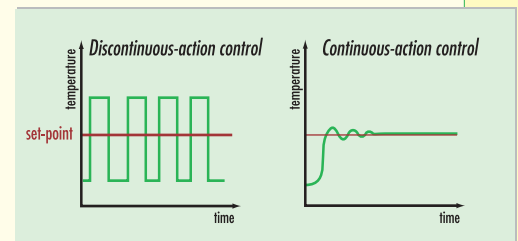
Control methods are distinguished according to the manner in which the controller behaves as soon as a deviation is detected in the process. For applications in production, it is important to know how the actuating variable is influenced in terms of time. Controllers have either a continuous or a discontinuous behaviour. A difference is therefore made between discontinuous-action control (two or multipoint control) and continuous-action control (proportional control).

DISCONTINUOUS-ACTION CONTROL

A process which takes place step-by-step is called discontinuous. A discontinuous-action controller influences the process with short switching actions at a constant level of energy. Discontinuous-action controllers are therefore also called switching controllers.

Discontinuous-action controllers assure the actuating function by triggering a sequence of energy pulses. These pulses have influencing times at fixed energy levels but limited influencing periods. On-off controllers which are normally found in household appliances and heating technology just have two actuating constants: "ON" and "OFF". A disadvantage of this is that a shock-like (impulsive) operation is triggered when the controller is switched on. Moreover, variations of the feedback value around the set-point cannot be avoided. The interval level at which the controlled variable constantly swings between the on and the off state is called the range of fluctuation. This range is the characteristic feature of discontinuous action. Three-point

or multipoint controllers have at least one intermediate stage besides the on and off state (e.g.: air conditioning - heating - neutral - cooling).



CONTINUOUS-ACTION CONTROL

Continuous-action controllers assure the actuating function by having a continuous influence on the process. Controlling takes place permanently. The controlled variable can have any value within the defined control range. Non-intermittent, random control signals between 0 and 100 % are triggered.

Example: A heavy load is to be smoothly accelerated and decelerated. In the case of a discontinuous-action controller, the load must first be set into motion at velocity V1 and then at velocity V2. The load is transported at a constant speed V3 which is subsequently decelerated at velocity V4 and V5 (see illustration opposite). The velocity is accelerated and decelerated step by step. The sharp edges of the individual velocity steps are slightly levelled out by the volume flow and the inertia of the cylinder. It is difficult to reduce fluctuations (i.e. to obtain smaller, smoother steps). One way to obtain a considerable reduction of the fluctuation is to use a proportional valve which can continuously control the process – i.e. the speed of cylinders

and motors. Sudden switching impacts are avoided. Moreover, cylinder and motor speeds can be defined in advance.

