International Journal of Scientific & Engineering Research, Volume 8, Issue 4, April-2017
ISSN 2229-5518

Process Control - Automation

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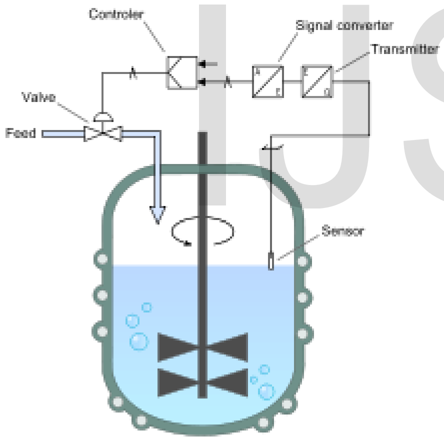
Abstract— Nowadays several Controlled Processing Systems are very common in our daily life from wakeup to sleeping time, e.g., Cooking Ovens - Time and Temperature Control, Washing Machines - Time Control. In Process Industries Control of Pressure, Temperature, Level, Flow and Humidity, PH like Process Parameters is very essential factor of Quality of the Product. Our Human Body Organisms also need control of Sugar Levels in the body and BP level etc., for Good Health. Automatic Control with suitable Sensors is the Automation of Process Control.

1. INTRODUCTION

Process control is an engineering discipline that deals with architectures, mechanisms and algorithms for maintaining the output of a specific process within a desired range. For instance, the temperature of a chemical reactor may be controlled to maintain a consistent product output.

2. PROCESS CONTROL



Example: A control system of a continuous stirred-tank reactor.

Process control is extensively used in industry and enables mass production of consistent products from continuously operated processes such as oil refining, paper manufacturing, chemicals, power plants and many others. Process control enables automation, by which a small staff of operating personnel can operate a complex process from a central control room.

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3. TYPES OF CONTROLLERS

Controllers are mainly two types. They are Blinded or Non Feed Back Controllers and Wise or Feed Back Controllers.

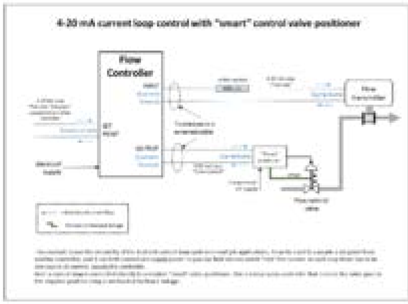
- Blind Controllers – The Controller activated by the external agency and not a function related to the output of the process. As a result it can't perform quality of the product.
- Wise Controllers – The Controller activated by the agency whichever is a function related to the output of the process. So called Feed Back Controllers. As a result it is able to perform quality of the product.

3.1 BLIND CONTROLLERS

The Controller activated by external agency and not a function related to the output of the process. As a result it can't perform quality of the product. E.g., Electrical Rice Cooker, Electrical Iron Box, Washing Machine etc., these are timely activated Systems and operate with presetting time and not response with the output quality.

3.2 WISE CONTROLLERS

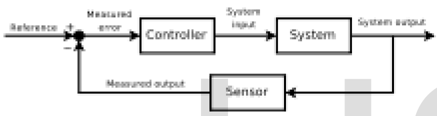
The Controller activated by agency whichever is a function related to the output of the process. So, it is called as Feed Back Controllers. As a result it is able to perform quality of the product e.g., Hot Water Geezers using in the Showering Rooms. The water is heated up to certain pre determine temperature and maintained the water for that temperature only till the system is activated.
Example: a continuous flow control loop. Signaling is by industry standard 4-20 mA current loops, and a "smart" valve positioner ensures the control valve operates correctly.



4 Type of Feedback Controllers

However these Feed Back Controllers is of two types, namely Positive Feed Back Controllers and Negative Feed Back Controllers. Their functions are determined by the System functions (the differential equations relating the output/input of the system) respectively and characterized by the loop diagrams and Niquist diagrams.

Block diagram of a of closed control (Feedback) loop



Process control may either use feedback or it may be open loop. Control may also be continuous (automobile cruise control) or cause a sequence of discrete events, such as a timer on a lawn sprinkler (on/off) or controls on an elevator (logical sequence).

A thermostat on a heater is an example of control that is on or off. A temperature sensor turns the heat source on if the temperature falls below the set point and turns the heat source off when the set point is reached. There is no measurement of the difference between the set point and the measured temperature (e.g. no error measurement) and no adjustment to the rate at which heat is added other than all or none.

A familiar example of feedback control is cruise control on an automobile. Here speed is the measured variable. The operator (driver) adjusts the desired speed set point (e.g. 100 km/hr) and the controller monitors the speed sensor and compares the measured speed to the set point. Any deviations, such as changes in grade, drag, wind speed or even using a different grade of fuel (for example an ethanol blend) are corrected by the controller making a compensating adjustment to the fuel valve open position, which is the manipulated variable. The controller makes adjustments having information only about the error (magnitude, rate of change or cumulative error) although settings known as tuning are used to achieve stable control. The operation of such controllers is the subject of control theory.

5 Feedback Technics

There are different varieties of techniques are adopted for feedback operations. viz.,

- Proportional Controllers
- Integral Controllers
- Derivative Controllers
- Proportional and Integral Controllers
- Proportional and Derivative Controllers
- Proportional and Integral and Derivative Controllers

5.1 Proportional Controllers

It is the controller that can control the process variable in proportion to the deviation of the process variable from the set point. It is the ideal controller for the user. Really it suffers delay in controlling the process with instability.

5.2 Integral Controllers

It is the controller that can control the process variable as integral relation to the deviation of the process variable from the set point. The output lags behind the input however it performs boosting action.

5.3 Derivative Controllers

It is the controller that can control the process variable as derivative relation to the deviation of the process variable from the set point. The output leads behind the input however it performs stable action.

5.4 Proportional and Integral Controllers

It is the controller that can control the process variable in proportion and integral relation to the deviation of the process variable from the set point. The output lags behind the input with erecting the variable. However it performs boosting and erecting action.

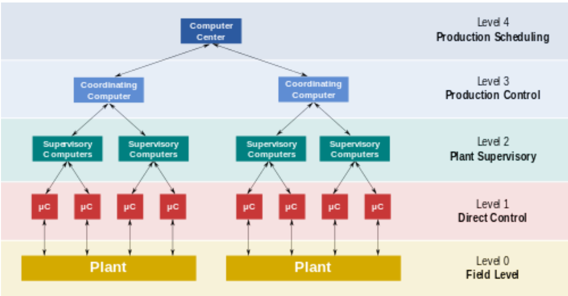
5.5 Proportional and Derivative Controllers

It is the controller that can control the process variable in proportion and differential relation to the deviation of the process variable from the set point. The output leads behind the input with erecting the variable. However it performs stable and erecting action.

5.6 Proportional, Integral and Derivative Controllers

It is the controller that can control the process variable in proportion, integral and differential relation to the deviation of the process variable from the set point. So that it performs stable and erecting and boosting action.

6 Hierarchy of Process Control



Functional levels of a manufacturing control operation.

The accompanying diagram is a general model which shows functional manufacturing levels in a large process using computerised control.

Referring to the diagram;

- Level 0 contains the field devices such as flow and temperature sensors, and final control elements, such as control valves
- Level 1 contains the industrialised Input/output (I/O) modules, and their associated distributed electronic processors.
- Level 2 contains the supervisory computers, which collate information from processor nodes on the system, and provide the operator control screens.
- Level 3 is the production control level, which does not directly control the process, but is concerned with monitoring production and monitoring targets
- Level 4 is the production scheduling level.

7 Activation Techniques of the Controllers

The activations of the controllers may be preferred depending up on the users choice, viz.,

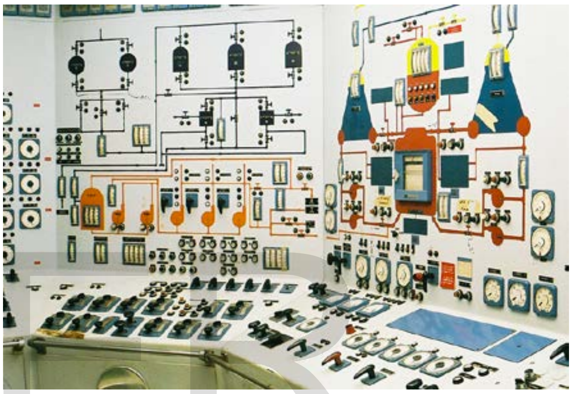
- Pneumatic – Operated by Air Pressure
- Hydraulic – Operated by the pressure of the liquids
- Electric – Operated by Electrical Circuits includes Passive devices such as motors and transformers
- Electronic – Operated by Electronic Circuits includes both Active and Passive devices such as Transistors, motors and transformers
- Automation – Operated by Programmable Systems. Such as Microprocessors, Computers Namely DCS, PLC, SCADA etc.,

As the technology develops recently Automation dominates the other activating systems.

8 Automation

A commonly used control device called a programmable logic controller, or a PLC, is used to read a set of digital and analog inputs, apply a set of logic statements, and generate a set of analog and digital outputs.

For example, if an adjustable valve were used to hold level in a tank the logical statements would compare the equivalent pressure at depth set point to the pressure reading of a sensor below the normal low liquid level and determine whether more or less valve opening was necessary to keep the level constant. A PLC output would then calculate an incremental amount of change in the valve position. Larger more complex systems can be controlled by process control systems like Distributed Control System (DCS) or SCADA.



Control panel of a nuclear reactor.

9 Type of Process Using Process Control

Processes can be characterized as one or more of the following forms:

- ✓ Discrete – Found in many manufacturing, motion and packaging applications. Robotic assembly, such as that found in automotive production, can be characterized as discrete process control. Most discrete manufacturing involves the production of discrete pieces of product, such as metal stamping.
- ✓ Batch – Some applications require that specific quantities of raw materials be combined in specific ways for particular durations to produce an intermediate or end result. One example is the production of adhesives and glues, which normally require the mixing of raw materials in a heated vessel for a period of time to form a quantity of end product. Other important examples are the production of food, beverages and medicine. Batch processes are generally used to produce a relatively low to intermediate quantity of product

per year (a few pounds to millions of pounds).

- ✓ Continuous – Often, a physical system is represented through variables that are smooth and uninterrupted in time. The control of the water temperature in a heating jacket, for example, is an example of continuous process control. Some important continuous processes are the production of fuels, chemicals and plastics. Continuous processes in manufacturing are used to produce very large quantities of product per year (millions to billions of pounds).

Applications having elements of discrete, batch and continuous process control are often called hybrid applications.

Examples:

An anti-lock braking system (ABS) is a complex example, consisting of multiple inputs, conditions and outputs.

Aircraft stability control is a highly complex example using multiple inputs and outputs.

10 Conclusion

At present Automation Process Controls are Demands the life style of human beings in the field of Biomedical Instrumentation as well as thin film and Nano technology in the industrial fields. So more research works need to carried out in these fields.

11 Acknowledgement

I exhibit gratitude to all of my professors, Lecturers and Teachers whoever guides me during my educational life. At the same time I am expressing my thanks to my students whoever encouraging me while delivering my lectures with their prompt attempt ion.

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