ROHINI COLLEGE OF ENGINEERING AND TECHNOLOGY
AUTONOMOUS INSTITUTION
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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

VII Semester

AU3008 Sensors and Actuators

UNIT – 5 - AUTOMATIC TEMPERATURE CONTROL ACTUATORS

5.1 Different types of actuators used in automatic temperature control

In automatic temperature control systems, various types of actuators are used to manage heating, cooling, and ventilation processes by adjusting components in response to control signals. The main types of actuators used in these systems include:

1. Electric Actuators

❒ **Electric Motors:**

➢ **AC Motors:** Versatile, reliable, and widely used in various applications.

While AC motors aren't directly involved in heating or cooling processes, they play a crucial role in driving the mechanical components that regulate temperature. Here's a breakdown of how they contribute:

❒ **Fan and Blower Control:**

- ❖ **Air Circulation:** AC motors power fans and blowers that circulate air, ensuring even distribution of heated or cooled air throughout a space.
- ❖ **Heat Dissipation:** In electronic devices, AC motors drive fans to remove excess heat, maintaining optimal operating temperatures.
- ❖ **Condenser Fans:** In refrigeration systems, AC motors operate condenser fans to dissipate heat to the environment.

❒ **Pump Control:**

- **Fluid Circulation:** AC motors power pumps that circulate heating or cooling fluids, such as water or refrigerant, through pipes and radiators.
- **Heat Exchange:** These pumps facilitate heat transfer between the fluid and the environment or the space to be heated or cooled.

❒ **Damper Control:**

- **Airflow Regulation:** AC motors can drive actuators that control the position of dampers, directing airflow to specific areas or adjusting the amount of air entering or leaving a space.
- **Zone Control:** This enables precise temperature control in different zones of a building, optimizing energy efficiency.

➢ **DC Motors:** Offer precise control and efficient operation, especially in smaller-scale systems.

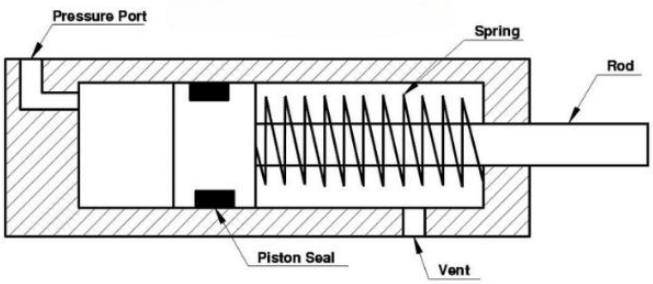
➢ **Solenoid Valves:**

- **Direct-acting:** Simple and cost-effective for low-pressure applications.
- **Pilot-operated:** Suitable for high-pressure and demanding applications.

1. **Sensor Input:** A temperature sensor monitors the current temperature and sends a signal to a controller.
2. **Controller Processing:** The controller compares the sensed temperature to the desired setpoint and determines the necessary action.
3. **Solenoid Valve Activation:** The controller sends an electrical signal to the solenoid valve, energizing the coil.
4. **Valve Operation:** The energized coil generates a magnetic field, which attracts a plunger or diaphragm, opening or closing the valve.
5. **Fluid Flow Control:** The valve controls the flow of the fluid (e.g., water, steam, refrigerant) to the heating or cooling device, such as a radiator, coil, or fan coil unit.

2. Pneumatic Actuators

Pneumatic actuators are devices that convert compressed air energy into mechanical motion. They are widely used in temperature control systems to position valves and dampers, thereby regulating the flow of heating or cooling fluids.



<u>Pneumatic Actuators in Temperature Control</u>:

- **Sensor Input:** A temperature sensor monitors the current temperature and sends a signal to a controller.
- **Controller Processing:** The controller compares the sensed temperature to the desired setpoint and calculates the necessary adjustment.
- **Pneumatic Signal:** The controller sends a pneumatic signal, typically compressed air at a specific pressure, to the pneumatic actuator.
- **Actuator Response:** The pneumatic actuator receives the signal and converts it into mechanical force, moving a piston or diaphragm.
- **Valve or Damper Positioning:** The mechanical force from the actuator positions a valve or damper, controlling the flow of heating or cooling fluid.

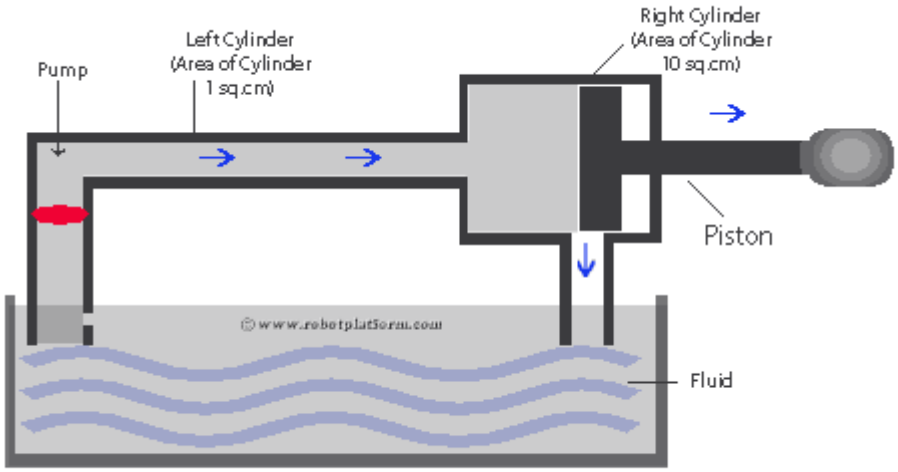
- **Diaphragm Actuators:** Compact and reliable, often used in HVAC systems. The pressure of the compressed air acts on the diaphragm, causing it to deflect. The deflection of the diaphragm is transmitted to a stem, which is connected to the valve or damper.

- **Piston Actuators:** Provide high force and torque, suitable for demanding applications. Compressed air is supplied to the actuator's cylinder. The

compressed air exerts pressure on the piston, causing it to move. The piston's movement is transmitted to a stem, which is connected to the valve or damper.

3. Hydraulic Actuators

- Hydraulic actuators use fluid pressure to generate movement, often providing higher force than pneumatic actuators. Although less common in HVAC due to maintenance needs, they are used in specialized industrial temperature control applications.



Hydraulic Actuator

Hydraulic Actuators in Temperature Control:

- **Hydraulic Fluid Supply:** A hydraulic pump pressurizes the hydraulic fluid.
- **Fluid Flow Control:** A control valve regulates the flow of pressurized fluid to the actuator.
- **Piston Movement:** The pressurized fluid forces a piston to move within a cylinder.
- **Mechanical Output:** The piston's movement is converted into mechanical work, such as rotating a valve or positioning a damper.

4. Thermal Actuators

- Thermal actuators expand or contract based on temperature changes. They contain materials that react to temperature variations, such as wax, which expands with heat and contracts as it cools, moving a piston or valve.

- ❒ These are often found in thermostatic radiator valves or small-scale applications where simplicity and reliability are important.

- ❒ **How Thermal Actuators Work:**

- ❖ **Temperature Change:** The temperature of the actuator changes, either due to the ambient temperature or a controlled heat source.
- ❖ **Material Expansion or Contraction:** The actuator's material, often a bimetallic strip, expands or contracts in response to the temperature change.
- ❖ **Mechanical Movement:** The expansion or contraction of the material causes a mechanical movement, such as opening or closing a valve.

5. Electrohydraulic Actuators

- ❒ Combining electric and hydraulic components, these actuators provide the precision of electric actuators with the power of hydraulic systems. They're used in heavy-duty applications where both fine control and force are required.

- ❒ **How Electro-Hydraulic Actuators Work:**

- ❖ **Electrical Signal:** An electrical signal, typically from a control system, is received by the actuator's control unit.
- ❖ **Hydraulic Valve Control:** The control unit activates a hydraulic valve, which regulates the flow of pressurized hydraulic fluid to a hydraulic cylinder.
- ❖ **Piston Movement:** The pressurized fluid forces a piston to move within the cylinder.
- ❖ **Mechanical Output:** The piston's movement is converted into mechanical work, such as rotating a valve or positioning a damper.

6. Other Actuators:

- ❒ **Piezoelectric Actuators:** Offer fast response times and high precision, used in specialized applications.

- **Shape Memory Alloy (SMA) Actuators:** Utilize the shape-changing properties of certain alloys for precise control.

Each type of actuator has unique characteristics that make it suitable for specific temperature control needs, whether it be rapid response, precision, or the ability to handle large forces in industrial settings.

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