

BEYOND

SMART CITIES



BUILDING AUTOMATION & CONTROL SYSTEM

CEM REFRESHER TRAINING

KRISHNAJI PAWAR, LEED AP BD+C, GSAS CGP, ISO 14001:2015, GCP

ENERGY MANAGEMENT SPECIALIST CURRICULUM



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BASIC TECHNOLOGIES

FOR ENERGY PROFESSIONALS

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WHAT SHOULD YOU LEARN





Basic Technologies

Pneumatic

Electric

Direct Digital Control - DDC

Control Terminologies

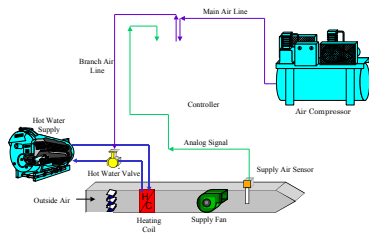


BASIC TECHNOLOGIES

- ✓ **Pneumatic**
- ✓ **Electric**
- ✓ **Direct Digital Control (DDC)**



PNEUMATIC CONTROLS



- ✓ **Use clean, dry, oil-free compressed air to operate the control system.**
- ✓ **Have been used in many HVAC applications.**



PNEUMATIC CONTROLS

✓ **Advantages**

- ➔ **Are well understood by many designers and most maintenance people.**
- ➔ **Are inherently proportional and very reliable.**
- ➔ **Were relatively inexpensive in the past.**

✓ **Disadvantages**

- ➔ **Not very precise.**
- ➔ **Typically required frequent calibration.**
- ➔ **Pneumatic control algorithms are hard to change. (typically pre-set by manufacturer)**



ELECTRIC CONTROLS

- ✓ Can be analog electric or electronic controls.
- ✓ Use a variable, but continuous, electrical voltage or current to operate the control system.
- ✓ Transmit signals quickly and accurately.



ELECTRIC CONTROLS

✓ Advantages

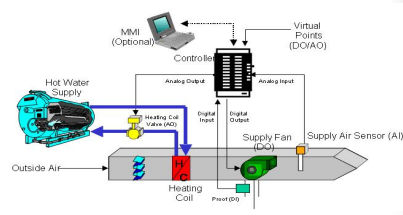
- ⇒ Can be very accurate and very stable.
- ⇒ Do not require field calibration, and are drift-free, if good quality sensors are used.
- ⇒ Relatively easy to implement proportional plus integral (PI) control electronically.

✓ Disadvantages

- ⇒ Difficult to interchange parts easily because of the many different systems.
- ⇒ Do not interface directly with our digital computers

DIRECT DIGITAL CONTROLS

- ✓ Use electrical pulses to send signals.
- ✓ Interface directly with microprocessors, directly &/or via the internet using TCP/IP.



DIRECT DIGITAL CONTROLS

✓ Advantages

- Algorithms can be adjusted relatively easily after installation
- Precise
- No controller drift, recalibration is normally not necessary
- Cost effective (similar to electronics market)

✓ Disadvantages

- Possibly not well understood by O&M staff
- Different communication protocols, interface standards, and internal logic are typically complex (BACNET-ASHRAE 135-2004; and Lonworks – Lonmark Corporation; are both addressing these interface problems)

WEB BASED ENERGY INFORMATION AND CONTROL SYSTEMS

- ✓ TCP/IP is Transmission Control Protocol/Internet Protocol
- ✓ Internet Explorer, Netscape Navigator, Mozilla Firefox all take TCP/IP input
- ✓ Many submeters now have data accumulators that have URL addresses, and send data by TCP/IP over Local Area Networks
- ✓ This data will come into your PC in standard spread sheet format for you to use as you like
- ✓ You can make charts, graphs, tables, etc in Excel or other common SS programs
- ✓ You now have your own web based energy information system
- ✓ And it doesn't cost you a fortune. Save your money for the really fancy analysis and diagnostic systems that many companies can provide to you

CONTROL TERMINOLOGY

- ✓ Set Point – The value of the controlled variable that is to be maintained.
- ✓ Control Point - The actual value of the controlled variable (temperature, pressure, flow, etc.).
- ✓ Offset - The difference between the set point and the control point or the actual value of the controlled variable. (This is sometimes called drift, deviation, or control point shift.)
- ✓ Direct Acting Controller – A controller for which an increase in the level of the sensor signal (temperature, pressure, etc.) results in an increase in the level of the controller output.
- ✓ Modulating Controller – A type of controller for which the output can vary infinitely over the range of the controller.

CONTROL TERMINOLOGY

- ☑ **Differential** – For a two-position controller it is the difference between the setting at which the controller operates at one position and the setting at which it changes to the other position. (All two-position controller need a differential to prevent “hunting,” or rapid cycling. For a thermostat, the differential is expressed in degrees of temperature.)
- ☑ **Dead-Band** – The range over which the output of the controller remains constant as the input varies, with the output changing only in response to an input outside the differential range.
- ☑ **Throttling Range** – The amount of change in the controlled variable required to run the actuator of the controlled device from one end of its stroke to the other end. (If the actual value of the controlled variable lies within the throttling range of the controller, it is said to be in control. When it exceeds the throttling range it is said to be out of control.)

CONTROL TERMINOLOGY

- ☑ **Gain** – The ratio of the output of the controller to the input. In a pneumatic temperature controller, for example, the gain would be expressed as:

$$\text{gain} = \text{Controller Output (kPa)} / \text{Throttling Range (degrees)}$$

- ☑ **Linear Percentage Valve** – A valve with a plug shaped so that the flow varies directly with the lift.
 - ☑ **Equal Percentage Valve** – A valve with a plug shaped so the flow varies as the square root of the lift.
- Flow (LPS) = $C_v \times \sqrt{\Delta P}$

WATER FLOW THROUGH VALVES

