

P3005 PROCESS CONTROL SIMULATOR

INTRODUCTION

The P3005 Process Control Simulator is designed to educate the student in the principles and use of control equipment in the context of process operations.

The design facilitates observation and operation of the various components along with detailed study of the performance characteristics of each of the control loops both individually and in relationship to each other.

The choice of instrument hardware presents as varied a selection of types of instruments as possible, such as pneumatic, electronic, interfaced equipment and in particular introduces the use of microprocessor based technology in the design of a controller.

DESCRIPTION

The process which forms the basis of operation of the various control loops and equipment is illustrated in Fig. 1. Water is fed to a centrifugal pump from sump tank T1 and then to a water heater HE2 before passing into two vessels V1 and V2, mounted in series and simulating a reactor system. The water finally flows back into the sump tank T1, the heat introduced into the system being removed by a water cooler, HE1.

V2 simulates a vessel used for a hazardous process reaction, demanding the use of flame proof control equipment in its immediate vicinity, thus providing a logical reason for the use of pneumatic and interfaced control equipment.

Four standard areas of control are presented i.e.

Pressure, Flow, Temperature and Level

In addition **Cascade Control** and **Time Lag** can also be demonstrated.

Facility is provided to introduce deliberate faults into the system so as to simulate conditions which could be encountered in practice.

A recorder is included for monitoring both process conditions and controller output signals. An event marker is provided to indicate on the electronic recorder chart the time at which a deliberate change has been made to the process condition.

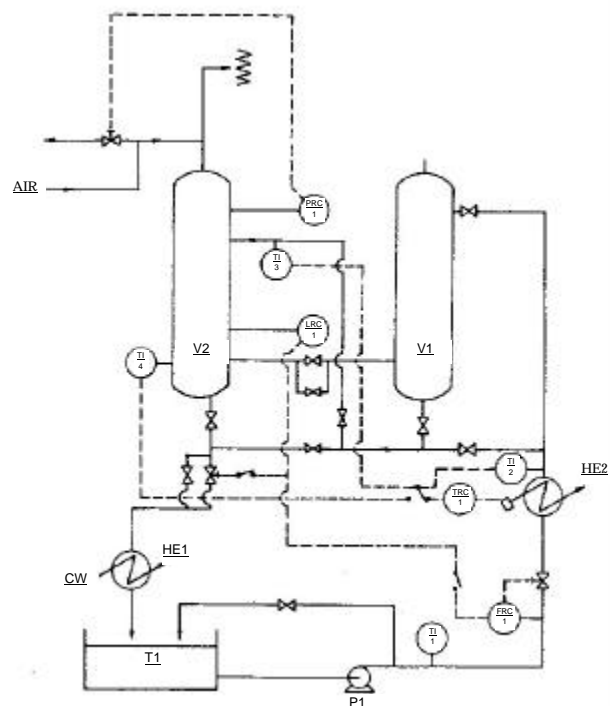


FIG. 1

LEVEL CONTROL LOOP

The control equipment in this loop has been chosen to demonstrate the use of both pneumatic and electronic components and incorporates five major items as follows:

1. Differential Pressure (D.P.) Transmitter used to transmit a pneumatic signal proportional to the differential pressure between top and bottom of the 'reactor vessel'.
2. Pressure transducer which converts the pneumatic signal from the D.P. transmitter to an electrical signal.
3. 3 term controller incorporating proportional, proportional plus integral, and proportional plus derivative control functions. The facility to operate automatically or in manual mode, and the ability to self tune or adaptive tune whilst the process is running.
4. Electrical Control Valve positioned in the exit line from the 'reactor vessel'.
5. Electronic Recorder used to record the volume of process level and output signal to the control valve.

DEMONSTRATION OF TIME LAG

Normally the control loop is used to control the level in V2, but with vessel V1 in operation, and the interconnection line between the two vessels open, then the level in V2 will lag behind that in vessel V1.

A high level cut-out switch is included in the control loop to demonstrate the use of such an item and protect the low pressure loop of the differential level transmitter from flooding.

FLOW CONTROL LOOP

The main component of this control system consists of a 3 term microprocessor controller used in industry today.

The process signal to the controller originates from an in-line orifice plate assembly, the differential pressure from which is converted to an electronic signal by means of a wet to wet pressure transducer. The signal from the transducer is fed to the microprocessor controller. This signal is processed by the controller and displayed as a flow by the square root function incorporated in the controller.

The control signal from the microprocessor is fed to an electronic control valve via a valve positioner having both automatic and manual facility. The control signal can be monitored by a recorder which can also record the flow through the orifice as calculated by the microprocessor controller.

TEMPERATURE CONTROL LOOP

The temperature control loop represents a control system using only electronic component items. The process signal is from one of a series of thermocouples fed to a 3 term controller, the output signal of which controls the power fed into the heater HE2 via a series of thyristor drive units.

The electronic recorder can plot both the process temperature as selected by the controller input switch, and the controller output, whilst a pen is available for recording the signal from one of the remaining thermocouples.

The three thermocouples available to provide the input signal to the controller are positioned at varying distances downstream from the heater so as to give a variation in response time to any change in the process conditions.

PRESSURE CONTROL LOOP

Compressed air at ~ 1.5 bar is fed to the vessel V2, the pressure of which is controlled by means of a control valve CV3 positioned on a bypass line discharging to atmosphere.

The control loop comprises the following:

1. Pneumatic Indicating Transmitter which measures and indicates the pressure in V2 and retransmits this process variable in the form of a linearised signal of magnitude 3 to 15 psi. to the Pneumatic Indicating Controller.
2. Pneumatic Indicating Controller with proportional, integral and derivative action. The process condition is indicated by a pointer and scale mechanism and the controlling signal fed to the control valve, an auto/manual function is also provided to afford the operator manual control of the valve.
3. Control Valve, consisting of a diaphragm operated valve having air to close characteristic.
4. Pneumatic Recorder for plotting the process variable signal and the controllers output signal.

CASCADE CONTROL

Facilities are provided to enable output signal from the three term level controller to reset the flow controller set point giving an application of cascade control.

SERVICES

Electricity 1kW max. 110/220V 1ph. 50/60 Hz. (and) 8kW max. 220/440V 3ph. 50/60 Hz.

Compressed Air 1m³/hr maximum at 1.5 bar.

Water 10 l/mm maximum at 25°C
1.5 bar minimum pressure

OPTIONAL ADDITIONAL EQUIPMENT

P3006 Air Compressor for use with P3005.

P3007 Packaged water chiller for use with P3005/6.
(for use when cooling water is not available)

SHIPPING SPECIFICATIONS

Case size: 239 x 94 x 249 cm (approximate)

Weight: 580 Kg nett, 800 Kg gross