

## RT 586

## Control of Water Quality



\* Control of pH value, redox potential, oxygen concentration and electrical conductivity

\* 4 control loops with industrial controllers

#### Technical Description

Adequate water quality is essential to many production processes. With RT 586 key water parameters can be monitored and controlled.

Water flows into a transparent tank which contains a stirrer. A sensor allows for measurement of the conductivity of the water. It is displayed on a meter and transmitted as an electrical signal to a controller. The desired conductivity is preset as the reference variable on the controller. The controller influences the conductivity of the water by adding diluted caustic soda with a metering pump.

The addition of caustic soda causes the pH value of the water to rise. It flows into a second transparent tank. A sensor provides for the measurement of the pH value. The desired pH value is preset as the reference variable on the controller. The water is neutralized by adding diluted sulphuric acid with a metering pump. Another sensor in this tank is used to measure the oxygen concentration of the water. It is displayed on a meter and transmitted as an electrical signal to the controller. The controller influences the injection of compressed air, and thus the oxygen concentration of the water, by way of a control valve. The water flows into a collecting tank.

The redox potential is controlled in a separate section of the collecting tank. In this section the redox potential is measured using a sensor. The controller influences the redox potential of the water by the addition of iodine solution with a metering pump.

As a further check of performance, a sensor is employed to measure the pH value of the water in the collecting tank. It is displayed digitally on the switch cabinet. A six-channel line recorder is provided to record the control processes.

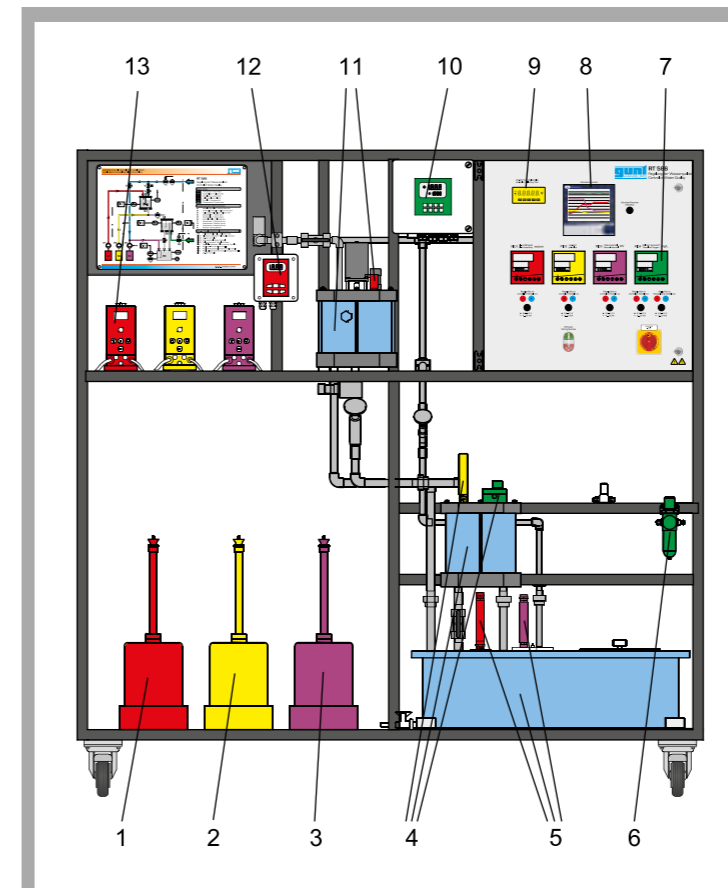
The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

#### Learning Objectives / Experiments

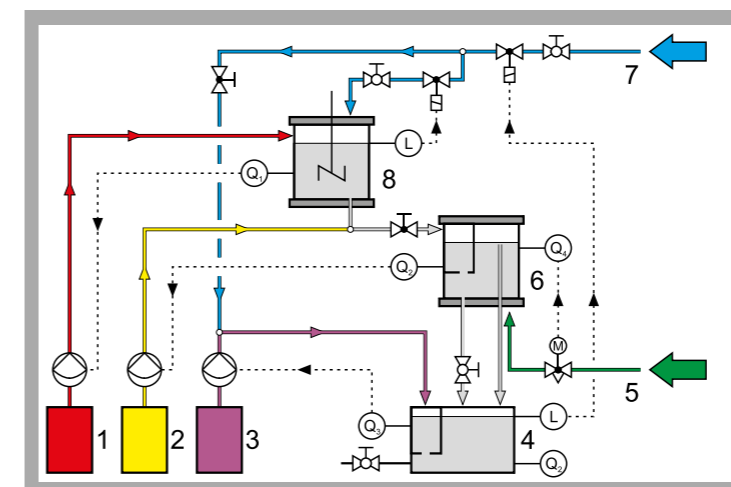
- comparison of various controller types
- \* P, PD, PI and PID controllers
- \* two-point controller
- influence of caustic soda on electrical conductivity and pH value
- influence of sulphuric acid on pH value
- influence of air injection on oxygen concentration
- influence of iodine on redox potential

## RT 586

## Control of Water Quality



1 caustic soda, 2 sulphuric acid, 3 iodine solution, 4 tank with sensors for pH value and oxygen concentration, 5 collecting tank with sensors for redox potential and pH value, 6 compressed air maintenance unit, 7 controller, 8 line recorder, 9 collecting tank pH value display, 10 oxygen meter, 11 tank with stirrer and conductivity sensor, 12 conductivity meter, 13 metering pump



1 caustic soda, 2 sulphuric acid, 3 iodine solution, 4 collecting tank for control of redox potential, 5 compressed air, 6 tank for control of pH value and oxygen concentration, 7 water inlet, 8 tank for control of conductivity; Q<sub>1</sub> conductivity, Q<sub>2</sub> pH value, Q<sub>3</sub> redox potential, Q<sub>4</sub> oxygen concentration

#### Specification

- [1] control of water parameters; pH value, redox potential, oxygen concentration and electrical conductivity
- [2] control of conductivity in transparent tank with stirrer
- [3] control of pH value and oxygen concentration in transparent tank
- [4] control of redox potential in collecting tank
- [5] change in conductivity, pH value and redox potential by addition of caustic soda, sulphuric acid and iodine solution
- [6] 3 industrial metering pumps
- [7] change in oxygen concentration by injection of compressed air
- [8] 4 parameterisable industrial controllers
- [9] 6-channel line recorder
- [10] 3 plastic tanks for caustic soda, sulphuric acid and iodine solution
- [11] recording of pH value in collecting tank

#### Technical Data

##### Tanks

- transparent tanks: 2x 5L
- collecting tank: 80L
- plastic tanks: 3x each

##### Metering pumps

- max. flow rate: each 2,1L/h
- max. head: each 160m
- 4 controllers parameterisable as
- P, PI or PID controller
- 2-point controller

##### Measuring ranges

- conductivity: 0...100mS/cm
- pH value: 1...12
- oxygen concentration: 0...60mg/L
- redox potential: 0...1000mV

#### Dimensions and Weight

LxWxH: 1800x700x1830mm  
Weight: approx. 182kg

#### Required for Operation

230V, 50Hz, 1 phase  
Compressed air: 3...8bar, water connection, drainage, iodine solution, caustic soda, sulphuric acid

#### Scope of Delivery

- 1 trainer
- 1 hose
- 1 set of instructional material

#### Order Details

080.58600 RT 586 Control of Water Quality

**RT 578 Control of 4 Variables from Process Engineering**


\* **Practical control of level, flow rate, pressure and temperature**

\* **Cascade control**

\* **Process control software**

**Technical Description**

The RT 578 facilitates practical learning in the control of four controlled variables which are commonplace in process engineering.

A circuit with a graduated transparent tank is provided for the control of flow rate, level and pressure. Two actuator possibilities are included for use, namely, a variable-speed pump and a pneumatic control valve. A disturbance variable can be generated by a valve in the tank outlet for level and pressure control. A valve at the tank head also permits investigation of level control with and without counter pressure.

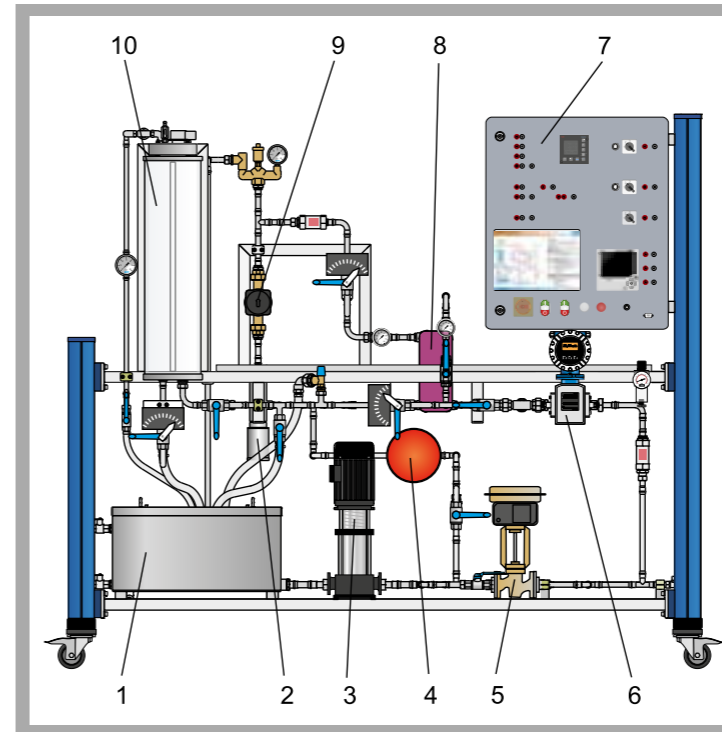
A heating circuit with a heater, heat exchanger and pump is provided for temperature control. The temperature can be controlled using the heater as the actuator, or by way of the flow of cooling water through the heat exchanger.

Two forms of cascade control are possible. The level in the tank can be controlled by way of the flow rate. The temperature in the heating circuit can be controlled by way of the flow rate through the heat exchanger. For these two cascade controls, either the pump or the control valve can be used as the actuator.

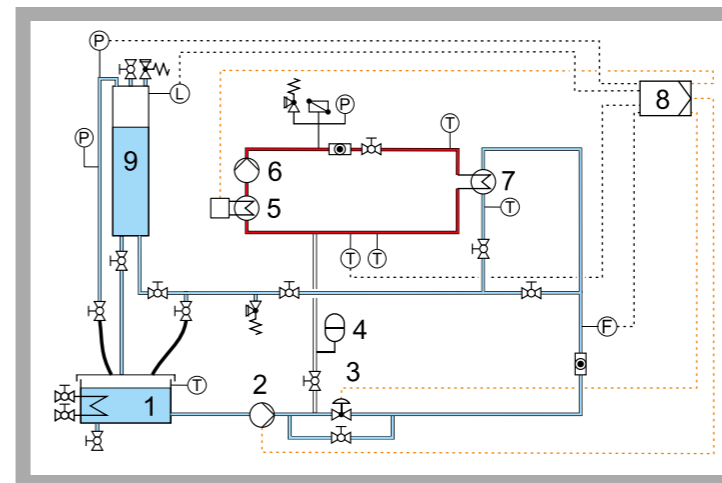
Sensors provide for measurement of the controlled variables. The variables can also be read-off directly from analogue meters. A line recorder is provided to record the control processes. The industrial controller has four selectable control loops. It has a Profibus DP interface. This enables the trainer to be controlled by way of a process control software. The software also permits recording of the process variables and parameterisation of the controller on the PC.

**Learning Objectives / Experiments**

- familiarisation with industrial control loop components
- setup, parameterisation and configuration on the controller
- optimisation of controller settings
- flow rate control
- level control in closed tank with or without counter pressure
- pressure control
- temperature control
- cascade control, level - flow rate
- cascade control, temperature - flow rate
- two-point control, temperature
- plotting step responses

**RT 578 Control of 4 Variables from Process Engineering**


1 collecting tank, 2 heater, 3 pump, 4 expansion vessel, 5 control valve, 6 flow rate sensor, 7 switch cabinet, 8 heat exchanger, 9 heating circuit pump, 10 graduated tank



1 collecting tank, 2 pump, 3 control valve, 4 expansion vessel, 5 heater, 6 heating circuit pump, 7 heat exchanger, 8 controller, 9 graduated tank;  
Sensors: F flow rate, P pressure, L level, T temperature

**Specification**

- [1] control of level, flow rate, pressure, temperature and cascade control
- [2] circuit with collecting tank, graduated tank, pneumatic control valve and 6-stage variable-speed centrifugal pump
- [3] heating circuit with heater, pump, expansion vessel and heat exchanger
- [4] heater, pneumatic control valve and 6-stage variable-speed centrifugal pump as actuators
- [5] sensors for measurement of the controlled variables; level, flow rate, pressure and temperature
- [6] 2 flow indicators, 1 manometer and 3 thermometers for direct display
- [7] parameterisable controller with 4 selectable control loops
- [8] 3-channel line recorder
- [9] GUNT process control software via Profibus DP interface under Windows 7

**Technical Data**
**Tanks**

- graduated tank: approx. 6L
- collecting tank: approx. 90L

**6-stage centrifugal pump**

- max. flow rate: approx. 55L/min
- max. head: approx. 60m

**Heating circuit pump**

- max. flow rate: approx. 50L/min
- max. head: approx. 3,5m

**Heater power output: approx. 2kW**
**Controller parameterisable as**

- P, PI or PID controller
- switching controller

**Sensor measuring ranges**

- level: 0...700mm
- flow rate: 0...4000L/h
- pressure: 0...6bar
- temperature: 0...200°C

**Dimensions and Weight**

LxWxH: 2260x800x1990mm

Weight: approx. 250kg

**Required for Operation**

230V, 50/60Hz, 1 phase or 230V, 60Hz/CSA, 3 phase compressed air: 3...8bar; 25...50L/min

**Scope of Delivery**

- 1 trainer
- 1 set of cables
- 1 set of hoses
- 1 Profibus card
- 1 GUNT software CD
- 1 set of instructional material

**Order Details**

080.57800 RT 578 Control of 4 Variables from Process Engineering

RT 580

## Fault Finding in Control Systems



- \* Practical control of level, flow rate and temperature
- \* Simulation of typical faults
- \* PLC to monitor safety devices
- \* Refrigeration system for independent cold supply

## Technical Description

The RT 580 facilitates practical learning in the control of three controlled variables which are commonplace in process engineering.

A circuit with a collecting tank, pump and graduated tank is provided for control of level and flow rate. A pneumatic control valve is used as the actuator. There is a valve in the tank outlet to generate a disturbance variable in level control. Cascade control is possible whereby the level in the tank is controlled by way of the flow rate.

Two circuits are used in the control of the temperature. A refrigeration system cools the water in the collecting tank. A pump circulates the water via a heat exchanger (cooling circuit). A heater heats the water in the graduated tank. Another pump also circulates the warm water via the heat exchanger. In the heat exchanger the water in the cooling circuit is heated. The controlled variable is the temperature of the water in the cooling circuit after heating in the heat exchanger. The actuator is the pneumatic control valve which adjusts the flow rate of the warm water. Cascade control is also possible to control the temperature.

Two industrial controllers are supplied which can be employed as the master and slave in the implementation of cascade control. They have a Profibus DP interface. This enables the trainer to be controlled by way of a software. The software also permits recording of the process variables and parameterisation of the controllers on the PC.

The trainer is equipped with a PLC for monitoring of safety devices, such as a low water cut-off which protects the heater. On the switch cabinet there are also pushbuttons for the simulation of typical faults

such as failure of sensors or cable breaks.

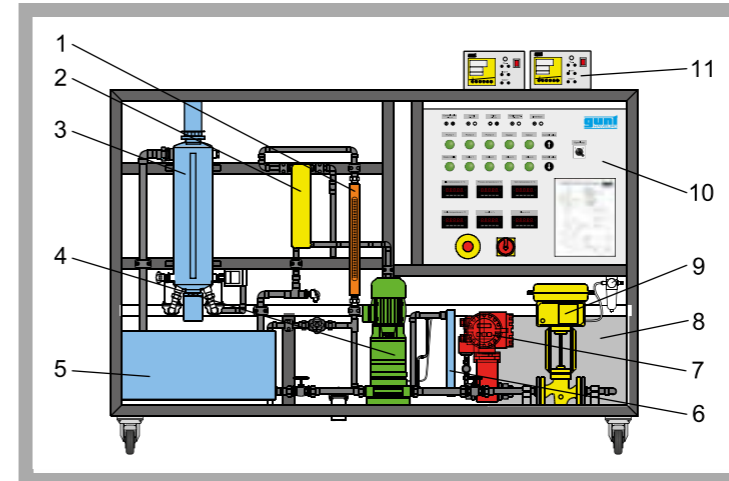
The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

## Learning Objectives / Experiments

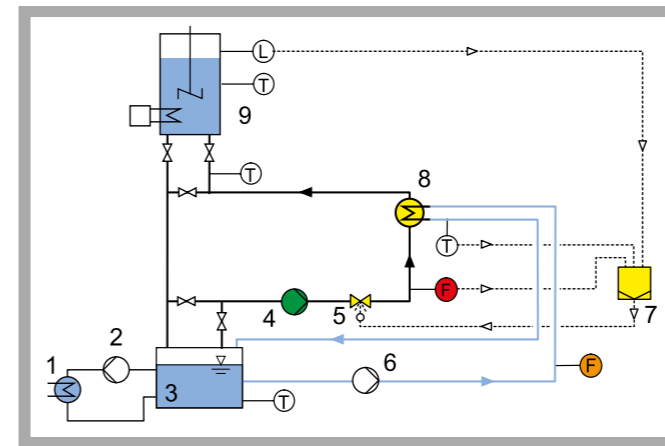
- familiarisation with industrial control loop components
- setup, parameterisation and configuration on the controller
- optimisation of controller settings
- level control
- flow rate control
- temperature control
- cascade control, level - flow rate
- cascade control, temperature - flow rate
- plotting step responses
- fault finding

RT 580

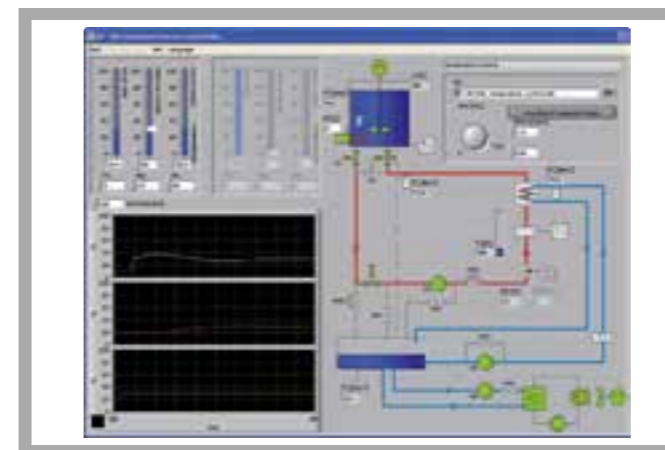
## Fault Finding in Control Systems



1 flow meter, 2 heat exchanger, 3 stirred tank with heater, 4 main circuit pump, 5 collecting tank, 6 refrigeration system evaporator, 7 flow rate sensor, 8 refrigeration system, 9 control valve, 10 switch cabinet, 11 controller



1 refrigeration system evaporator, 2 refrigeration system pump, 3 collecting tank, 4 main circuit pump, 5 control valve, 6 cooling circuit pump, 7 controller, 8 heat exchanger, 9 stirred tank with heater; F flow rate, L level, T temperature



Process control software screenshot

## Specification

- [1] control of level, flow rate, temperature and cascade control
- [2] main circuit with collecting tank, graduated stirred tank with heater, pneumatic control valve and centrifugal pump
- [3] cooling circuit with pump, heat exchanger and rotameter
- [4] refrigeration system and pump to cool the water in the collecting tank
- [5] pneumatic control valve in main circuit as actuator for all controls
- [6] sensors for the measurement of the controlled variables; level, flow rate and temperature
- [7] 2 parameterisable industrial controllers
- [8] 6 pushbuttons for fault simulation
- [9] PLC to monitor safety devices
- [10] GUNT process control software via Profibus DP interface under Windows Vista or Windows 7

## Technical Data

## Tanks

- stirred tank with scale: approx. 7L
- collecting tank: approx. 90L

## Main circuit centrifugal pump

- max. flow rate: approx. 75L/min
- max. head: approx. 20m

## 2 pumps, cooling circuit and refrigeration system

- max. flow rate: approx. 60L/min
- max. head: approx. 4m
- Heater power output: approx. 2kW
- Controller parameterisable as
- P, PI or PID controller

## Measuring ranges

- level: 0...350mm
- flow rate: 0...1999L/h
- temperature: 0...100°C

## Dimensions and Weight

LxWxH: 1920x800x1530mm

Weight: approx. 245kg

## Required for Operation

230V, 50/60Hz, 1 phase or 230V, 60Hz, 3 phases  
compressed air: 3...8bar; 25...50L/min

## Scope of Delivery

- 1 trainer
- 2 controllers
- 1 set of cables
- 1 Profibus card
- 1 CD with PLC programming software
- 1 GUNT software CD
- 1 set of instructional material

## Order Details

080.58000 RT 580 Fault Finding in Control Systems

## RT 590 590 PROCESS CONTROL ENGINEERING EXPERIMENTATION PLANT

Complex process engineering systems are often operated and controlled from a central control station, where system status information is collated. This makes it easy to make decisions and initiate appropriate measures on-site. The consolidated, centralised supply of multiple processes with media such as cooling water, steam, compressed air and electric power is also typical of industrial process

engineering plants. Such consolidated supply delivers the advantage of cost and energy savings. RT 590 enables students to familiarise themselves with the required supplies to various processes as well as the centralised monitoring and control of these processes. The operating environment is very similar to those they will encounter in practice.

### THE TRAINER

Learning of many control tasks in process engineering can be facilitated with the trainer:

- Flow rate control
- Level control with and without counter pressure
- Level control with a second-order controlled system
- Cascade control of level and flow rate
- Pressure control with time-varying response of the controlled system
- Temperature control with time-varying response of the controlled system



### THE CONTROL STATION



- 4 parameterisable controllers with Profibus interface for connection to a PC
- 4 3-channel line recorders
- Process control software
  - ▶ trainer monitoring
  - ▶ selection of controlled system with display of process schematic
  - ▶ plotting of time charts
- Fault simulation, e.g. sensor failure or cable break

### THE SUPPLY UNIT

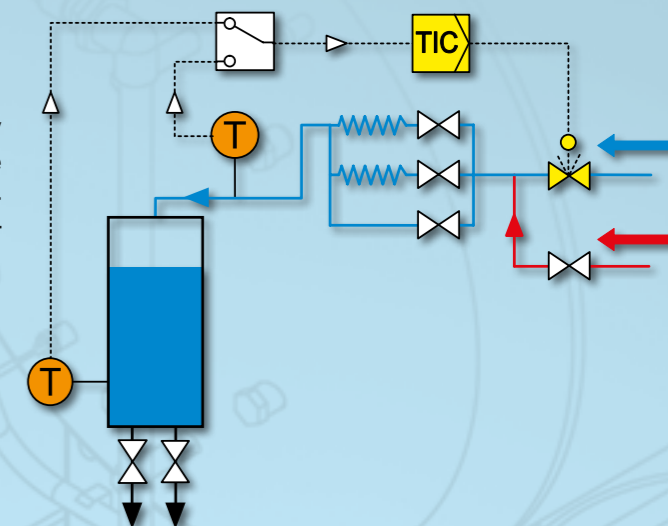
- Industrial compressor with pressure accumulator for supply of
  - ▶ compressed air for experiments
  - ▶ compressed air as auxiliary power for control valves
- Pump for water supply
- Heater for warm water supply for temperature control



### EXAMPLES OF SELECTABLE CONTROLLED SYSTEMS

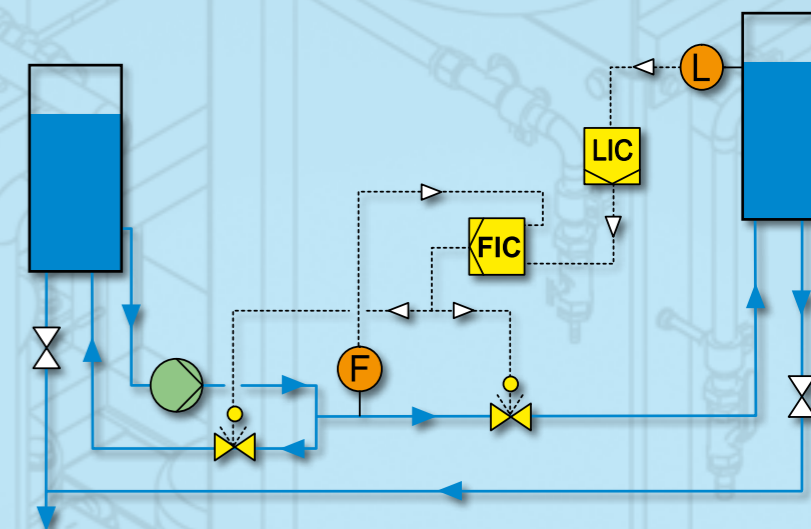
#### Temperature control

Warm water flows from the supply unit into the collecting tank. The temperature is altered by adding cold water by way of a control valve. Two different sensors are available for the measurement of the controlled variable. This enables the temperature to be controlled either in the collecting tank inlet or directly in the collecting tank. Three delay sections are included of differing lengths, these permit the setting of differing dead times.



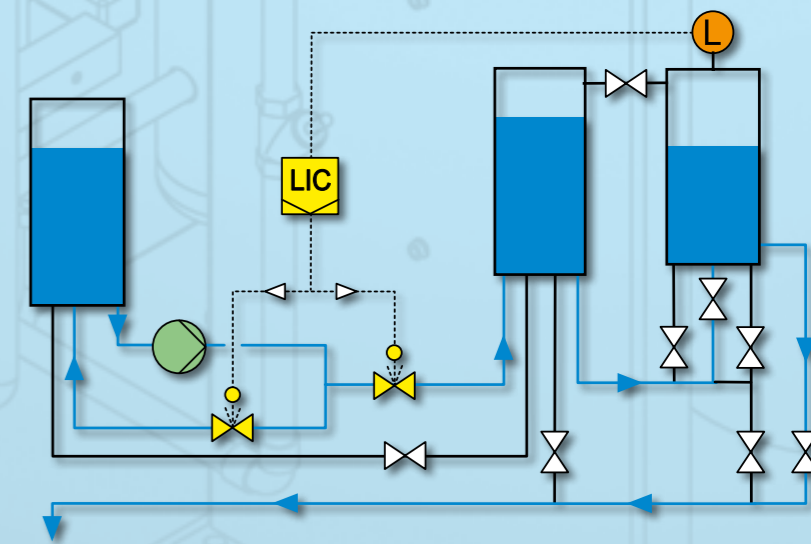
#### Cascade control level / flow rate

The level in the tank is controlled by way of the flow rate. The master controller (LIC) receives the actual level signal and the reference variable signal as inputs. The output signal from this controller and the actual flow rate signal are the input signals to the slave controller (FIC). This controller varies the flow rate by way of two opposite-acting control valves.



#### Level control with a second-order controlled system

Two series-configured tanks form the second-order controlled system. The level in the rear tank is measured and controlled by two opposite-acting control valves which vary the flow rate. The response over time of the controlled system is varied by way of valves.



## RT 590

## Process Control Engineering Experimentation Plant



From left: supply unit, trainer and control station

- \* Complete industrial-scale process engineering experimentation plant
- \* Control of level, flow rate, pressure, temperature and cascade control
- \* Simulation of typical faults

## Technical Description

The supply of processes with media such as water and compressed air in industry is usually provided from a separate, centralised supply unit. Control and monitoring of the processes are also centralised from a control station. RT 590 enables familiarisation with a practical scenario of this nature.

The trainer includes a water circuit with a pump, collecting tank and graduated tank. In this circuit, the flow rate and level are controlled by way of pneumatic control valves. The level control can also be executed under counter pressure or as cascade control. An additional tank can be connected to facilitate learning with a second-order level controlled system.

Compressed air is used in the control of pressure. The level of liquid in the tank can be varied to give time-varying response of the controlled system.

The temperature control takes place in the collecting tank. Warm water flows into the tank. Cold water is mixed in using a control valve, thereby regulating the temperature in the tank. Three delay sections are used to set different dead times.

The separate control station includes the controllers and line recorders for monitoring and control of the control processes. The controllers have a Profibus DP interface. This enables the trainer to be controlled by using a process control software. The software also permits recording of the

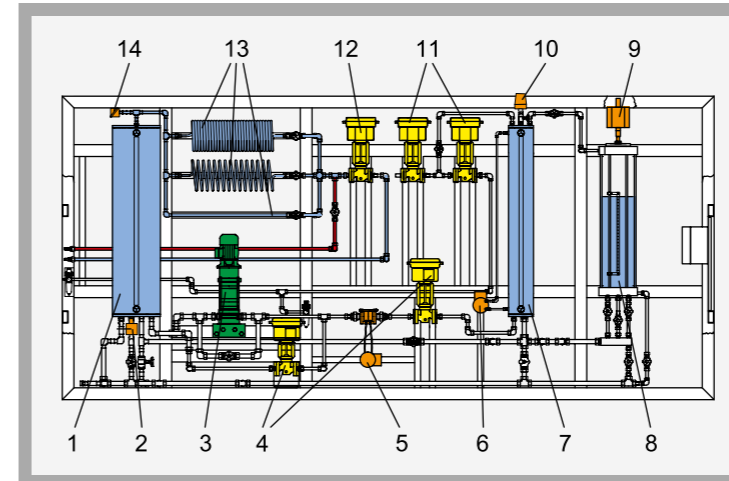
process variables and parameterisation of the controllers using the PC. Pushbuttons on the control station are used to simulate typical faults such as failure of sensors or cable breaks. The separate supply unit supplies compressed air and warm and cold water.

## Learning Objectives / Experiments

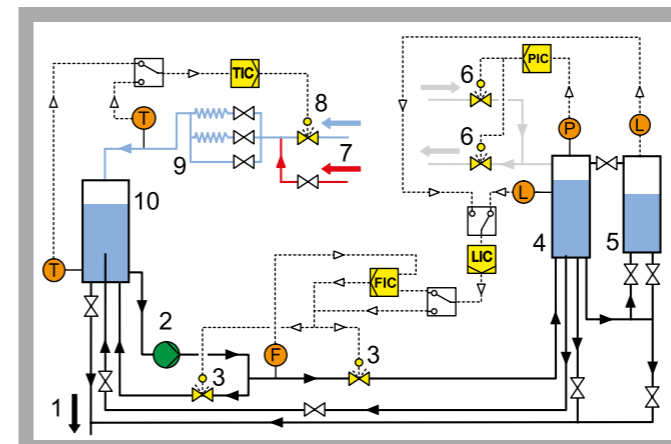
- familiarisation with industrial process engineering plant
- flow rate control
- level control with and without counter pressure
- level control with second-order controlled system
- cascade control of level and flow rate
- pressure control with time-varying response of the controlled system
- temperature control with time-varying response of the controlled system
- fault finding

## RT 590

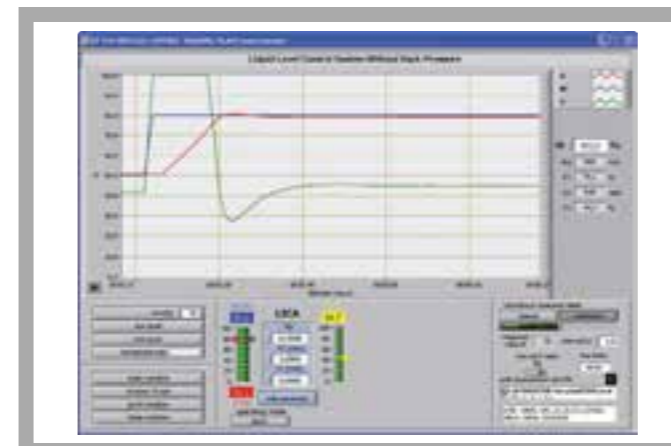
## Process Control Engineering Experimentation Plant



1 collecting tank, 2 temperature sensor in collecting tank, 3 pump, 4 flow control valves, 5 flow rate sensor, 6 level sensor, 7 tank for level and pressure control, 8 tank for second-order system, 9 level sensor, 10 pressure sensor, 11 compressed air control valve, 12 cold water control valve, 13 delay section, 14 temperature sensor in inlet



1 outlet, 2 pump, 3 flow control valve, 4 tank for level and pressure control, 5 tank for second-order system, 6 compressed air control valve, 7 warm water inlet, 8 cold water control valve, 9 delay sections, 10 collecting tank



Software screenshot

## Specification

- [1] control of level, flow rate, pressure, temperature and cascade control
- [2] trainer with pump, collecting tank and two tanks for level and pressure control
- [3] supply unit with compressor, pressure vessel, pump and heater
- [4] control station with four industrial controllers, 4 3-channel line recorders and fault simulation
- [5] level control with or without counter pressure, or second order system analysis
- [6] temperature control with three delay sections
- [7] pressure control via compressed air
- [8] control of level, flow rate and temperature with water
- [9] 5 pneumatic control valves as actuators
- [10] GUNT process control software via Profibus DP interface under Windows Vista or Windows 7

## Technical Data

## Tanks

- collecting tank: 100L
- level / pressure: 25L
- level, 2<sup>nd</sup> order: 25L

## Pump

- max. flow rate: approx. 55L/min
- max. head: approx. 60m

## Compressor

- max. pressure: 10bar
- pressure vessel: 270L

Heater power output: 18kW

Controller parameterisable: P, PI or PID controller

## Measuring ranges

- flow rate: 0...40L/min
- level: 1x 0...1.2m; 1x 0...0.5m
- temperature: 1x 0...200°C; 1x 0...100°C
- pressure: 0...6bar

## Dimensions and Weight

Trainer: LxWxH: 4400x600x2100mm

Supply unit: LxWxH: 2400x730x1620mm

Control station: LxWxH: 1350x750x1350mm

Weight: approx. 1500kg (complete system)

## Required for Operation

400V, 50/60Hz, 3 phase or 230V, 60Hz, 3 phase  
Cold water connection: 30L/min

## Scope of Delivery

- 1 trainer
- 1 supply unit
- 1 control station
- 1 set of cables
- 1 set of hoses
- 1 Profibus card
- 1 GUNT software CD
- 1 set of instructional material

## Order Details

080.59000 RT 590 Process Control Engineering Experimentation Plant