



## ≡ THERMAL CONTROL PROCESS APPARATUS

CE103

A self-contained, benchtop temperature control apparatus that mimics common industrial processes, designed to allow students at all academic levels to investigate the basic and advanced principles of control.



### KEY FEATURES

- Self-contained and compact benchtop unit
- Electrically-heated and air-cooled model process that mimics a real industrial process
- Includes variable hysteresis for advanced process control experiments
- Temperature sensors with different thermal contact to the process give variations in thermal inertia and time constant
- Front panel includes mimic diagram of the process so students can see what they are controlling
- All inputs and outputs buffered for connection to TecQuipment's optional controllers or other suitable controllers



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## DESCRIPTION

The Thermal Control Process Apparatus mimics a common industrial process, including an air-conditioning plant, where a combination of adjustments can control temperature. These can be:

- Varying the heat energy input to the system
- Varying the speed of a circulating fan
- Using a variable vane to restrict the flow

The apparatus has a variable-speed fan that forces air through a duct. In the duct is an electrically-heated process block. A balance of the heat gained from electrical heating and heat lost by convection and conduction gives a steady temperature at the block.

Two temperature sensors measure the temperature of the block. One sensor is in direct thermal contact with the block. The other sensor mounts on an insulating spacer to introduce thermal inertia and variable-time constants into the control loop. A servo-driven vane, mounted after the fan and the process block, creates a variable restriction downstream for more advanced experiments.

The control problem is to keep the process temperature within acceptable limits while it works under various conditions. A combination of regulating the electrical energy to the heater, varying the air flow rate and rotating the vane gives the heat control. The apparatus has scaled-down time constants for shorter laboratory time.

A relay amplifier with variable hysteresis allows more advanced experiments.

## STANDARD FEATURES

- Supplied with comprehensive user guide
- Five-year warranty
- Made in accordance with the latest European Union directives
- ISO9001 certified manufacturer

## LEARNING OUTCOMES

- Heat transfer
- On/off control – experiment includes investigation of overshoot and undershoot, on and off time ratio, rates of heating and cooling, offset and hysteresis
- Proportional, proportional + integral, or proportional + integral + differential control
- Frequency response of model process
- Thermal inertia and variable-time constants
- Multi-variable control – up to three variables can be monitored and individually controlled

The flexible design of the equipment allows the user to develop many other analysis and control exercises to suit their needs. It is good for extended or advanced control experiments, and is ideal for student project work.

## ESSENTIAL BASE UNIT

- Controller (CE120) – A controller with analogue and digital controls and instruments or
- Digital Interface (CE122) – An interface which connects between most products in the Control Engineering range and a suitable computer (not included) or
- Other suitable controller with +/- 10 V inputs and outputs

Both the CE120 and the CE122 include TecEquipment's CE2000 Control Software (see separate datasheet) with editable, pre-made control experiments for use with the CE103.

## ESSENTIAL SERVICES

### ELECTRICAL SUPPLY:

240/110 VAC, 1 A, 50/60 Hz, with earth

Other voltages and frequencies available to special order

### BENCH SPACE NEEDED:

1 m x 750 mm

## OPERATING CONDITIONS

### OPERATING ENVIRONMENT:

Laboratory

### STORAGE TEMPERATURE RANGE:

-25°C to +55°C (when packed for transport)

### OPERATING TEMPERATURE RANGE:

+5°C to +40°C

### OPERATING RELATIVE HUMIDITY RANGE:

80% at temperatures < 31°C decreasing linearly to 50% at 40°C

## SOUND LEVELS

Less than 70 dB(A)

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## SPECIFICATIONS

TecQuipment is committed to a programme of continuous improvement; hence we reserve the right to alter the design and product specification without prior notice.

### NETT DIMENSIONS:

540 mm x 330 mm x 420 mm and 17 kg

### APPROXIMATE PACKED DIMENSIONS:

0.34 m<sup>3</sup> and 41 kg

### INPUTS (0-10 VDC):

- Fan speed
- Heater
- Vane position
- Hysteresis relay input: 0 to +/- 10 VDC
- Hysteresis relay control

### OUTPUTS (0-10 VDC):

- Temperature Sensor 1: direct contact
- Temperature Sensor 2: on insulating spacer
- Hysteresis relay output

### OTHER PARTS INCLUDED:

Connecting cables