RT 681 *Multivariable Control: Vacuum Degassing*

*** Practical multivariable control of level and pressure in a vacuum tank**

*** Model of "degassing of fluids" application from process engineering**

*** 2 configurable industrial controllers**

*** Optional process control software RT 650.60 available**

Technical Description

With RT 681 the complexities of a multivariable control system can be learned in a practical manner. The model for the controlled process is a typical application from process engineering: separation of gas dissolved in liquid. The pressure falls below the vapour pressure of the dissolved gas in a vacuum tank, so that it passes into the gas phase and can be removed (desorption).

The liquid used in RT 681 is water, and the gas is ambient air. A water jet pump generates the negative pressure in the vacuum tank. The negative pressure firstly draws water from a collecting tank into the vacuum tank. Secondly, ambient air is drawn in and mixed with the water before entering the vacuum tank. The water/air mixing ratio can be adjusted by way of rotameters and valves. The negative pressure in the vacuum tank degasses the water again. A pump transports the water out of the vacuum tank back into the collecting tank. A control valve is used to influence the flow rate and thus the level in the vacuum tank. Another pump circulates water from the collecting tank to operate the water jet pump. A control valve adjusts the flow rate in this circuit. In this way the negative pressure in the vacuum tank is adjusted. The negative pressure and level are mutually dependent variables. It is this dependence that makes this multivariable control system so complex.

Two industrial controllers are provided as level and pressure controllers. They can be configured and parameterised using a supplied software. The controllers have a Profibus DP interface. The interface permits monitoring of the trainer via an optionally available software RT 650.60. The RT 650.60 software also permits recording of the process variables and parameterisation of the controllers using the PC. It is also possible to interconnect multiple trainers from this series through the Profibus DP interface.

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

Learning Objectives / Experiments

- coupled level and pressure control
- level control with various controller types
- pressure control with various controller types
- plotting step responses

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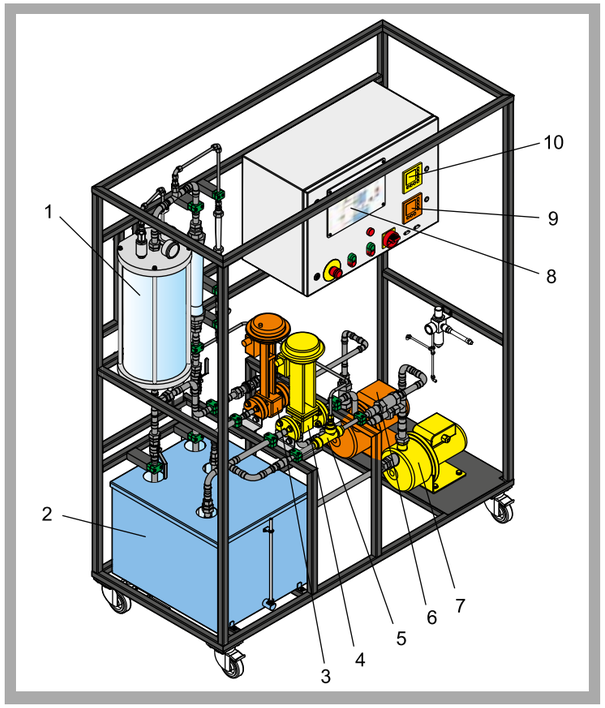
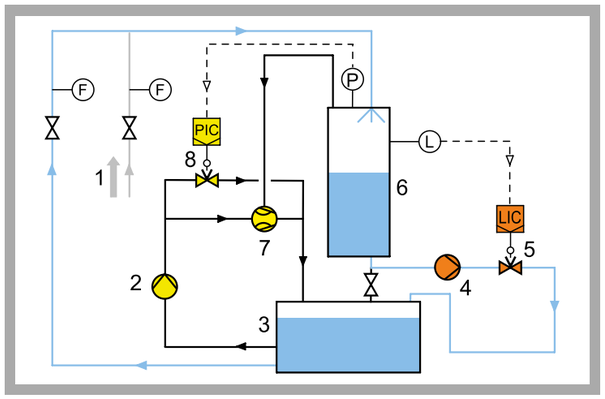
RT 681 *Multivariable Control: Vacuum Degassing*



1 vacuum tank, 2 collecting tank, 3 level control valve, 4 pressure control valve, 5 water jet pump, 6 pump (vacuum tank), 7 pump for operation of water jet pump, 8 process schematic, 9 level controller, 10 pressure controller



1 ambient air, 2 pump for operation of water jet pump, 3 collecting tank, 4 pump (vacuum tank), 5 level control valve, 6 vacuum tank, 7 water jet pump, 8 pressure control valve;
F flow rate, P pressure, L level, PIC controller (pressure), LIC controller (level)

Specification

[1] coupled level and pressure control in one vacuum tank
[2] water circuit with vacuum tank, collecting tank, pump and ambient air input device
[3] water jet pump to generate a negative pressure in the vacuum tank
[4] circuit with pump for operation of the water jet pump
[5] level control with pneumatic control valve as actuator
[6] pressure control with pneumatic control valve in the circuit for operation of the water jet pump
[7] level controller and pressure controller configurable and parameterisable with software
[8] optional process control software RT 650.60 via Profibus DP interface

Technical Data

Tanks
- vacuum tank: 19L
- collecting tank: 100L

2 centrifugal pumps
- max. flow rate: approx. 50L/min
- max. head: approx. 30m

Water jet pump: final vacuum: approx. 0,3bar
Pressure and level controller parameterisable as
- P, PI or PID controller
- switching controller

Measuring ranges
- pressure: -1...0,6bar
- level: 30...480mm
- flow rate: 1x 200...2500L/h, 1x 0...360L/h

Dimensions and Weight

LxWxH: 1150x700x1970mm
Weight: approx. 115kg

Required for Operation

230V, 50/60Hz, 1 phase or 120V, 60Hz, 1 phase
Compressed air connection for control valve: 2...10bar

Scope of Delivery

1 trainer
1 cable
1 hose
1 CD with software for parameterisation and configuration of the controllers
1 set of instructional material

Order Details

080.68100 RT 681 Multivariable Control: Vacuum Degassing

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RT 682 Multivariable Control: Stirred Tank

* **Practical multivariable control of temperature and level in a stirred tank**
* **Typical application from process engineering with heat recovery**
* **2 configurable industrial controllers**
* **Optional process control software RT 650.60 available**

Technical Description

With RT 682 the complexities of a multivariable control system can be learned in a practical manner. The model for the controlled process is a typical application from process engineering: A chemical reaction taking place in a heated stirred tank. The reactants entering the stirred tank are pre-heated by the outflowing products in order to enhance energy efficiency.

Water is used as the product and reactant for RT 682. A pump transports the reactant out of a collecting tank via a heat exchanger into the stirred tank. The reactant is pre-heated by the heat exchanger. A heater in the double jacket permits control of the temperature in the stirred tank. Another pump transports the heated product out of the stirred tank via the heat exchanger back into the collecting tank. A bypass in the inlet routes the flow past the heat exchanger. A three-way motorised valve adjusts the ratio between the flow heated in the heat exchanger and the flow in the bypass. This is a further method of controlling the temperature in the stirred tank. A control valve changes the flow rate in the outlet and thus the level in the stirred tank. The temperature and level are mutually dependent variables. It is this dependence that makes this multivariable control system so complex.

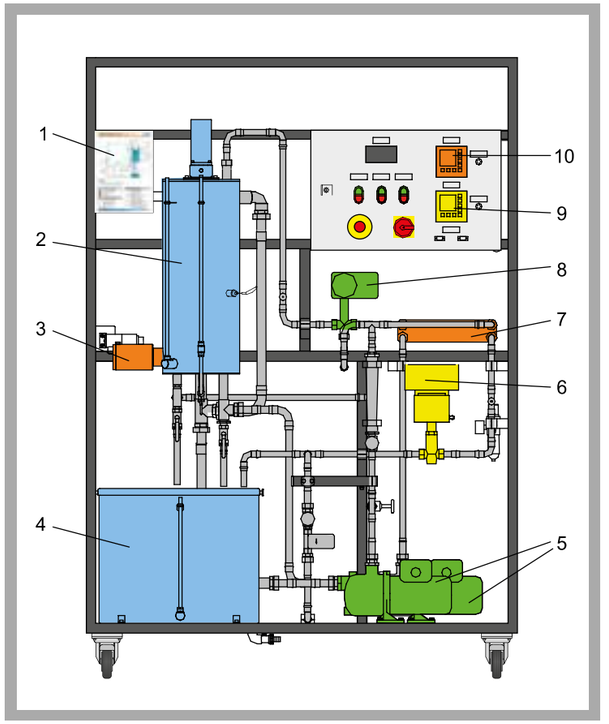
Two industrial controllers are provided as temperature and level controllers. They can be configured and parameterised using a supplied software. The controllers have a Profibus DP interface. The interface permits monitoring of the trainer via an optionally available software RT 650.60. The RT 650.60 software also permits recording of the process variables and parameterisation of the controllers using the PC. It is also possible to interconnect multiple trainers from this series through the Profibus DP interface.

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

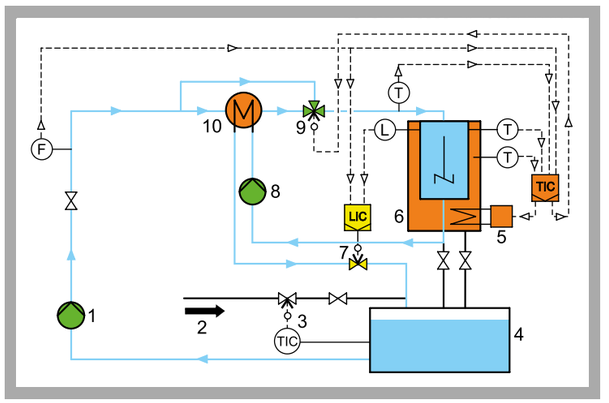
Learning Objectives / Experiments

- coupled level and temperature control
- level control with
  * PI controller
  * disturbance feedforward control
- temperature control
  * with two-point controller
  * with three-point controller (split range)
  * with override control
  * via motorised valve with position feedback
- plotting step responses

RT 682 Multivariable Control: Stirred Tank



1 process schematic, 2 stirred tank, 3 heater, 4 collecting tank, 5 pumps, 6 level control valve, 7 heat exchanger, 8 3-way motorised valve, 9 level controller, 10 temperature controller



1 main circuit pump, 2 external cooling water, 3 collecting tank temperature control, 4 collecting tank, 5 heater, 6 stirred tank, 7 level control valve, 8 pre-heating pump, 9 3-way motorised valve, 10 heat exchanger; F flow rate, T temperature, L level, LIC controller (level), TIC controller (temperature)

Specification

[1] coupled level and temperature control in one stirred tank
[2] circuit with stirred tank, collecting tank and pump
[3] heat recovery with heat exchanger
[4] stirred tank with double jacket and heater; level display for tank and jacket
[5] temperature control with heater and 3-way motorised valve as actuators
[6] level control with pneumatic control valve as actuator
[7] temperature controller and level controller configurable and parameterisable with software
[8] 2-point controller for constant temperature in collecting tank via external cooling water
[9] optional process control software RT 650.60 via Profibus DP interface

Technical Data

Tanks
- stirred tank: 15L
- collecting tank: 70L

2 pumps
- max. flow rate: approx. 60L/min
- max. head: approx. 20m

Heat exchanger transfer surface: approx. 0,8m²
Heater power output: approx. 2kW
Temperature and level controller parameterisable as
- P, PI or PID controller
- switching controller

Measuring ranges
- flow rate: 60...640L/h
- temperature: 0...100°C
- level: 0...1000mm
- 3-way motorised valve opening: 0...100%

Dimensions and Weight

LxWxH: 1360x610x1940mm
Weight: approx. 162kg

Required for Operation

230V, 50Hz, 1 phase
Water connection: min. 60L/h
Compressed air connection for control valve: 2...10bar

Scope of Delivery

1 trainer
1 set of cables
1 set of hoses
1 CD with software for parameterisation and configuration of the controllers
1 set of instructional material

Order Details

080.68200	RT 682	Multivariable Control: Stirred Tank

2E a division of G.U.N.T Gerätebau GmbH, P.O.Box 1125, D-22885 Barsbüttel, t +49 (40)67 08 54-0, f +49 (40)67 08 54-42, E-mail sales@gunt.de
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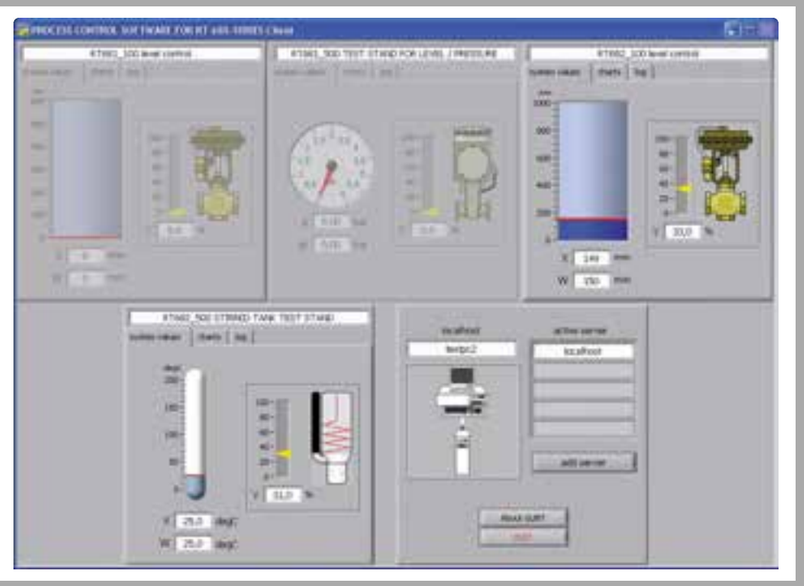
RT 650.60 Process Control Software for RT 681 and RT 682



*** Process control software for Profibus DP connection**

*** Control station function provides for simultaneous operation of both trainers**

*** Automatic operation with programmer possible**

*** Alarm function with four limit values for triggering an alarm or message**

Technical Description

The RT 650.60 process control software (SCADA) was developed specifically for the RT 681 and the RT 682. It is possible to connect both trainers simultaneously. The software and the trainers communicate via Profibus DP modules. Changes to the software are transmitted to the controller of the relevant trainer.

The process is represented in the "Process schematic" window. The reference variable, controlled variable and manipulating variable are displayed in real time. Status displays for the alarms are also included.

The "Charts" menu item offers features including controller mode selection, parameterisation, setting of the reference variable and limit values for the alarm function, as well as display of the controlled and manipulating variables. The reference variable characteristic is specified in the programmer. A total of three programs are available, each with 15 segments, which are saved together with custom controller parameters. The messages are divided into alarms (status indicators, over/under limit) and information (status monitoring, approaching the limit). The message status is colour-coded. The control station function permits simultaneous monitoring and (if required) access to both connected trainers.

Learning Objectives / Experiments

- familiarisation with and use of a process control system

stand-alone with a single trainer
- process schematics with online display of all process variables
- alarm function with logging
- parameterisation of the single controllers
- manual or automatic controller mode
- mode of operation of a programmer
- network mode with Server/Client

additionally with combination of both trainers on a PC
- control station function

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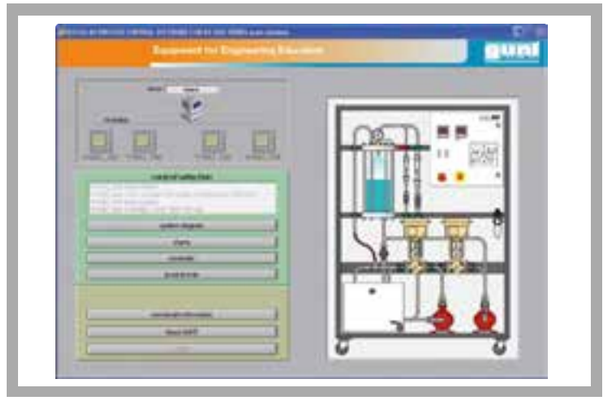
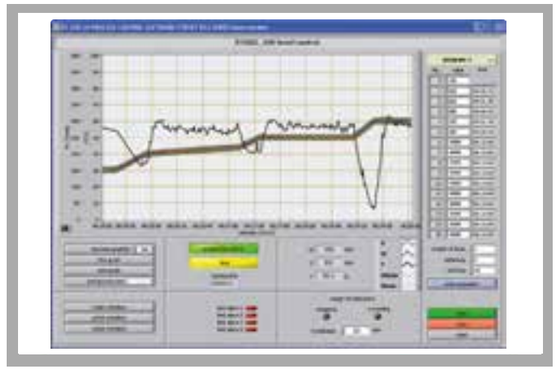
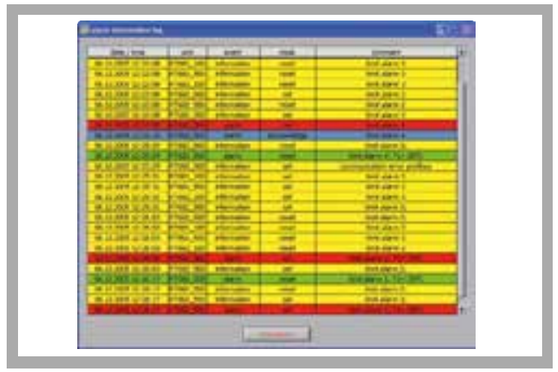
RT 650.60 Process Control Software for RT 681 and RT 682



Menu for selection of trainer, controller and user interface



Programmer for input of a reference variable characteristic



Alarm log

Specification

[1] interactive, menu-driven process control software (SCADA) for operation and monitoring of control processes
[2] control station function for simultaneous operation of both trainers
[3] process schematic with real-time data display
[4] recorder function with data saving
[5] operation and parameterisation of hardware controllers
[6] automatic operation with programmer (input of reference variable characteristics)
[7] alarm function with logging
[8] data communication via Profibus DP
[9] use together with Profibus card RT 650.12; one Profibus DP card RT 650.12 per PC workstation required

Technical Data

Recorder function with data saving
- plotting and saving of time charts
- evaluation of step responses

Programmer
- up to 3 programs with 15 values in each
- custom controller parameters for each program
- setting of a tolerance band

Alarm function with 4 programmable values
- upper and lower alarm limit
- upper and lower message limit
- comments about alarms/messages can be entered

Language selection
- 4 pre-selectable languages
- 1 user-defined language possible

Software basis: LabVIEW

System requirements
- Windows Vista or Windows 7
- PCI slot

Scope of Delivery

1 GUNT software CD
1 set of instructional material

Order Details

080.65060	RT 650.60	Process Control Software for RT 681 and RT 682

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