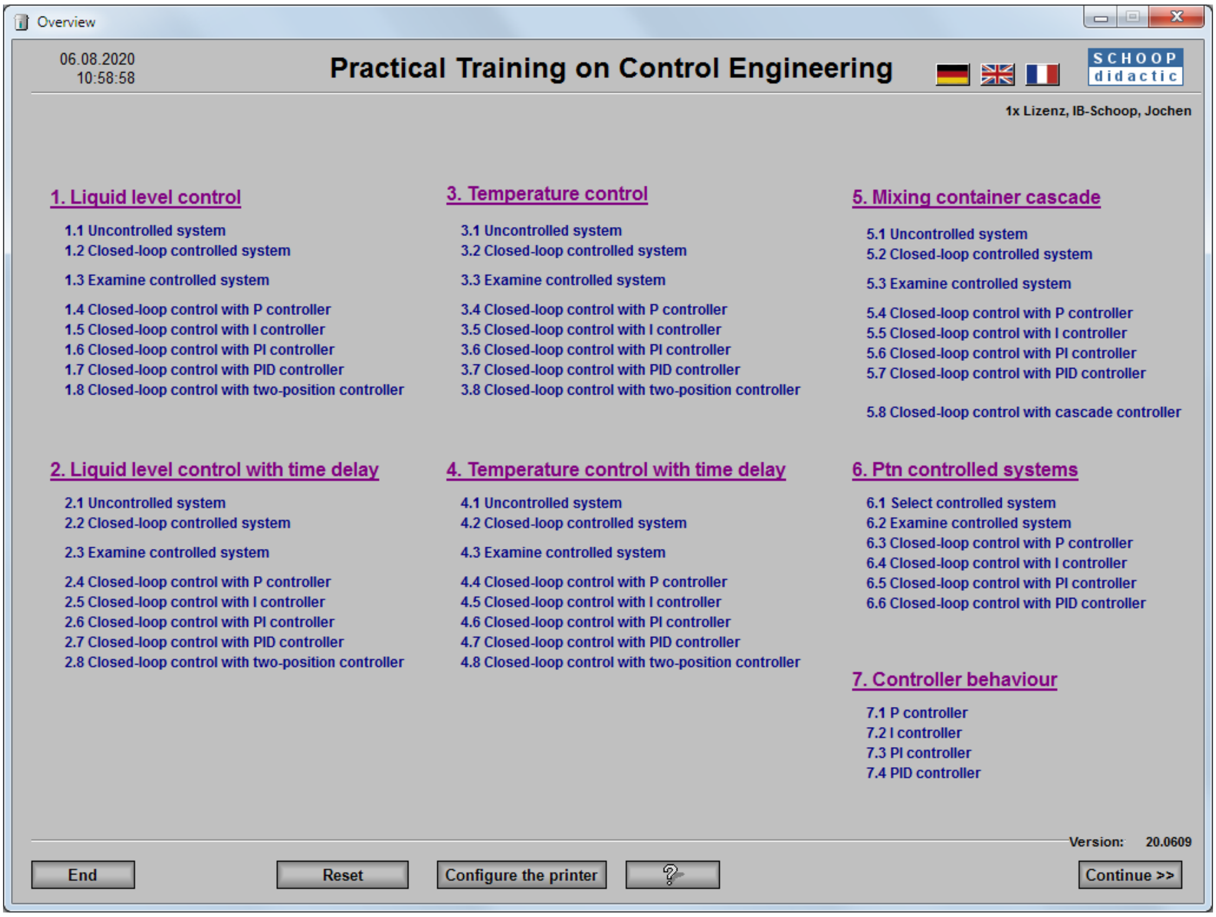
HELP Control Training I

Overview

This program is a simulation application for the process control and simulation system WinErs, which can be used to practice and analyze the field of control engineering in vocational training.



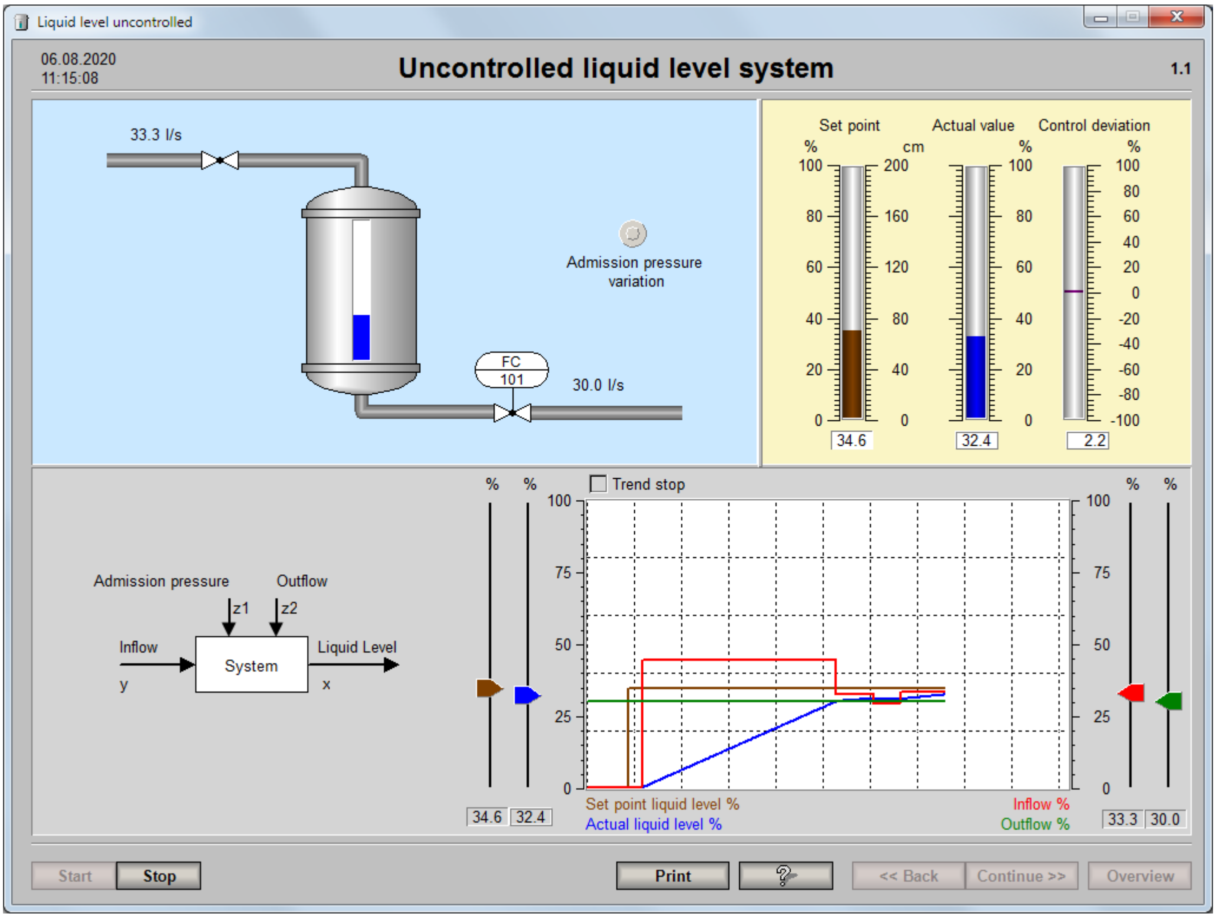
The overview contains a list of different process pages, on which you can conduct various exercises and analyzes. To reach the pages, click on the blue texts. You may also run through the individual pages by clicking on the "Continue >>" button. Exit the program by clicking on the "End" button.

Furthermore, the practical course on control engineering has been designed, so that you can study the performance of the individual standard controllers P, I , PI and the PID controller by applying input jumps under item 1. Items 1 - 6 contain various processes or controlled systems, which can be used to examine the performance of controlled systems and control loops with different controllers. Apart from monitoring the process signals in the trend diagram, the signal curves are recorded, so that the performance of controlled systems, controllers and control loops can later be analyzed and measured. For individual controlled systems, you can examine the response to setpoint changes and interference with the standard controllers P, I, PI, the PID controller and two-position controllers as well as a cascade control. The controller parameters are variable, so that the control loop response can be individually optimized.

The liquid level and the temperature control with delay also allows you to easily determine the setting rules according to Ziegler / Nichols. Furthermore, the r.m.s. system deviation is issued for every control loop, and for the processes demonstrated in items 1 - 5, manual / automatic control can be selected. All the signal curves are recorded, so that they can later be analyzed and measured.

1 Liquid Level Control

1.1 Uncontrolled System

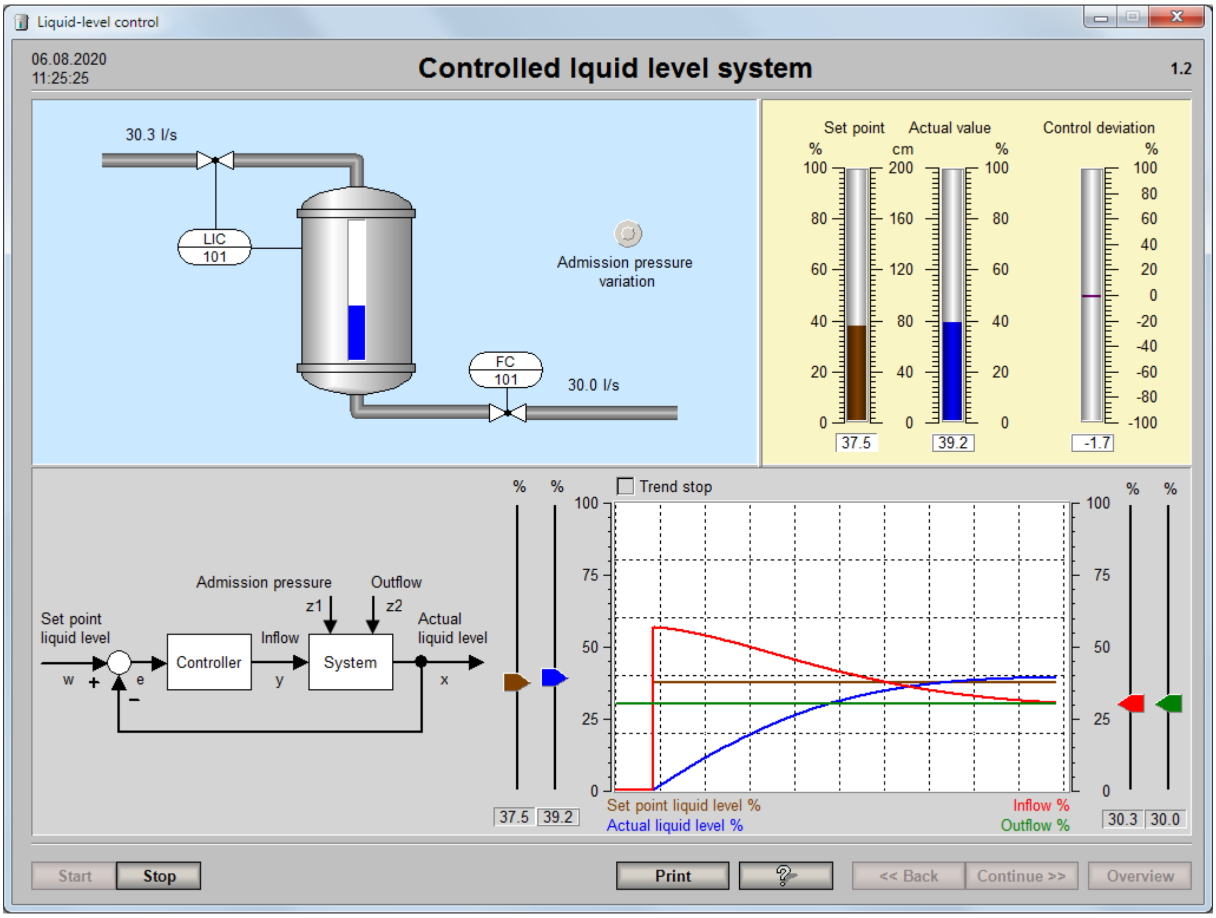


A container with inlet and outlet will be simulated as a controlled system. The size of the inlet or outlet can be adjusted with valves (by adjusting the shift buttons). The exercise on control engineering is to control the liquid level by changing the inlet, so that the level corresponds to a certain setpoint value. Therefore, the inlet constitutes the input variable, and the liquid level the output variable of the system. The outlet and varying admission pressure values for the inlet act as disturbances.

Start the process simulation by clicking on the "Start" button. A defined initial state is automatically set. Try to manually correct the actual level to the setpoint level by changing the inlet or outlet with the shift button, the up/down counters or by entering numeric values. Clicking on the "Admission pressure variation" button causes an interference of the outlet, which is to be controlled.

Terminate the simulation by clicking on the "Stop" button. Click on the "Continue >>" or "<< Back" button to get to other process images.

1.2 Closed-Loop Control System



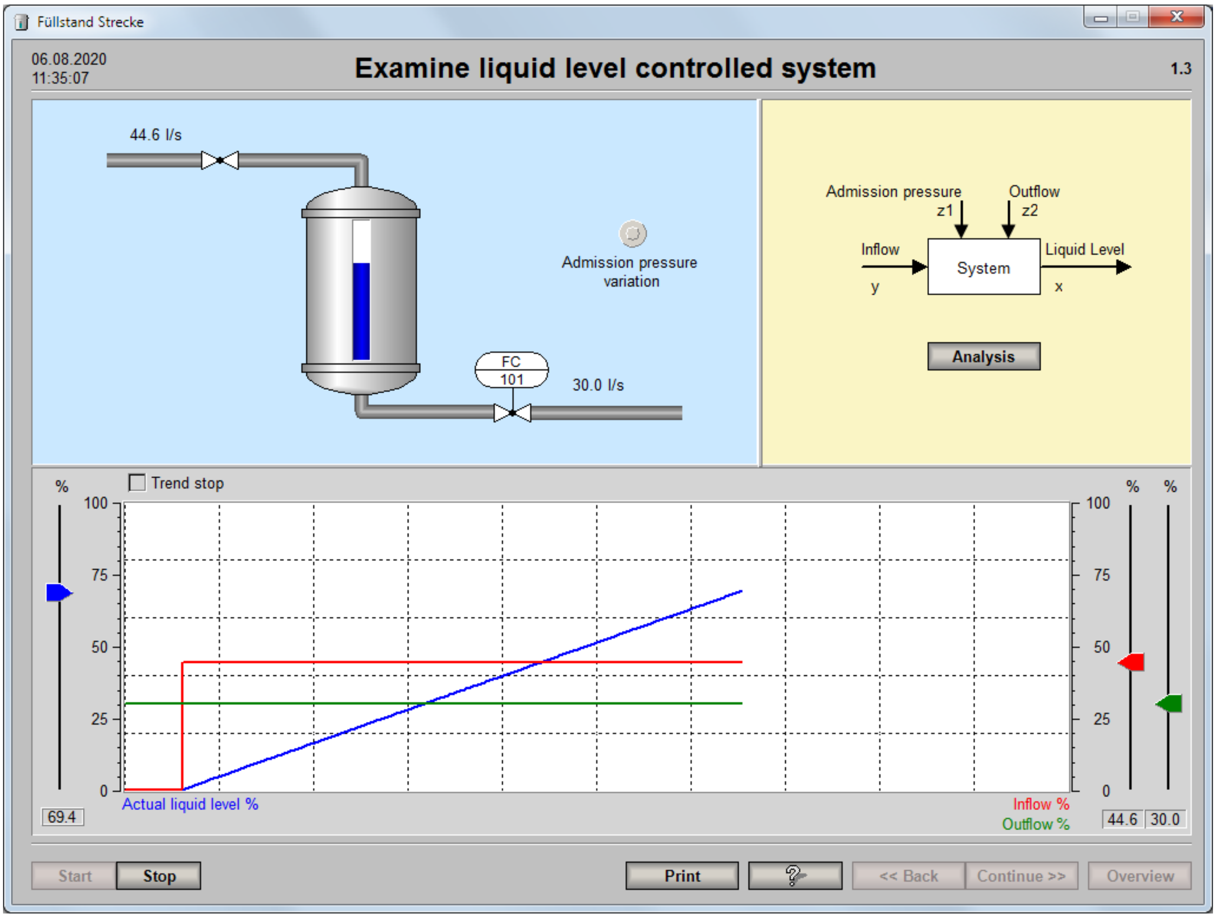
Contrary to the last page *Uncontrolled System*, the closed-loop control process for the liquid level is not actuated manually, but with a PI controller.

Start the process simulation by clicking on the "Start" button. Defined initial states are set automatically. A PI controller starts to reach the setpoint value by regulating the inlet.

You may change the setpoint and the outlet via the respective shift buttons, the up/down counters or by entering values below the up/down counters. Clicking on the "Admission pressure variation" button causes interference to the outlet.

Terminate the simulation by clicking on the "Stop" button. Click on the "Continue >>" or "<< Back" button to get to other process images.

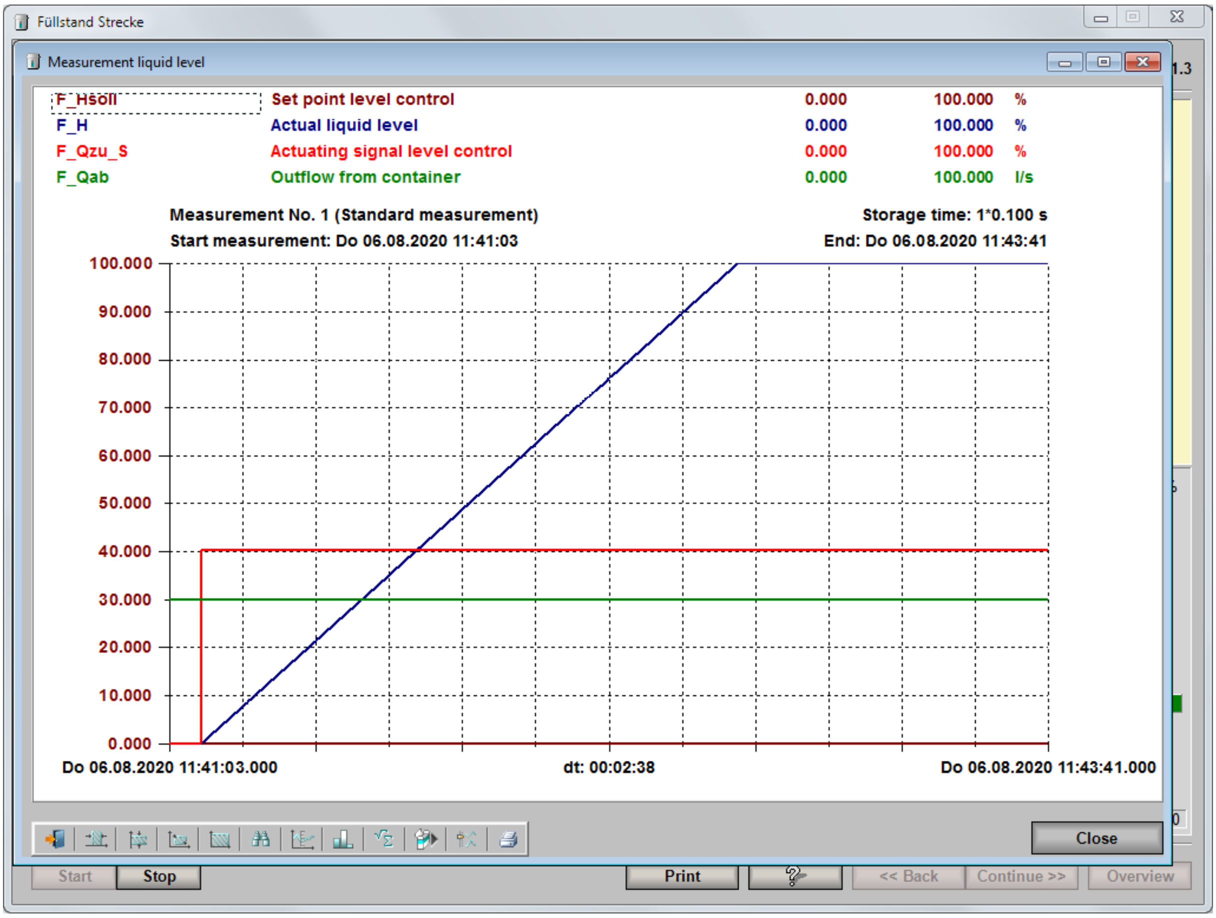
1.3 Examine Controlled System



Here you can study the response of the controlled system when the inlet and the outlet change.

Start the simulation by clicking on the "Start" button. The inlet and the outlet can be changed with the shift button or the display fields below the shift button or below the bar diagram. It is also possible to change the setpoint variable "inlet" in jumps by clicking on the "Admission pressure variation" button.

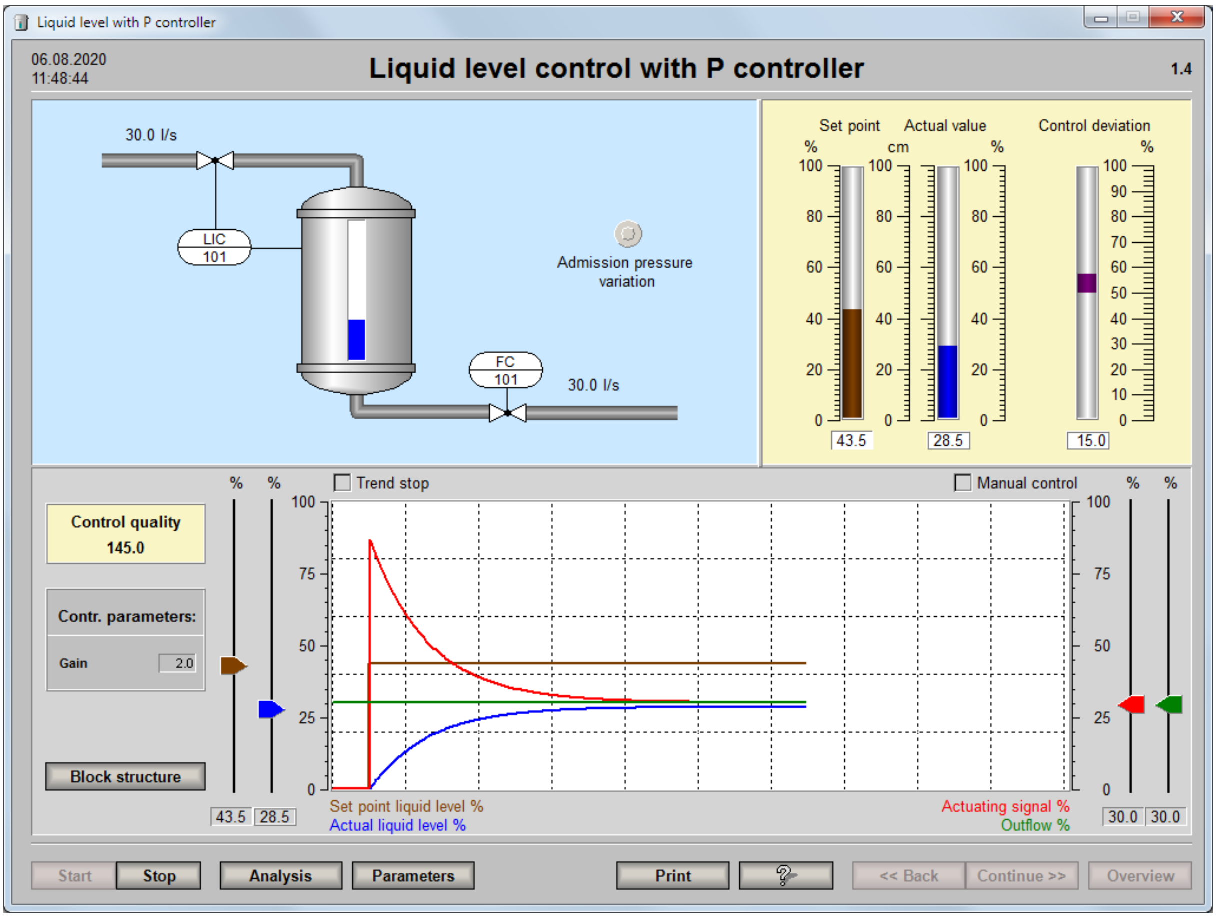
The actual values for the liquid level, the inlet and the outlet are graphically indicated in a diagram. The signal values are automatically stored, so that they can later be analyzed in a timing diagram, e.g. to determine the time constant for the controlled system.



When clicking on "Analysis", the stored measured values are indicated in a timing diagram. Here you have various methods of analysis. By clicking on the signal names, the Y scale is changed over. By clicking on the signal curves, the value of the active signal will be indicated and by holding and dragging the difference in value and time will be displayed. When you click on the buttons below, various analysis methods will be available, such as zoom, change time view, change value range, ruler function, methods to export the signal values into a text file, statistic analyzing methods.

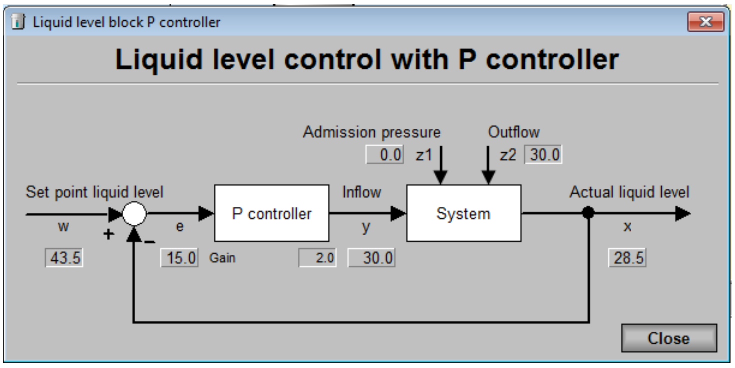
Terminate the simulation by clicking on the "Stop" button. The defined initial states are reset and you may get to other process images by clicking on the buttons "Continue >>", "<< Back" and "Overview".

1.4 Closed-Loop Control with P Controller



Here you can study the performance of the control loop when the setpoint and the disturbance change. For this purpose, a P controller is used.

The block structure of the control loop can be viewed by clicking on the "Block structure" button.

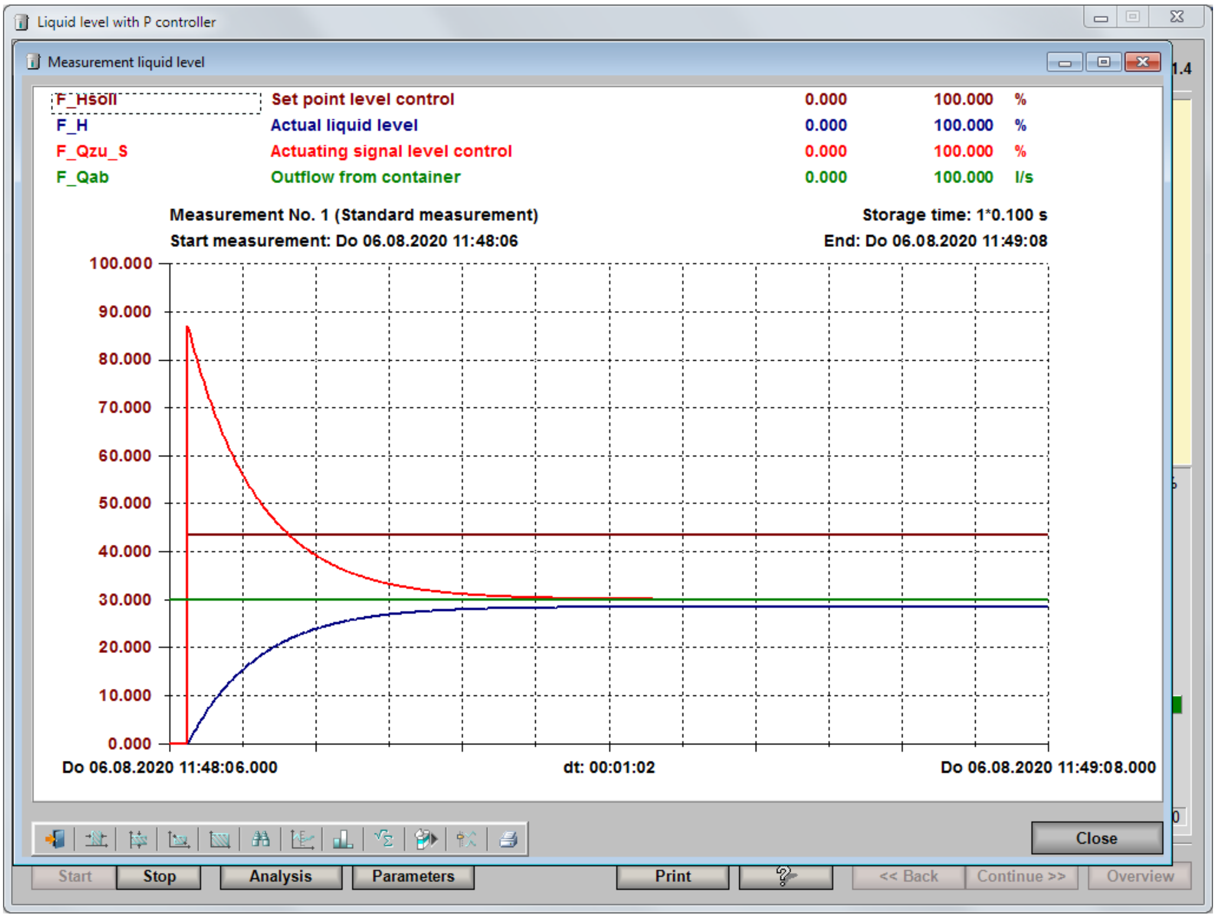


Start the simulation by clicking on the "Start" button. The current values of the setpoint, the actual value, the inlet and the outlet are indicated in the diagram. The setpoint and the outlet (as a disturbance) can be changed with the shift buttons or the display fields below the shift buttons or the bar displays. It is also possible to apply a further disturbance by clicking on the " Admission pressure variation" button. By clicking on the "Manual control" button, the controller is switched to manual operation. It is now possible to adjust the actuating signal (the inlet) with the shift button or by entering values in the display fields. By clicking on "Manual control" again, the controller is automatically reset to automatic operation.

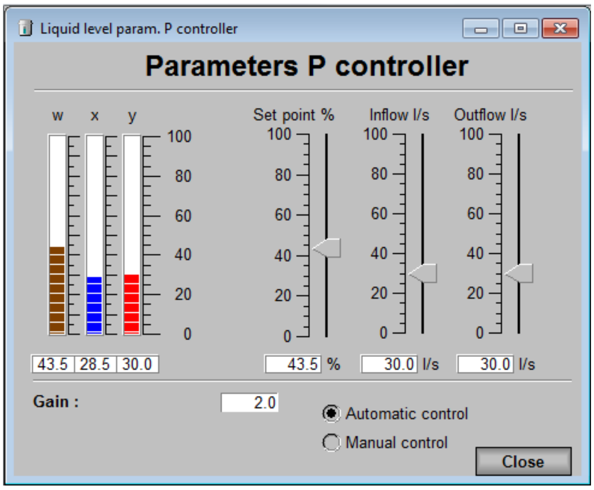
When you click on "Trend Stop", the current trend diagram is stopped. The calculation continues.

The system deviation box shows the integrated squared system deviation. When the setpoint value or the disturbance value changes, the system deviation is set to 0 and restarts to integrate.

The values for all the signals are automatically saved and can later be viewed and analyzed in a diagram. When you click on "Analysis", a timing diagram containing the saved measured values opens up. Here you have several choices for an analysis. By clicking on the signal names, the Y scale is changed over. By clicking on the signal curves, the value of the active signal will be indicated and by holding and dragging the difference in value and time will be displayed. When you click on the buttons below, various analysis methods will be available, such as zoom, change time view, change value range, ruler function, methods to export the signal values into a text file, statistic analyzing methods.



When you click on the "Parameter" button, another window opens up in which you can change the controller parameters, the setpoint liquid level and the outlet. The controller can also be switched from manual to automatic operation and vice versa, so that the actuating signal can be set manually.



Terminate the simulation by clicking on the "Stop" button. The defined initial states are reset and you may get to other process images by clicking on the buttons "Continue >>", "<< Back" and "Overview".

1.5 Closed-Loop Control with I Controller

Here you can study the performance of the control loop when the setpoint and the disturbance change. For this purpose, an I controller is used.

The block structure of the control loop can be viewed by clicking on the "Block structure" button.

Start the simulation by clicking on the "Start" button. The current values of the setpoint, the actual value, the inlet and the outlet are indicated in the diagram. The setpoint and the outlet (as a disturbance) can be changed with the shift buttons or the display fields below the shift buttons or the bar displays. It is also possible to apply a further disturbance by clicking on the " Admission pressure variation" button. By clicking on the "Manual control" button, the controller is switched to manual operation. It is now possible to adjust the actuating signal (the inlet) with the shift button or by entering values in the display fields. By clicking on "Manual control" again, the controller is automatically reset to automatic operation.

When you click on "Trend Stop", the current trend diagram is stopped. The calculation continues.

The system deviation box shows the integrated squared system deviation. When the setpoint value or the disturbance value changes, the system deviation is set to 0 and restarts to integrate.

The values for all the signals are automatically saved and can later be viewed and analyzed in a diagram. When you click on "Analysis", a timing diagram containing the saved measured values opens up. Here you have several choices for an analysis. By clicking on the signal names, the Y scale is changed over. By clicking on the signal curves, the value of the active signal will be indicated and by holding and dragging the difference in value and time will be displayed. When you click on the buttons below, various analysis methods will be available, such as zoom, change time view, change value range, ruler function, methods to export the signal values into a text file, statistic analyzing methods.

When you click on the "Parameter" button, another window opens up in which you can change the controller parameters, the setpoint liquid level and the outlet. The controller can also be switched from manual to automatic operation and vice versa, so that the actuating signal can be set manually.

Terminate the simulation by clicking on the "Stop" button. The defined initial states are reset and you may get to other process images by clicking on the buttons "Continue >>", "<< Back" and "Overview".

1.6 Closed-Loop Control with PI Controller

Here you can study the performance of the control loop when the setpoint and the disturbance change. For this purpose, a PI controller is used.

The block structure of the control loop can be viewed by clicking on the "Block structure" button.

Start the simulation by clicking on the "Start" button. The current values of the setpoint, the actual value, the inlet and the outlet are indicated in the diagram. The setpoint and the outlet (as a disturbance) can be changed with the shift buttons or the display fields below the shift buttons or the bar displays. It is also possible to apply a further disturbance by clicking on the " Admission pressure variation" button. By clicking on the "Manual control" button, the controller is switched to manual operation. It is now possible to adjust the actuating signal (the inlet) with the shift button or by entering values in the display fields. By clicking on "Manual control" again, the controller is automatically reset to automatic operation.

When you click on "Trend Stop", the current trend diagram is stopped. The calculation continues.

The system deviation box shows the integrated squared system deviation. When the setpoint value or the disturbance value changes, the system deviation is set to 0 and restarts to integrate.

The values for all the signals are automatically saved and can later be viewed and analyzed in a diagram. When you click on "Analysis", a timing diagram containing the saved measured values opens up. Here you have several choices for an analysis. By clicking on the signal names, the Y scale is changed over. By clicking on the signal curves, the value of the active signal will be indicated and by holding and dragging the difference in value and time will be displayed. When you click on the buttons below, various analysis methods will be available, such as zoom, change time view, change value range, ruler function, methods to export the signal values into a text file, statistic analyzing methods.

When you click on the "Parameter" button, another window opens up in which you can change the controller parameters, the setpoint liquid level and the outlet. The controller can also be switched from manual to automatic operation and vice versa, so that the actuating signal can be set manually.

Terminate the simulation by clicking on the "Stop" button. The defined initial states are reset and you may get to other process images by clicking on the buttons "Continue >>", "<< Back" and "Overview".

1.7 Closed-Loop Control with PID Controller

Here you can study the performance of the control loop when the setpoint and the disturbance change. For this purpose, a PID controller is used.

The block structure of the control loop can be viewed by clicking on the "Block structure" button.

Start the simulation by clicking on the "Start" button. The current values of the setpoint, the actual value, the inlet and the outlet are indicated in the diagram. The setpoint and the outlet (as a disturbance) can be changed with the shift buttons or the display fields below the shift buttons or the bar displays. It is also possible to apply a further disturbance by clicking on the " Admission pressure variation" button. By clicking on the "Manual control" button, the controller is switched to manual operation. It is now possible to adjust the actuating signal (the inlet) with the shift button or by entering values in the display fields. By clicking on "Manual control" again, the controller is automatically reset to automatic operation.

When you click on "Trend Stop", the current trend diagram is stopped. The calculation continues.

The system deviation box shows the integrated squared system deviation. When the setpoint value or the disturbance value changes, the system deviation is set to 0 and restarts to integrate.

The values for all the signals are automatically saved and can later be viewed and analyzed in a diagram. When you click on "Analysis", a timing diagram containing the saved measured values opens up. Here you have several choices for an analysis. By clicking on the signal names, the Y scale is changed over. By clicking on the signal curves, the value of the active signal will be indicated and by holding and dragging the difference in value and time will be displayed. When you click on the buttons below, various analysis methods will be available, such as zoom, change time view, change value range, ruler function, methods to export the signal values into a text file, statistic analyzing methods.

When you click on the "Parameter" button, another window opens up in which you can change the controller parameters, the setpoint liquid level and the outlet. The controller can also be switched from manual to automatic operation and vice versa, so that the actuating signal can be set manually.

Terminate the simulation by clicking on the "Stop" button. The defined initial states are reset and you may get to other process images by clicking on the buttons "Continue >>", "<< Back" and "Overview".

1.8 Closed-Loop Control with Two-Position Controller

Here you can study the performance of the control loop when the setpoint and the disturbance change. For this purpose, a two-position controller is used.

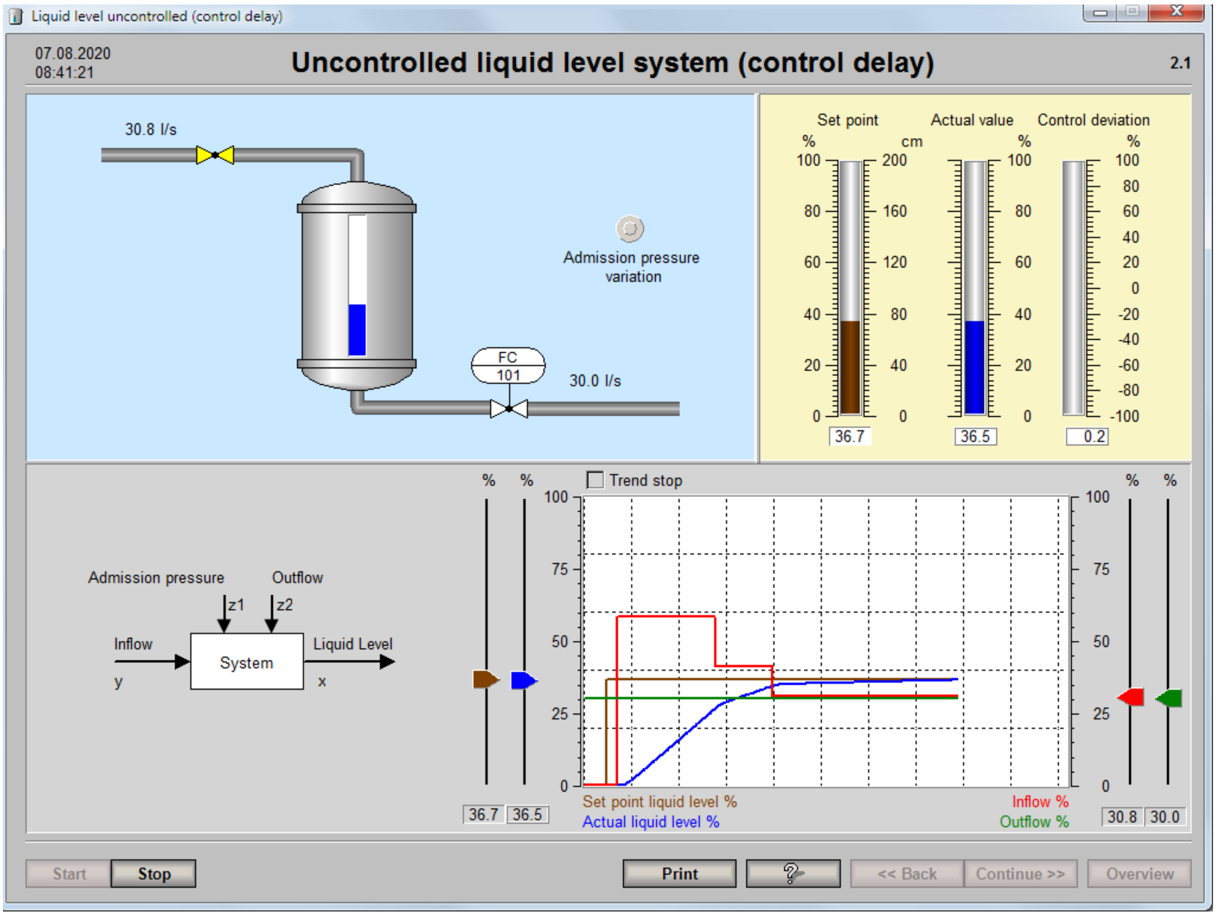
The block structure of the control loop can be viewed by clicking on the "Block structure" button.

Start the simulation by clicking on the "Start" button. The current values of the setpoint, the actual value, the inlet and the outlet are indicated in the diagram. The setpoint and the outlet (as a disturbance) can be changed with the shift buttons or the display fields below the shift buttons or the bar displays. It is also possible to apply a further disturbance by clicking on the " Admission pressure variation" button. By clicking on the "Manual control" button, the controller is switched to manual operation. It is now possible to adjust the actuating signal (the inlet) with the shift button or by entering values in the display fields. By clicking on "Manual control" again, the controller is automatically reset to automatic operation.

When you click on "Trend Stop", the current trend diagram is stopped. The calculation continues.

2 Liquid Level Control with Time Delay

2.1 Uncontrolled System

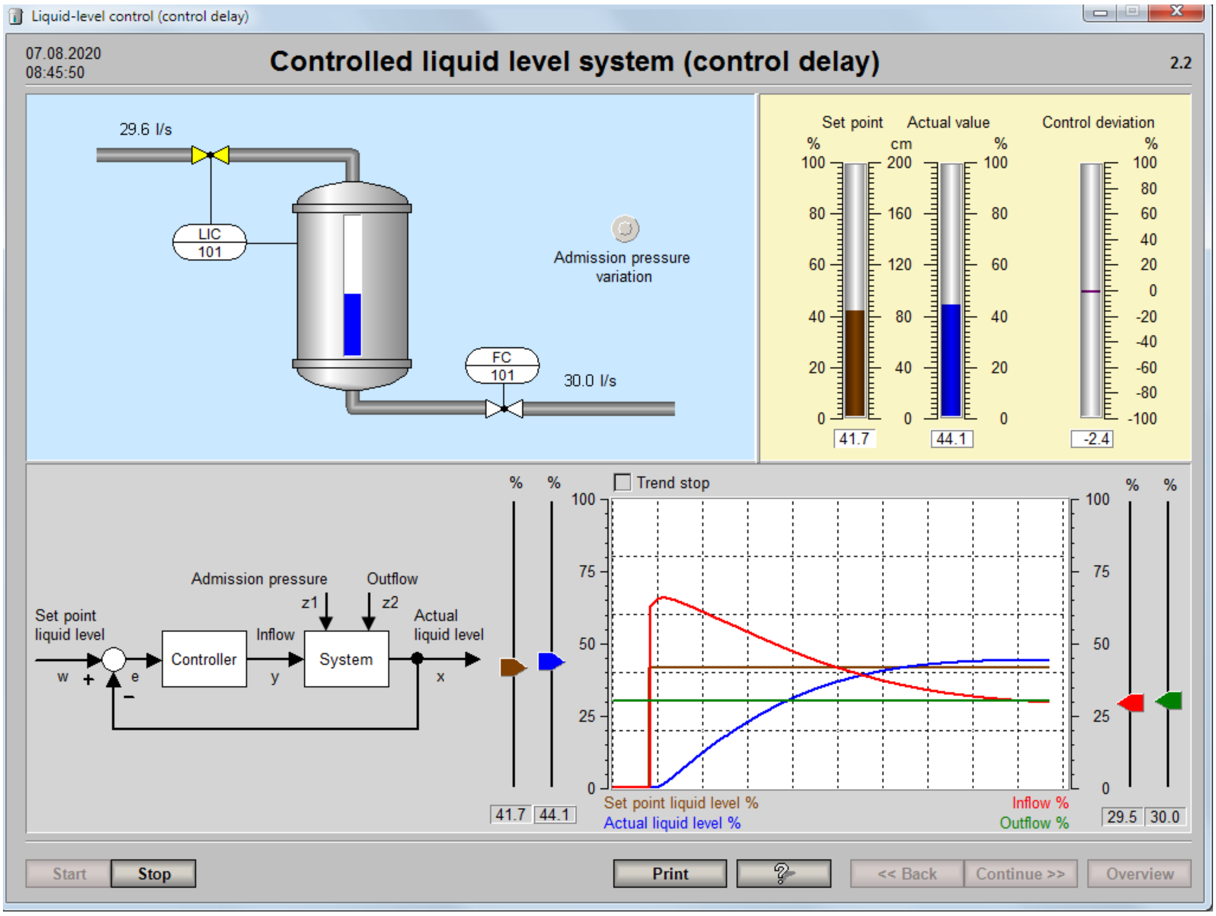


A container with inlet and outlet will be simulated as a controlled system. The size of the inlet or outlet can be adjusted with valves (by adjusting the shift buttons). The exercise on control engineering is to control the liquid level by changing the inlet, so that the level corresponds to a certain setpoint value. Therefore, the inlet constitutes the input variable, and the liquid level the output variable of the system. The outlet and varying admission pressure values for the inlet act as disturbances.

Start the process simulation by clicking on the "Start" button. A defined initial state is automatically set. Try to manually correct the actual level to the setpoint level by changing the inlet or outlet with the shift button, the up/down counters or by entering numeric values. Clicking on the "Admission pressure variation" button causes an interference of the outlet, which is to be controlled.

Terminate the simulation by clicking on the "Stop" button. Click on the "Continue >>" or "<< Back" button to get to other process images.

2.2 Closed-Loop Control System



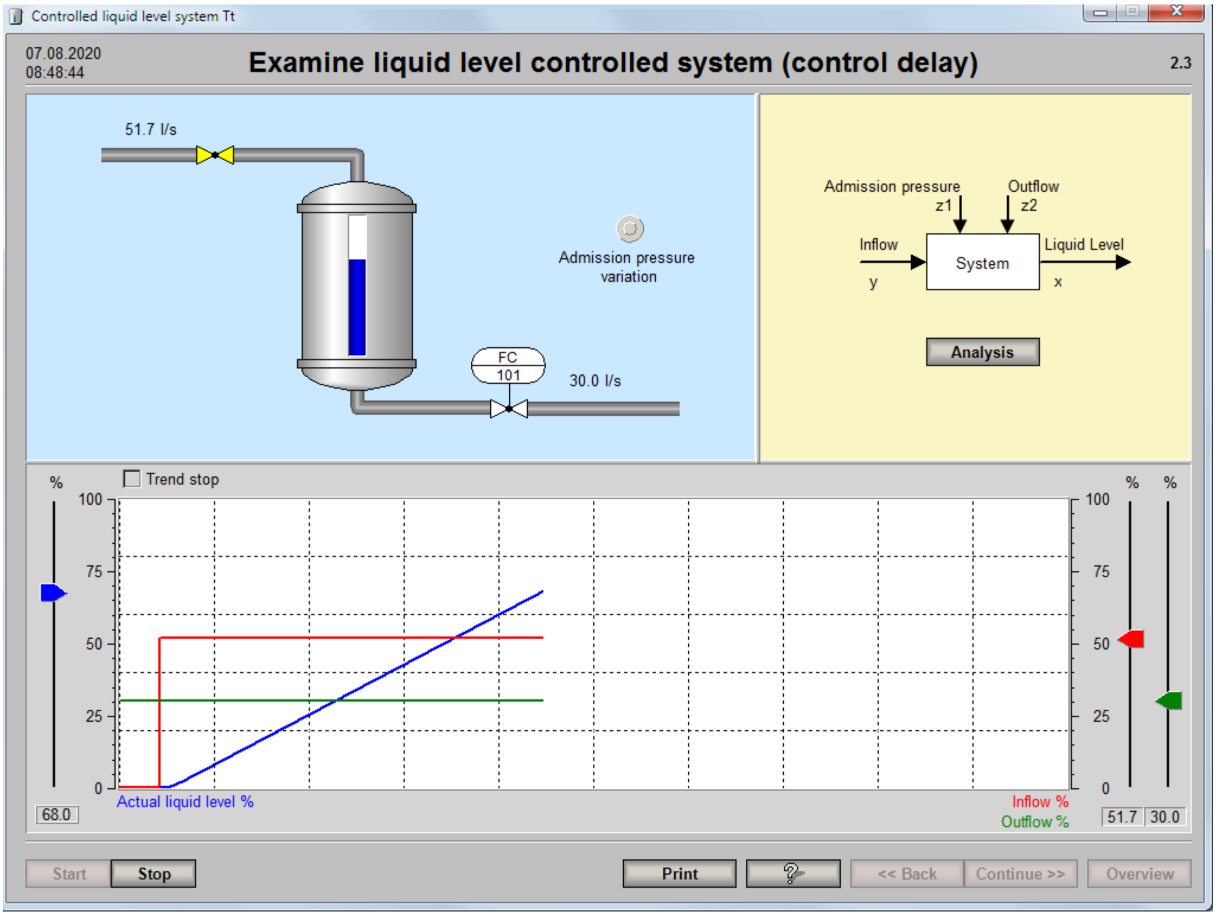
Contrary to the last page *Uncontrolled System*, the closed-loop control process for the liquid level is not actuated manually, but with a PI controller.

Start the process simulation by clicking on the "Start" button. Defined initial states are set automatically. A PI controller starts to reach the setpoint value by regulating the inlet.

You may change the setpoint and the outlet via the respective shift button, the up/down counters or by entering values above the up/down counters. Clicking on the "Admission pressure variation" button causes interference to the outlet.

Terminate the simulation by clicking on the "Stop" button. Click on the "Continue >>" or "<< Back" button to get to other process images.

2.3 Examine Controlled System



Here you can study the response of the controlled system when the inlet and the outlet change.

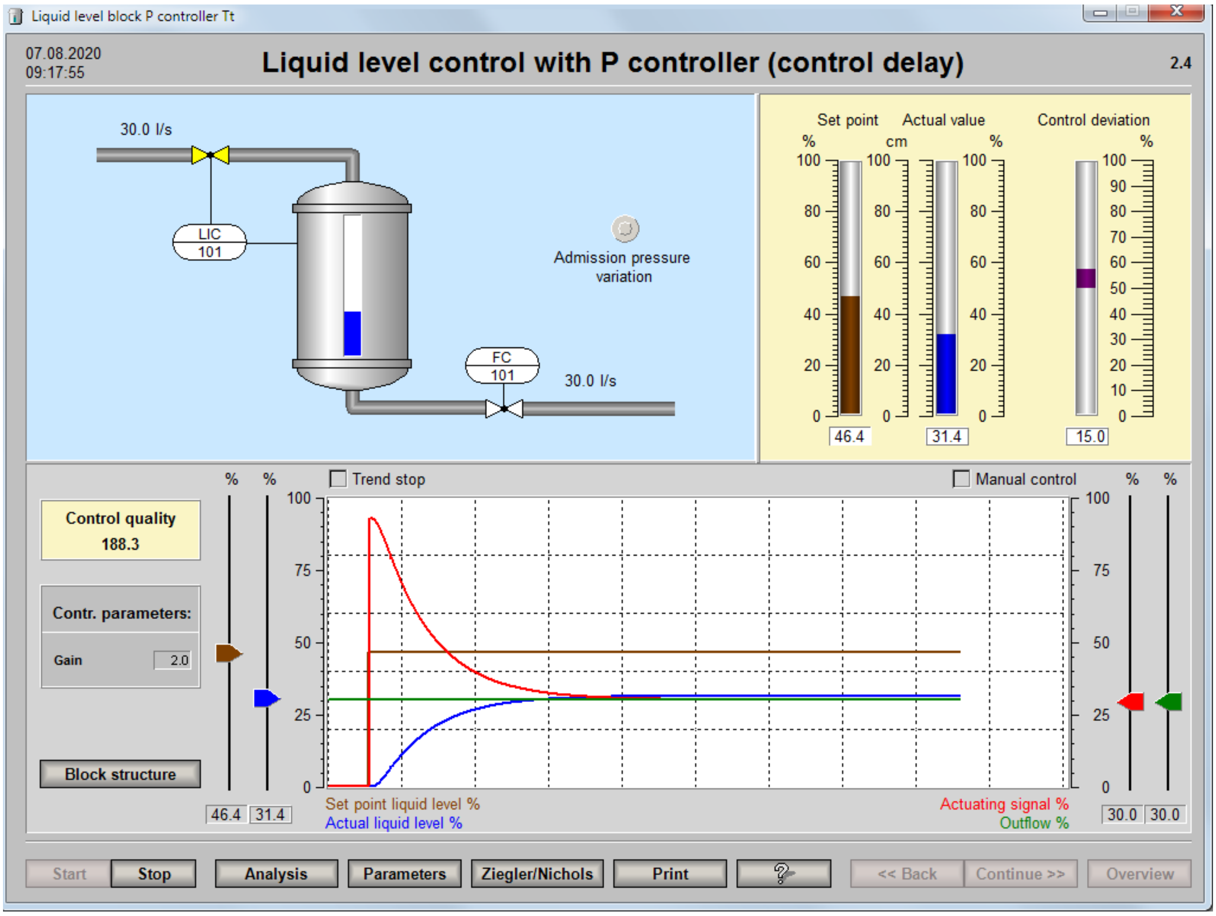
Start the simulation by clicking on the "Start" button. The inlet and the outlet can be changed with the shift button or the display fields below the shift button. It is also possible to change the variable "inlet" in jumps by clicking on the "Admission pressure variation" button.

The actual values for the liquid level, the inlet and the outlet are graphically indicated in a diagram. The signal values are automatically stored, so that they can later be analyzed in a timing diagram, e.g. to determine the time constant for the controlled system.

When clicking on "Analysis", the stored measured values are indicated in a timing diagram. Here you have various methods of analysis. By clicking on the signal names, the Y scale is changed over. By clicking on the signal curves, the value of the active signal will be indicated and by holding and dragging the difference in value and time will be displayed. When you click on the buttons below, various analysis methods will be available, such as zoom, change time view, change value range, ruler function, methods to export the signal values into a text file, statistic analyzing methods.

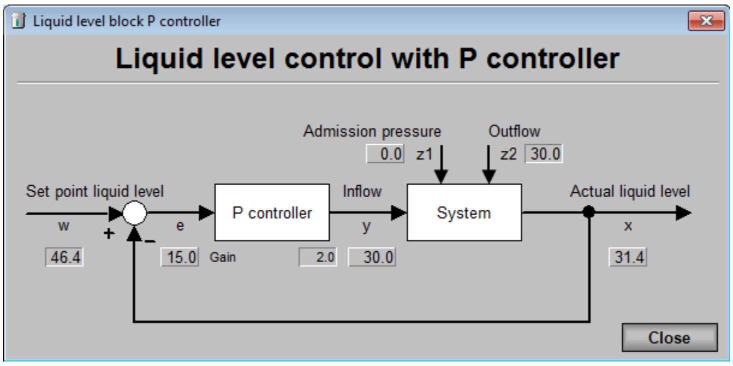
Terminate the simulation by clicking on the "Stop" button. The defined initial states are reset and you may get to other process images by clicking on the buttons "Continue >>", "<< Back" and "Overview".

2.4 Closed-Loop Control with P Controller



Here you can study the performance of the control loop when the setpoint and the disturbance change. For this purpose, a P controller is used.

The block structure of the control loop can be viewed by clicking on the "Block structure" button.

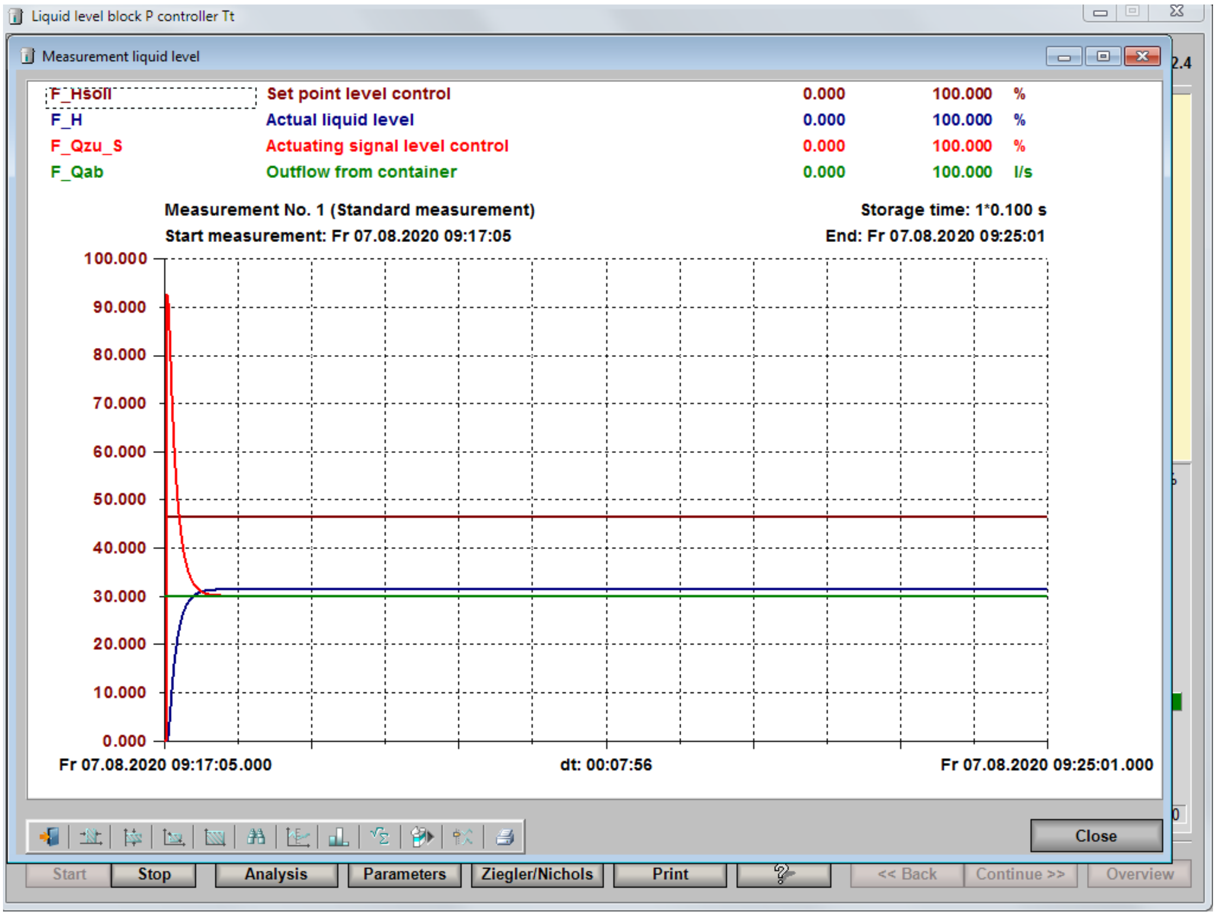


Start the simulation by clicking on the "Start" button. The current values of the setpoint, the actual value, the inlet and the outlet are indicated in the diagram. The setpoint and the outlet (as a disturbance) can be changed with the shift buttons or the display fields below the shift buttons or the bar displays. It is also possible to apply a further disturbance by clicking on the " Admission pressure variation" button. By clicking on the "Manual control" button, the controller is switched to manual operation. It is now possible to adjust the actuating signal (the inlet) with the shift button or by entering values in the display fields. By clicking on "Manual control" again, the controller is automatically reset to automatic operation.

When you click on "Trend Stop", the current trend diagram is stopped. The calculation continues.

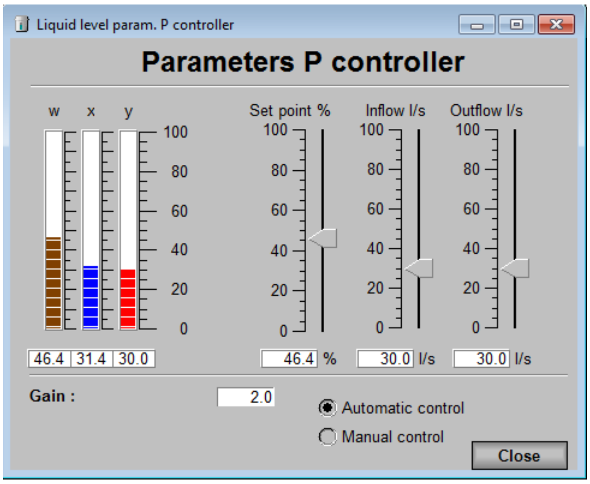
The system deviation box shows the integrated squared system deviation. When the setpoint value or the disturbance value changes, the system deviation is set to 0 and restarts to integrate.

The values for all the signals are automatically saved and can later be viewed and analyzed in a diagram. When you click on "Analysis", a timing diagram containing the saved measured values opens up.



Here you have several choices for an analysis. By clicking on the signal names, the Y scale is changed over. By clicking on the signal curves, the value of the active signal will be indicated and by holding and dragging the difference in value and time will be displayed. When you click on the buttons below, various analysis methods will be available, such as zoom, change time view, change value range, ruler function, methods to export the signal values into a text file, statistic analyzing methods.

When you click on the "Parameter" button, another window opens up in which you can change the controller parameters, the setpoint liquid level and the outlet. The controller can also be switched from manual to automatic operation and vice versa, so that the actuating signal can be set manually.



Terminate the simulation by clicking on the "Stop" button. The defined initial states are reset and you may get to other process images by clicking on the buttons "Continue >>", "<< Back" and "Overview".

2.5 Closed-Loop Control with I Controller

Here you can study the performance of the control loop when the setpoint and the disturbance change. For this purpose, an I controller is used.

The block structure of the control loop can be viewed by clicking on the "Block structure" button.

Start the simulation by clicking on the "Start" button. The current values of the setpoint, the actual value, the inlet and the outlet are indicated in the diagram. The setpoint and the outlet (as a disturbance) can be changed with the shift buttons or the display fields below the shift buttons or the bar displays. It is also possible to apply a further disturbance by clicking on the " Admission pressure variation" button. By clicking on the "Manual control" button, the controller is switched to manual operation. It is now possible to adjust the actuating signal (the inlet) with the shift button or by entering values in the display fields. By clicking on "Manual control" again, the controller is automatically reset to automatic operation.

When you click on "Trend Stop", the current trend diagram is stopped. The calculation continues.

The system deviation box shows the integrated squared system deviation. When the setpoint value or the disturbance value changes, the system deviation is set to 0 and restarts to integrate.

The values for all the signals are automatically saved and can later be viewed and analyzed in a diagram. When you click on "Analysis", a timing diagram containing the saved measured values opens up. Here you have several choices for an analysis. By clicking on the signal names, the Y scale is changed over. By clicking on the signal curves, the value of the active signal will be indicated and by holding and dragging the difference in value and time will be displayed. When you click on the buttons below, various analysis methods will be available, such as zoom, change time view, change value range, ruler function, methods to export the signal values into a text file, statistic analyzing methods.

When you click on the "Parameter" button, another window opens up in which you can change the controller parameters, the setpoint liquid level and the outlet. The controller can also be switched from manual to automatic operation and vice versa, so that the actuating signal can be set manually.

Terminate the simulation by clicking on the "Stop" button. The defined initial states are reset and you may get to other process images by clicking on the buttons "Continue >>", "<< Back" and "Overview".

2.6 Closed-Loop Control with PI Controller

Here you can study the performance of the control loop when the setpoint and the disturbance change. For this purpose, a PI controller is used.

The block structure of the control loop can be viewed by clicking on the "Block structure" button.

Start the simulation by clicking on the "Start" button. The current values of the setpoint, the actual value, the inlet and the outlet are indicated in the diagram. The setpoint and the outlet (as a disturbance) can be changed with the shift buttons or the display fields below the shift buttons or the bar displays. It is also possible to apply a further disturbance by clicking on the " Admission pressure variation" button. By clicking on the "Manual control" button, the controller is switched to manual operation. It is now possible to adjust the actuating signal (the inlet) with the shift button or by entering values in the display fields. By clicking on "Manual control" again, the controller is automatically reset to automatic operation.

When you click on "Trend Stop", the current trend diagram is stopped. The calculation continues.

The system deviation box shows the integrated squared system deviation. When the setpoint value or the disturbance value changes, the system deviation is set to 0 and restarts to integrate.

The values for all the signals are automatically saved and can later be viewed and analyzed in a diagram. When you click on "Analysis", a timing diagram containing the saved measured values opens up. Here you have several choices for an analysis. By clicking on the signal names, the Y scale is changed over. By clicking on the signal curves, the value of the active signal will be indicated and by holding and dragging the difference in value and time will be displayed. When you click on the buttons below, various analysis methods will be available, such as zoom, change time view, change value range, ruler function, methods to export the signal values into a text file, statistic analyzing methods.

When you click on the "Parameter" button, another window opens up in which you can change the controller parameters, the setpoint liquid level and the outlet. The controller can also be switched from manual to automatic operation and vice versa, so that the actuating signal can be set manually.

Terminate the simulation by clicking on the "Stop" button. The defined initial states are reset and you may get to other process images by clicking on the buttons "Continue >>", "<< Back" and "Overview".

2.7 Closed-Loop Control with PID Controller

Here you can study the performance of the control loop when the setpoint and the disturbance change. For this purpose, a PID controller is used.

The block structure of the control loop can be viewed by clicking on the "Block structure" button.

Start the simulation by clicking on the "Start" button. The current values of the setpoint, the actual value, the inlet and the outlet are indicated in the diagram. The setpoint and the outlet (as a disturbance) can be changed with the shift buttons or the display fields below the shift buttons or the bar displays. It is also possible to apply a further disturbance by clicking on the " Admission pressure variation" button. By clicking on the "Manual control" button, the controller is switched to manual operation. It is now possible to adjust the actuating signal (the inlet) with the shift button or by entering values in the display fields. By clicking on "Manual control" again, the controller is automatically reset to automatic operation.

When you click on "Trend Stop", the current trend diagram is stopped. The calculation continues.

The system deviation box shows the integrated squared system deviation. When the setpoint value or the disturbance value changes, the system deviation is set to 0 and restarts to integrate.

The values for all the signals are automatically saved and can later be viewed and analyzed in a diagram. When you click on "Analysis", a timing diagram containing the saved measured values opens up. Here you have several choices for an analysis. By clicking on the signal names, the Y scale is changed over. By clicking on the signal curves, the value of the active signal will be indicated and by holding and dragging the difference in value and time will be displayed. When you click on the buttons below, various analysis methods will be available, such as zoom, change time view, change value range, ruler function, methods to export the signal values into a text file, statistic analyzing methods.

When you click on the "Parameter" button, another window opens up in which you can change the controller parameters, the setpoint liquid level and the outlet. The controller can also be switched from manual to automatic operation and vice versa, so that the actuating signal can be set manually.

Terminate the simulation by clicking on the "Stop" button. The defined initial states are reset and you may get to other process images by clicking on the buttons "Continue >>", "<< Back" and "Overview".

2.8 Closed-Loop Control with Two-Position Controller

Here you can study the performance of the control loop when the setpoint and the disturbance change. For this purpose, a two-position controller is used.

The block structure of the control loop can be viewed by clicking on the "Block structure" button.

Start the simulation by clicking on the "Start" button. The current values of the setpoint, the actual value, the inlet and the outlet are indicated in the diagram. The setpoint and the outlet (as a disturbance) can be changed with the shift buttons or the display fields below the shift buttons or the bar displays. It is also possible to apply a further disturbance by clicking on the " Admission pressure variation" button. By clicking on the "Manual control" button, the controller is switched to manual operation. It is now possible to adjust the actuating signal (the inlet) with the shift button or by entering values in the display fields. By clicking on "Manual control" again, the controller is automatically reset to automatic operation.

When you click on "Trend Stop", the current trend diagram is stopped. The calculation continues.

The system deviation box shows the integrated squared system deviation. When the setpoint value or the disturbance value changes, the system deviation is set to 0 and restarts to integrate.

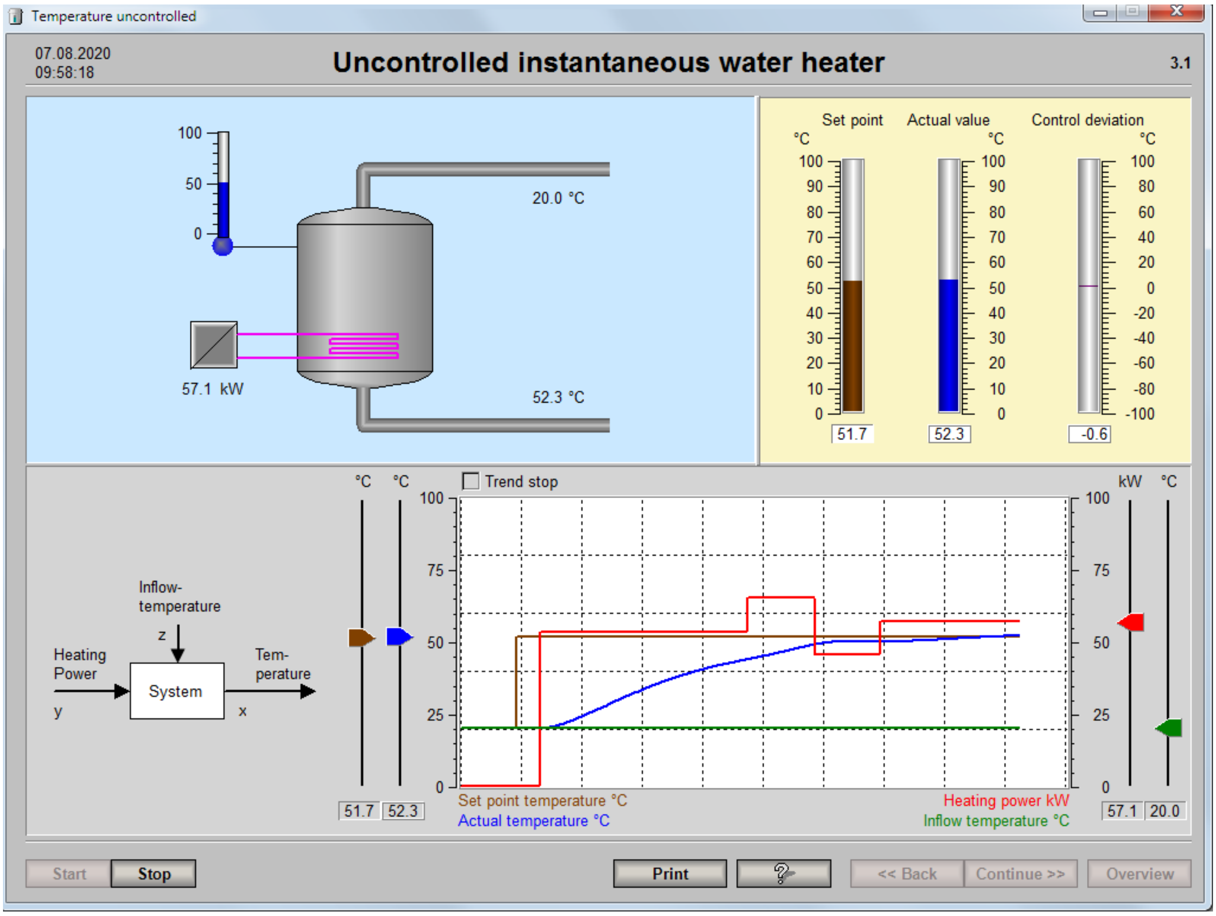
The values for all the signals are automatically saved and can later be viewed and analyzed in a diagram. When you click on "Analysis", a timing diagram containing the saved measured values opens up. Here you have various methods of analysis. By clicking on the signal names, the Y scale is changed over. By clicking on the signal curves, the value of the active signal will be indicated and by holding and dragging the difference in value and time will be displayed. When you click on the buttons below, various analysis methods will be available, such as zoom, change time view, change value range, ruler function, methods to export the signal values into a text file, statistic analyzing methods.

When you click on the "Parameter" button, another window opens up in which you can change the controller parameters, the setpoint liquid level and the outlet. The controller can also be switched from manual to automatic operation and vice versa, so that the actuating signal can be set manually.

Terminate the simulation by clicking on the "Stop" button. The defined initial states are reset and you may get to other process images by clicking on the buttons "Continue >>", "<< Back" and "Overview".

3 Temperature Control

3.1 Uncontrolled System

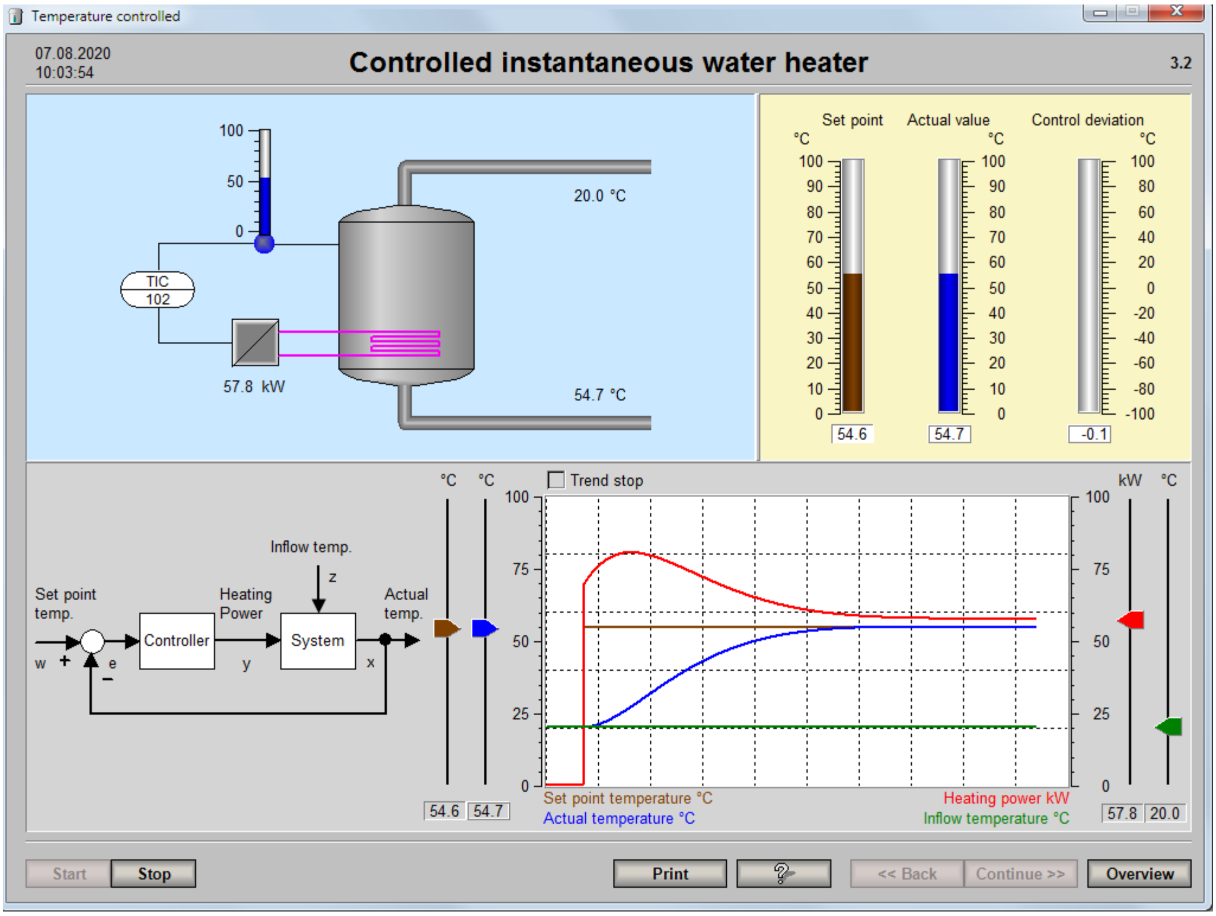


This process consists of a tank through which water is flowing continuously. The liquid level does not change. With the aid of an electrical heater, the temperature of the water in the tank is affected. The exercise regarding control engineering is to control the temperature of the water in the tank by changing the heater output, so that it corresponds to a certain setpoint value. The heater output is the input variable, the temperature of the water flowing off is the output variable of the system. Temperature changes of the water flowing in are a disturbance.

Start the process simulation by clicking on the "Start" button. A defined initial state is automatically set. Try to manually correct the actual temperature value to the setpoint value by changing the heater output with the shift button or the up/down counter. The change in the inlet temperature causes an interference, which is to be controlled.

Terminate the simulation by clicking on the "Stop" button. Click on the "Continue >>", "<< Back" and "Overview" button to get to other process images.

3.2 Closed-Loop Controlled System



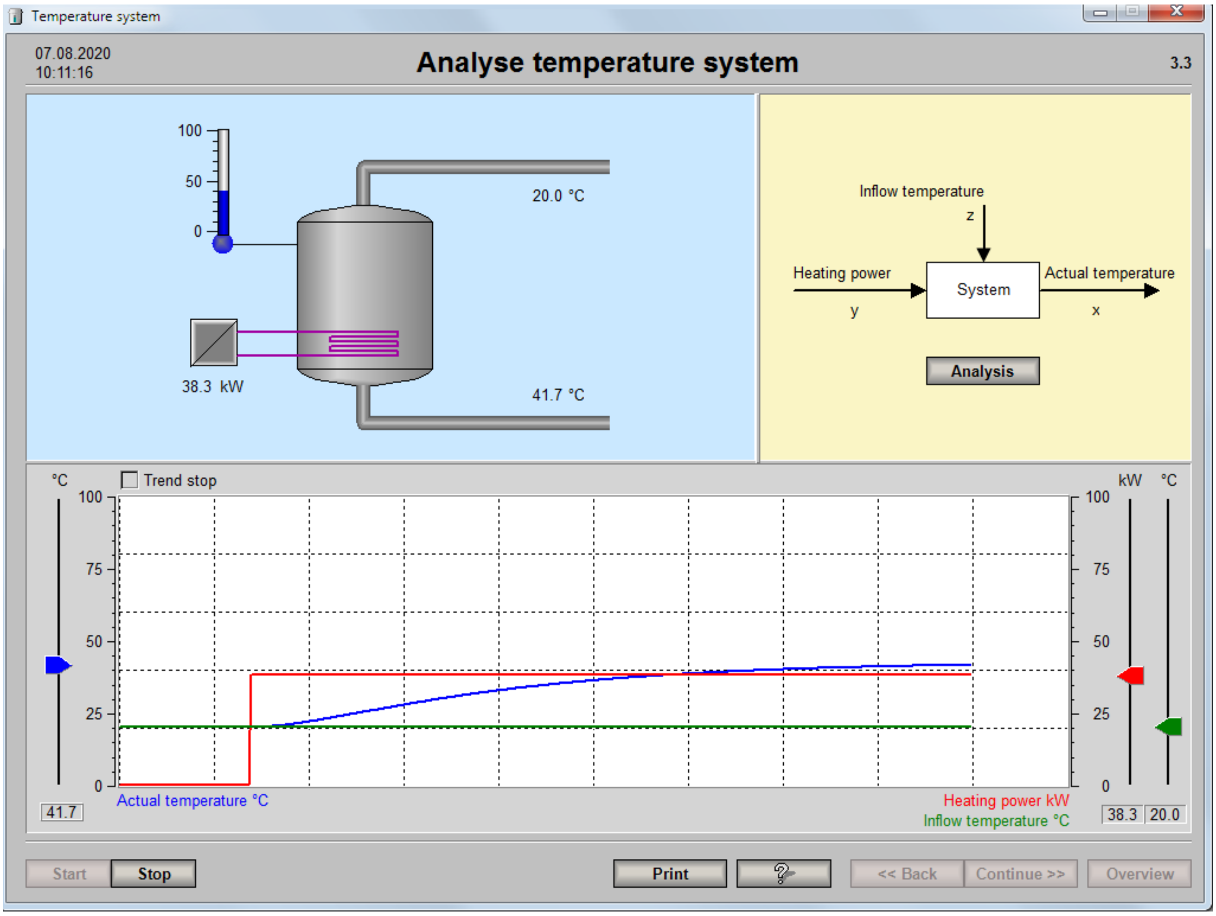
Contrary to the last page *Uncontrolled System*, the temperature is not controlled manually, but with a PI controller.

Start the process simulation by clicking on the "Start" button. Defined initial states are set automatically. A PI controller starts to reach the setpoint value by regulating the electrical heater output.

You may change the setpoint and the inlet temperature with the respective shift buttons, the up/down counters or by entering values above the up/down counters.

Terminate the simulation by clicking on the "Stop" button. Click on the "Continue >>" or "<< Back" button to get to other process images.Im Gegensatz zur vorherigen Seite wird die Regelung der Temperatur nicht manuell sondern von einem PI-Regler ausgeführt.

3.3 Examine Controlled System

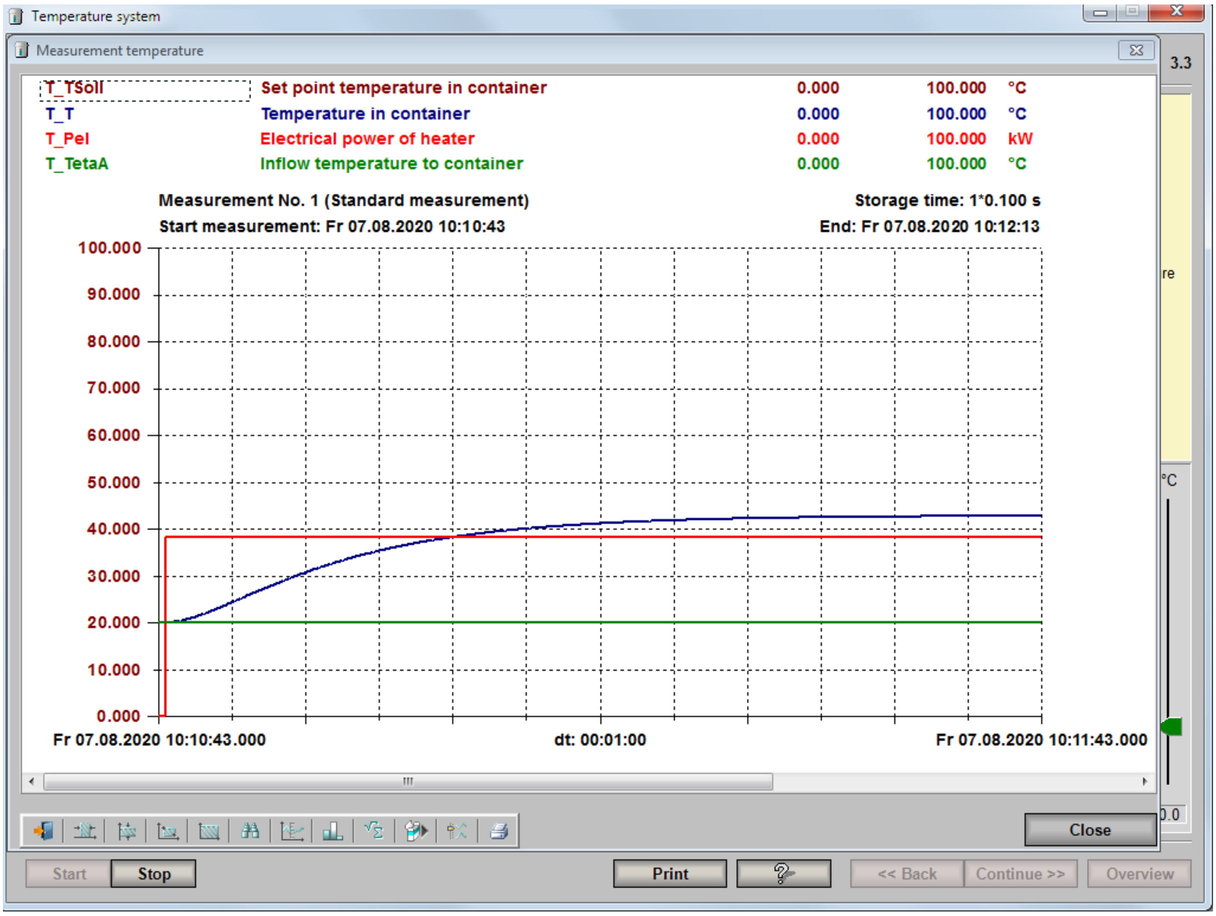


Here you can study the performance of the control loop responding to changes of the heater output and the inlet temperature.

Start the process simulation by clicking on the "Start" button. The heater output and the inlet temperature can be changed with the shift buttons or the display fields below the shift buttons or the bar displays.

The current values of the temperatures in the tank and of the inlet as well as the heater output are indicated in a diagram. The values of the signals are automatically saved, so that they can later be analyzed in a diagram, e.g. to determine the time constant for the controlled system.

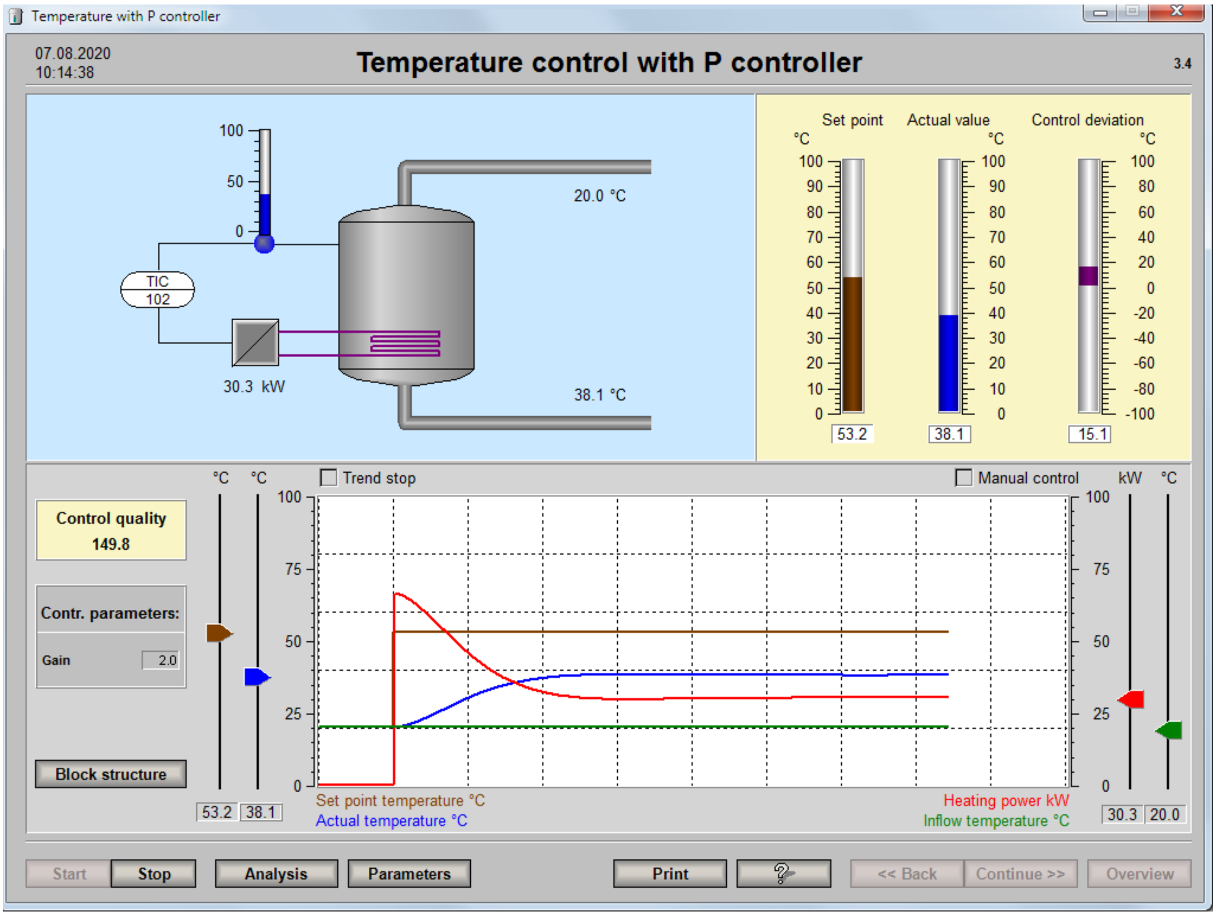
When clicking on "Analysis", the stored measured values are indicated in a timing diagram.



Here you have various methods of analysis. By clicking on the signal names, the Y scale is changed over. By clicking on the signal curves, the value of the active signal will be indicated and by holding and dragging the difference in value and time will be displayed. When you click on the buttons below, various analysis methods will be available, such as zoom, change time view, change value range, ruler function, methods to export the signal values into a text file, statistic analyzing methods

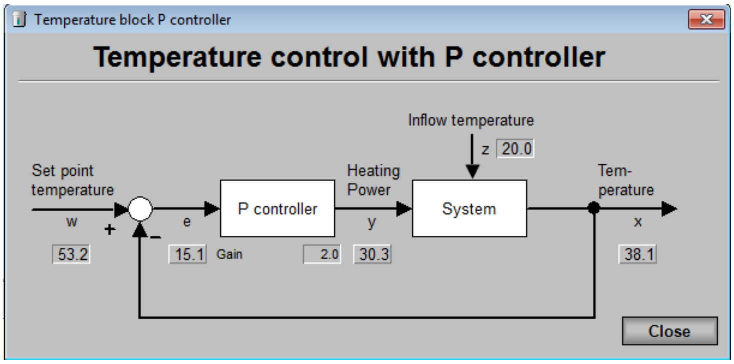
Terminate the simulation by clicking on the "Stop" button. The defined initial states are reset and you may get to other process images by clicking on the buttons "Continue >>", "<< Back" and "Overview".

3.4 Closed-Loop Control with P Controller



Here you can study the performance of the control loop when the setpoint and the disturbance change. For this purpose, a P controller is used.

The block structure of the control loop can be viewed by clicking on the "Block structure" button.

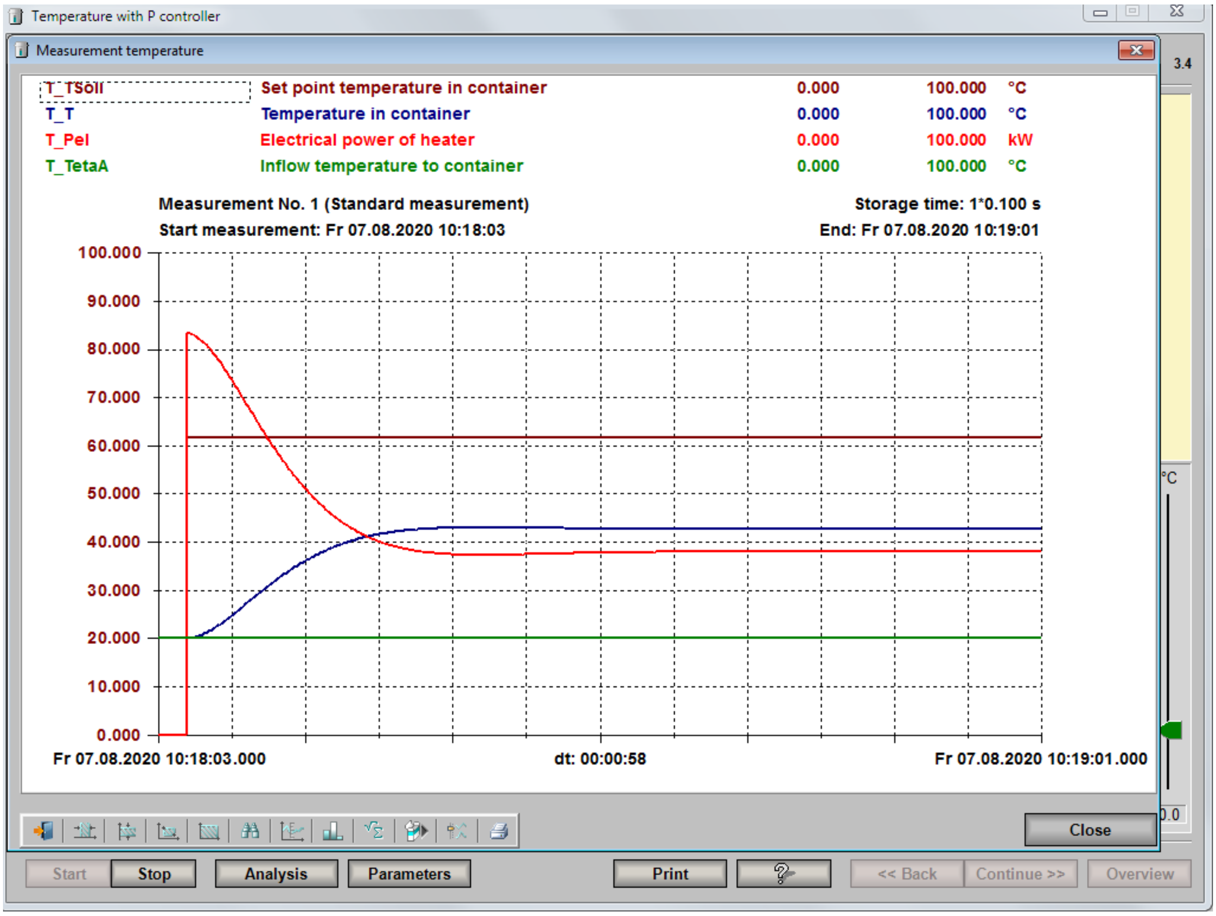


Start the simulation by clicking on the "Start" button. The current values of the setpoint temperature, the actual temperature and the inlet temperature are indicated in the diagram. The setpoint and the inlet temperature (as a disturbance) can be changed with the shift buttons or the display fields below the shift buttons or the bar displays. By clicking on the "Manual control" button, the controller is switched to manual operation. It is now possible to adjust the actuating signal (the heater output) with the shift button or by entering values in the display fields. By clicking on "Manual control" again, the controller is automatically reset to automatic operation.

When you click on "Trend Stop", the current trend diagram is stopped. The calculation continues.

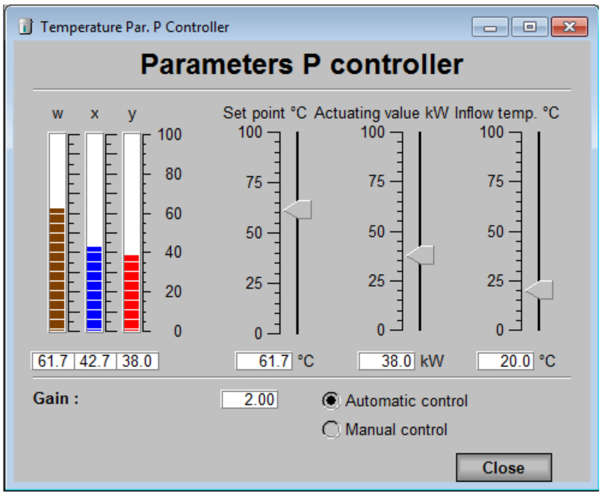
The system deviation box shows the integrated squared system deviation. When the setpoint value or the disturbance value changes, the system deviation is set to 0 and restarts to integrate.

The values for all the signals are automatically saved and can later be viewed and analyzed in a diagram. When you click on "Analysis", a timing diagram containing the saved measured values opens up.



Here you have several choices for an analysis. By clicking on the signal names, the Y scale is changed over. By clicking on the signal curves, the value of the active signal will be indicated and by holding and dragging the difference in value and time will be displayed. When you click on the buttons below, various analysis methods will be available, such as zoom, change time view, change value range, ruler function, methods to export the signal values into a text file, statistic analyzing methods

When you click on the "Parameter" button, another window opens up in which you can change the controller parameters, the setpoint temperature and the inlet temperature. The controller can also be switched from manual to automatic operation and vice versa, so that the actuating signal can be set manually.



Terminate the simulation by clicking on the "Stop" button. The defined initial states are reset and you may get to other process images by clicking on the buttons "Continue >>", "<< Back" and "Overview".

3.5 Closed-Loop Control with I Controller

Here you can study the performance of the control loop when the setpoint and the disturbance change. For this purpose, an I controller is used.

The block structure of the control loop can be viewed by clicking on the "Block structure" button.

Start the simulation by clicking on the "Start" button. The current values of the setpoint temperature, the actual temperature and the inlet temperature are indicated in the diagram. The setpoint and the inlet temperature (as a disturbance) can be changed with the shift buttons or the display fields below the shift buttons or the bar displays. By clicking on the "Manual control" button, the controller is switched to manual operation. It is now possible to adjust the actuating signal (the heater output) with the shift button or by entering values in the display fields. By clicking on "Manual control" again, the controller is automatically reset to automatic operation.

When you click on "Trend Stop", the current trend diagram is stopped. The calculation continues.

The system deviation box shows the integrated squared system deviation. When the setpoint value or the disturbance value changes, the system deviation is set to 0 and restarts to integrate.

The values for all the signals are automatically saved and can later be viewed and analyzed in a diagram. When you click on "Analysis", a timing diagram containing the saved measured values opens up. Here you have several choices for an analysis. By clicking on the signal names, the Y scale is changed over. By clicking on the signal curves, the value of the active signal will be indicated and by holding and dragging the difference in value and time will be displayed. When you click on the buttons below, various analysis methods will be available, such as zoom, change time view, change value range, ruler function, methods to export the signal values into a text file, statistic analyzing methods

When you click on the "Parameter" button, another window opens up in which you can change the controller parameters, the setpoint temperature and the inlet temperature. The controller can also be switched from manual to automatic operation and vice versa, so that the actuating signal can be set manually.

Terminate the simulation by clicking on the "Stop" button. The defined initial states are reset and you may get to other process images by clicking on the buttons "Continue >>", "<< Back" and "Overview".

3.6 Closed-Loop Control with PI Controller

Here you can study the performance of the control loop when the setpoint and the disturbance change. For this purpose, a PI controller is used.

The block structure of the control loop can be viewed by clicking on the "Block structure" button.

Start the simulation by clicking on the "Start" button. The current values of the setpoint temperature, the actual temperature and the inlet temperature are indicated in the diagram. The setpoint and the inlet temperature (as a disturbance) can be changed with the shift buttons or the display fields below the shift buttons or the bar displays. By clicking on the "Manual control" button, the controller is switched to manual operation. It is now possible to adjust the actuating signal (the heater output) with the shift button or by entering values in the display fields. By clicking on "Manual control" again, the controller is automatically reset to automatic operation.

When you click on "Trend Stop", the current trend diagram is stopped. The calculation continues.

The system deviation box shows the integrated squared system deviation. When the setpoint value or the disturbance value changes, the system deviation is set to 0 and restarts to integrate.

The values for all the signals are automatically saved and can later be viewed and analyzed in a diagram. When you click on "Analysis", a timing diagram containing the saved measured values opens up. Here you have several choices for an analysis. By clicking on the signal names, the Y scale is changed over. By clicking on the signal curves, the value of the active signal will be indicated and by holding and dragging the difference in value and time will be displayed. When you click on the buttons below, various analysis methods will be available, such as zoom, change time view, change value range, ruler function, methods to export the signal values into a text file, statistic analyzing methods

When you click on the "Parameter" button, another window opens up in which you can change the controller parameters, the setpoint temperature and the inlet temperature. The controller can also be switched from manual to automatic operation and vice versa, so that the actuating signal can be set manually.

Terminate the simulation by clicking on the "Stop" button. The defined initial states are reset and you may get to other process images by clicking on the buttons "Continue>>", "<< Back" and "Overview".

3.7 Closed-Loop Control with PID Controller

Here you can study the performance of the control loop when the setpoint and the disturbance change. For this purpose, a PID controller is used.

The block structure of the control loop can be viewed by clicking on the "Block structure" button.

Start the simulation by clicking on the "Start" button. The current values of the setpoint temperature, the actual temperature and the inlet temperature are indicated in the diagram. The setpoint and the inlet temperature (as a disturbance) can be changed with the shift buttons or the display fields below the shift buttons or the bar displays. By clicking on the "Manual control" button, the controller is switched to manual operation. It is now possible to adjust the actuating signal (the heater output) with the shift button or by entering values in the display fields. By clicking on "Manual control" again, the controller is automatically reset to automatic operation.

When you click on "Trend Stop", the current trend diagram is stopped. The calculation continues.

The system deviation box shows the integrated squared system deviation. When the setpoint value or the disturbance value changes, the system deviation is set to 0 and restarts to integrate.

The values for all the signals are automatically saved and can later be viewed and analyzed in a diagram. When you click on "Analysis", a timing diagram containing the saved measured values opens up. Here you have several choices for an analysis. By clicking on the signal names, the Y scale is changed over. By clicking on the signal curves, the value of the active signal will be indicated and by holding and dragging the difference in value and time will be displayed. When you click on the buttons below, various analysis methods will be available, such as zoom, change time view, change value range, ruler function, methods to export the signal values into a text file, statistic analyzing methods

When you click on the "Parameter" button, another window opens up in which you can change the controller parameters, the setpoint temperature and the inlet temperature. The controller can also be switched from manual to automatic operation and vice versa, so that the actuating signal can be set manually.

Terminate the simulation by clicking on the "Stop" button. The defined initial states are reset and you may get to other process images by clicking on the buttons "Continue >>", "<< Back" and "Overview".

3.8 Closed-Loop Control with Two-Position Controller

Here you can study the performance of the control loop when the setpoint and the disturbance change. For this purpose, a two-position controller is used.

The block structure of the control loop can be viewed by clicking on the "Block structure" button.

Start the simulation by clicking on the "Start" button. The current values of the setpoint temperature, the actual temperature and the inlet temperature are indicated in the diagram. The setpoint and the inlet temperature (as a disturbance) can be changed with the shift buttons or the display fields below the shift buttons or the bar displays. By clicking on the "Manual control" button, the controller is switched to manual operation. It is now possible to adjust the actuating signal (the heater output) with the shift button or by entering values in the display fields. By clicking on "Manual control" again, the controller is automatically reset to automatic operation.

When you click on "Trend Stop", the current trend diagram is stopped. The calculation continues.

The system deviation box shows the integrated squared system deviation. When the setpoint value or the disturbance value changes, the system deviation is set to 0 and restarts to integrate.

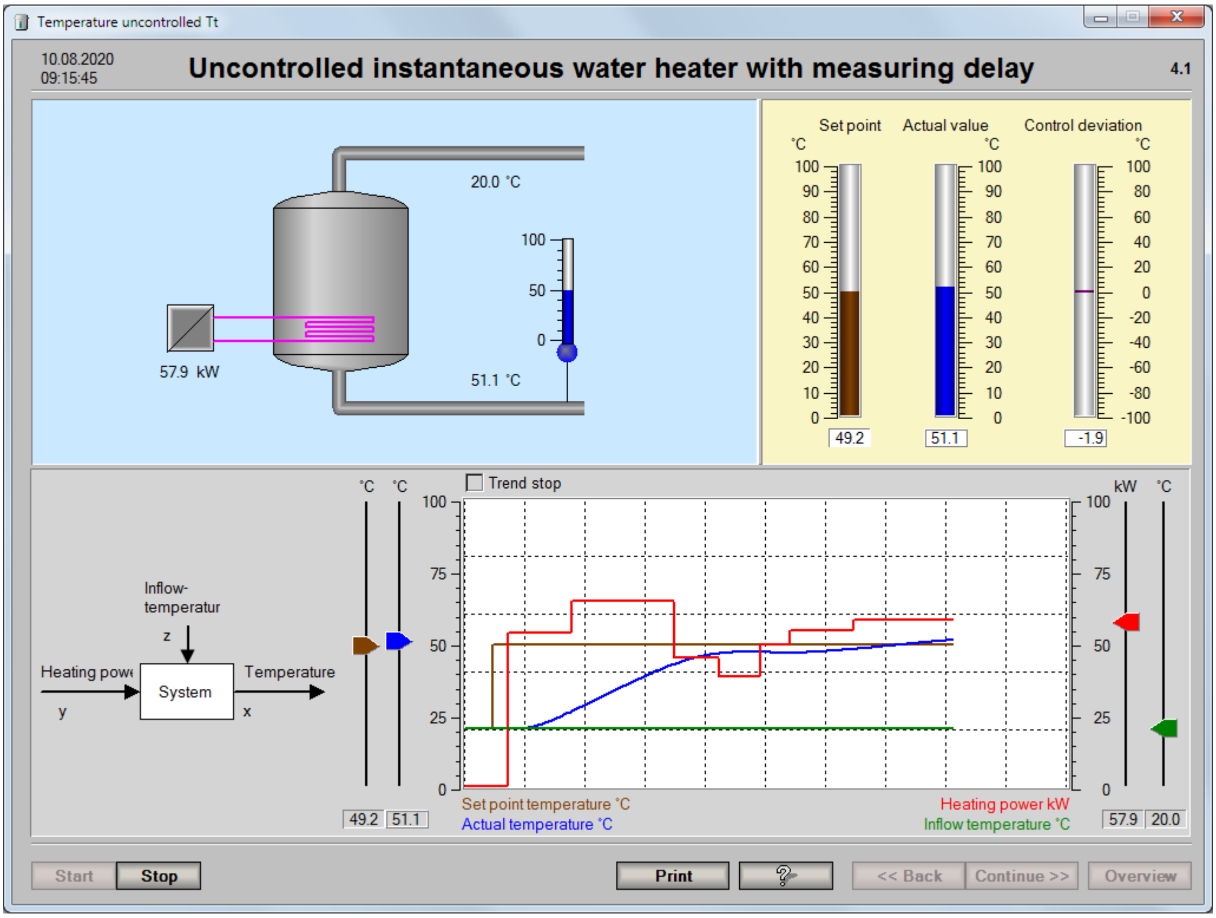
The values for all the signals are automatically saved and can later be viewed and analyzed in a diagram. When you click on "Analysis", a timing diagram containing the saved measured values opens up. Here you have several choices for an analysis. By clicking on the signal names, the Y scale is changed over. By clicking on the signal curves, the value of the active signal will be indicated and by holding and dragging the difference in value and time will be displayed. When you click on the buttons below, various analysis methods will be available, such as zoom, change time view, change value range, ruler function, methods to export the signal values into a text file, statistic analyzing methods

When you click on the "Parameter" button, another window opens up in which you can change the controller parameters (hysteresis), the setpoint temperature and the inlet temperature. The controller can also be switched from manual to automatic operation and vice versa, so that the actuating signal can be set manually.

Terminate the simulation by clicking on the "Stop" button. The defined initial states are reset and you may get to other process images by clicking on the buttons "Continue >>", "<< Back" and "Overview".

4 Temperature Control with Time Delay

4.1 Uncontrolled System

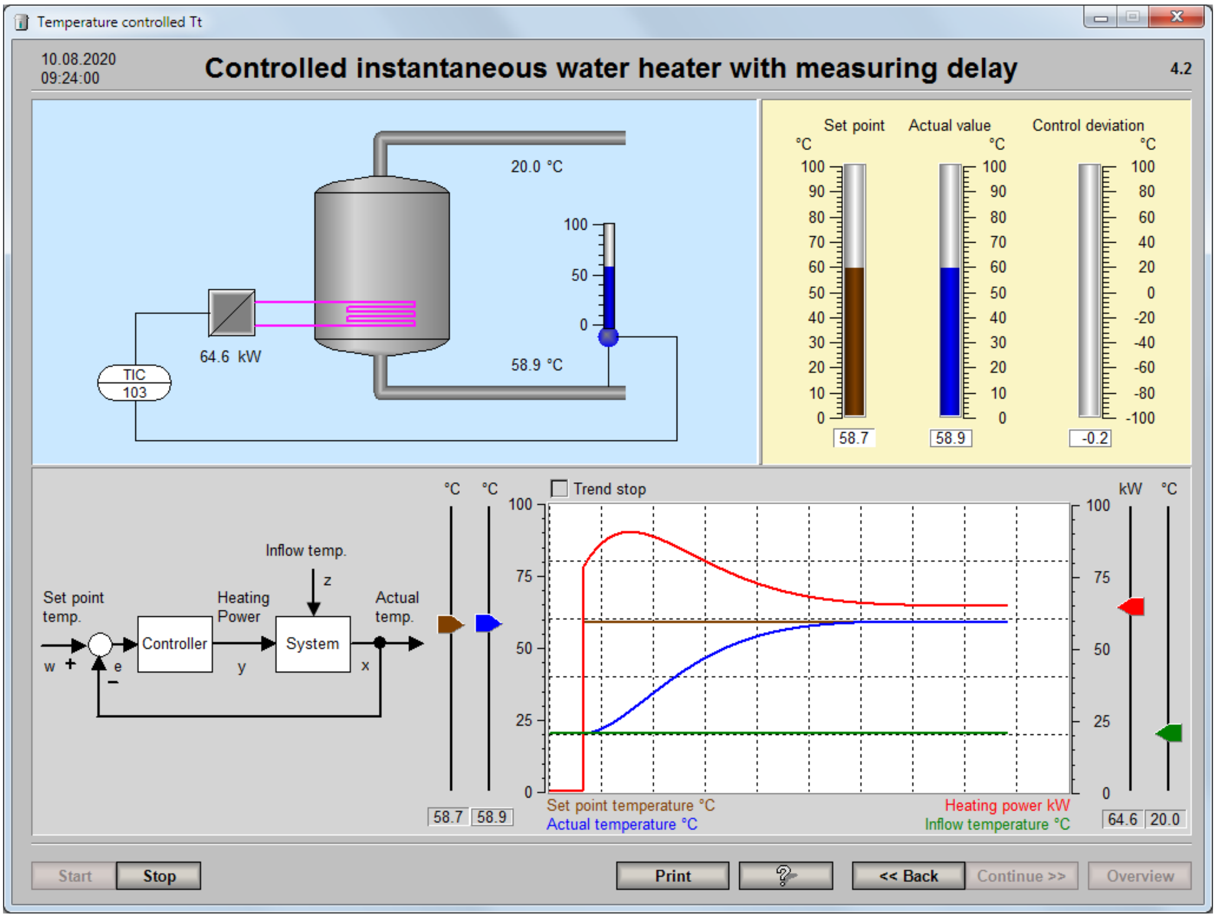


This process contains a tank through which water flows continuously. The liquid level does not change. With the aid of an electrical heater, the temperature of the water in the tank is affected. Since the temperature is measured in the outlet, the temperature is measured with a delay. The temperature in the outlet is measured with a dead time of one second. The exercise regarding control engineering is to control the temperature of the outlet water by changing the heater output, so that it corresponds to a certain setpoint value. The heater output is the input variable, the temperature of the water flowing off is the output variable of the system. Temperature changes of the water flowing in are a disturbance.

Start the process simulation by clicking on the "Start" button. A defined initial state is automatically set. Try to manually correct the actual temperature value to the setpoint value by changing the heater output with the shift button or the up/down counter. The change in the inlet temperature causes an interference, which is to be controlled.

Terminate the simulation by clicking on the "Stop" button. Click on the "Continue >>" or "<< Back" button to get to other process images.

4.2 Closed-Loop Controlled System



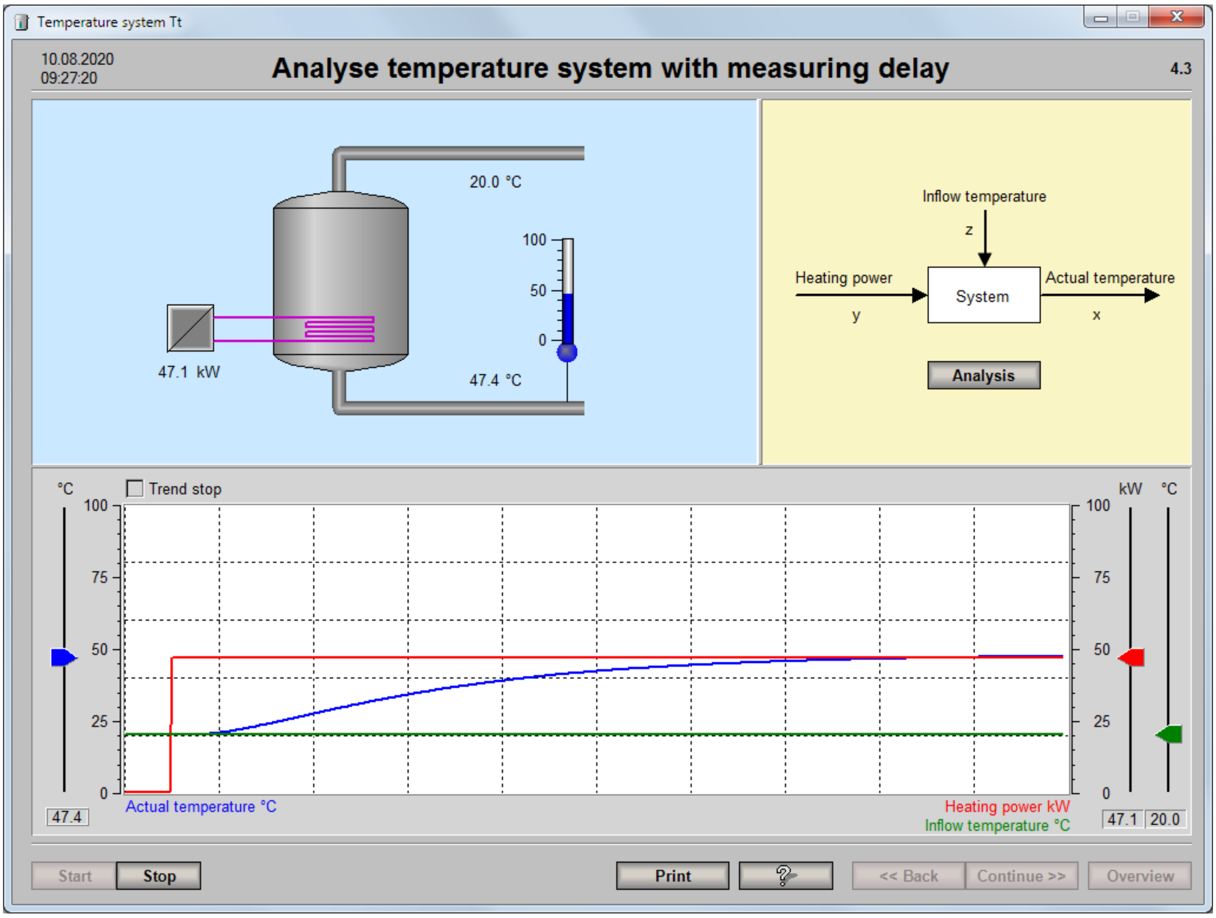
Contrary to the last page *Uncontrolled System* (Temperature with Time Delay), the temperature is not controlled manually, but with a PI controller.

Start the process simulation by clicking on the "Start" button. Defined initial states are set automatically. A PI controller starts to reach the setpoint value by regulating the electrical heater output.

You may change the setpoint and the inlet temperature with the respective shift button, the up/down counters or by entering values above the up/down counters.

Terminate the simulation by clicking on the "Stop" button. Click on the "Continue >>" or "<< Back" button to get to other process images.

4.3 Examine Controlled System

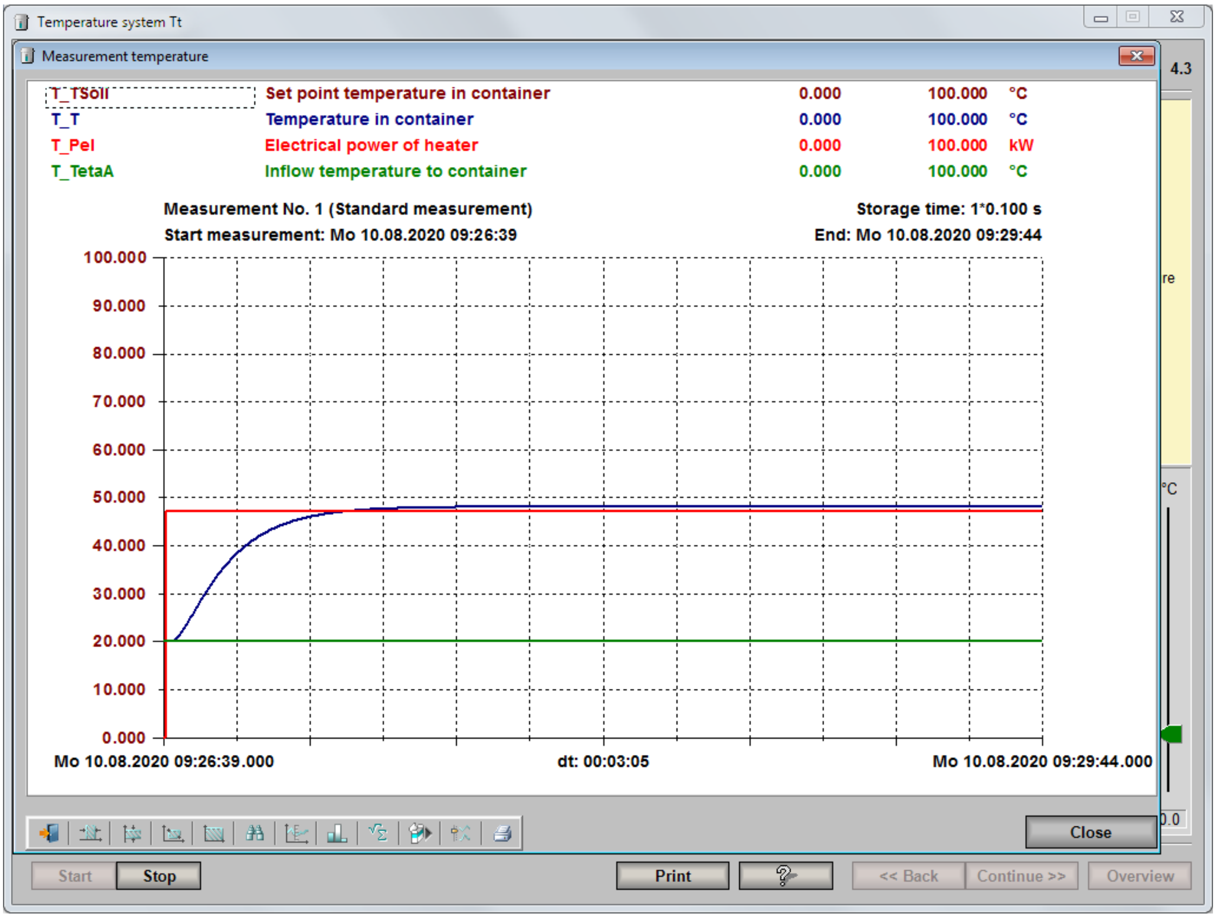


Here you can study the performance of the control loop responding to changes of the heater output and the inlet temperature.

Start the process simulation by clicking on the "Start" button. The heater output and the inlet temperature can be changed with the shift buttons or the display fields below the shift buttons or the bar displays.

The current values of the temperatures in the tank and of the inlet as well as the heater output are indicated in a diagram. The values of the signals are automatically saved, so that they can later be analyzed in a diagram, e.g. to determine the time constant for the controlled system.

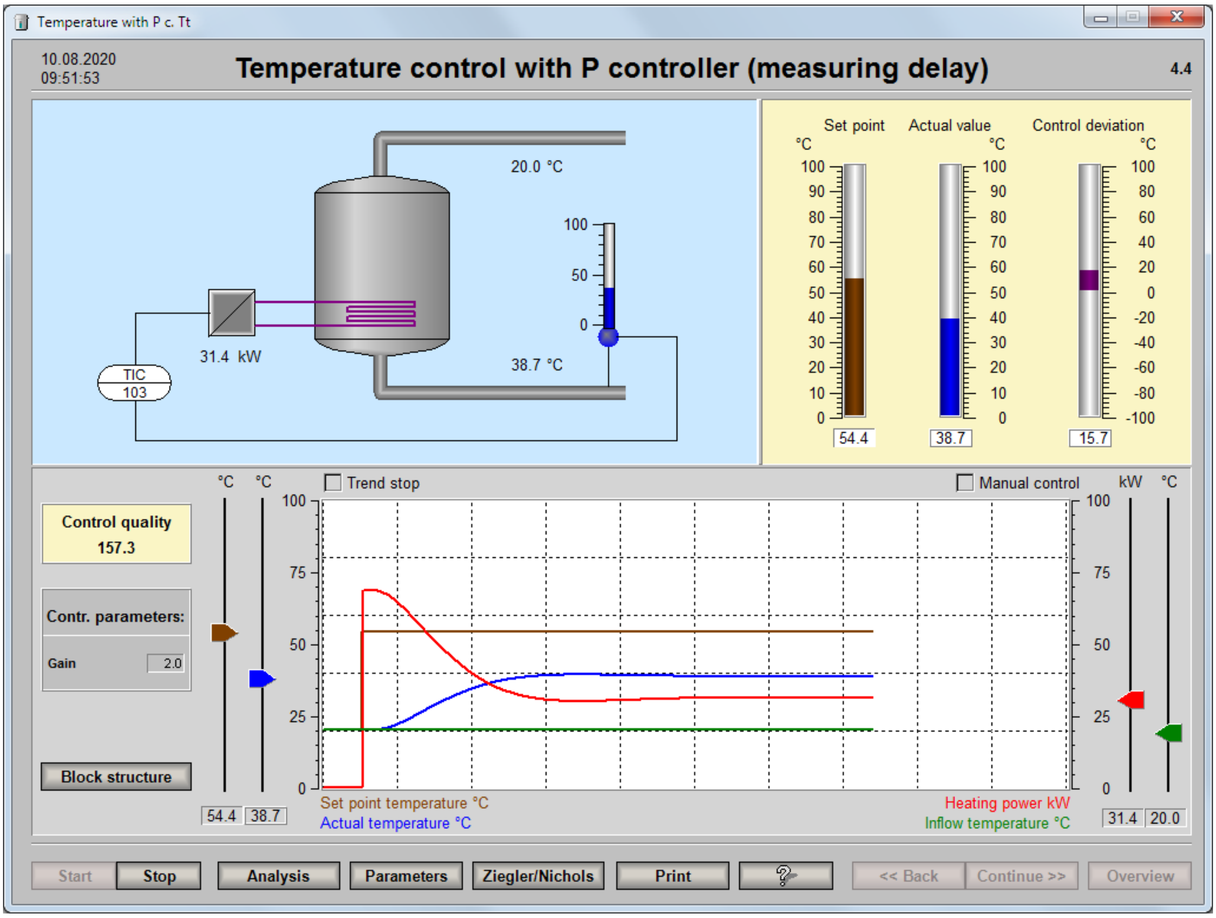
When clicking on "Analysis", the stored measured values are indicated in a timing diagram.



Here you have various methods of analysis. By clicking on the signal names, the Y scale is changed over. By clicking on the signal curves, the value of the active signal will be indicated and by holding and dragging the difference in value and time will be displayed. When you click on the buttons below, various analysis methods will be available, such as zoom, change time view, change value range, ruler function, methods to export the signal values into a text file, statistic analyzing methods

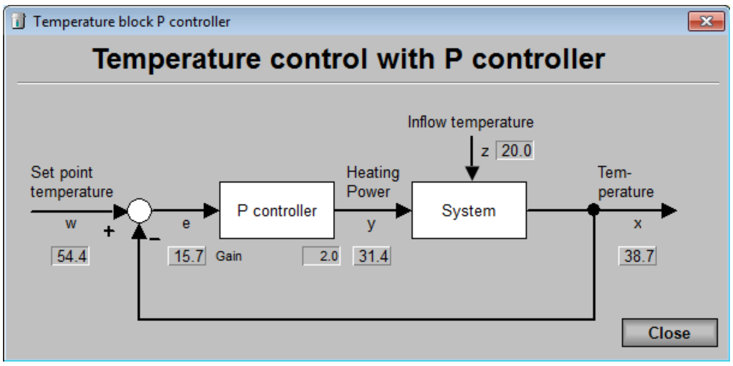
Terminate the simulation by clicking on the "Stop" button. The defined initial states are reset and you may get to other process images by clicking on the buttons "Continue >>", "<< Back" and "Overview".

4.4 Closed-Loop Control with P Controller



Here you can study the performance of the control loop when the setpoint and the disturbance change. For this purpose, a P controller is used.

The block structure of the control loop can be viewed by clicking on the "Block structure" button.

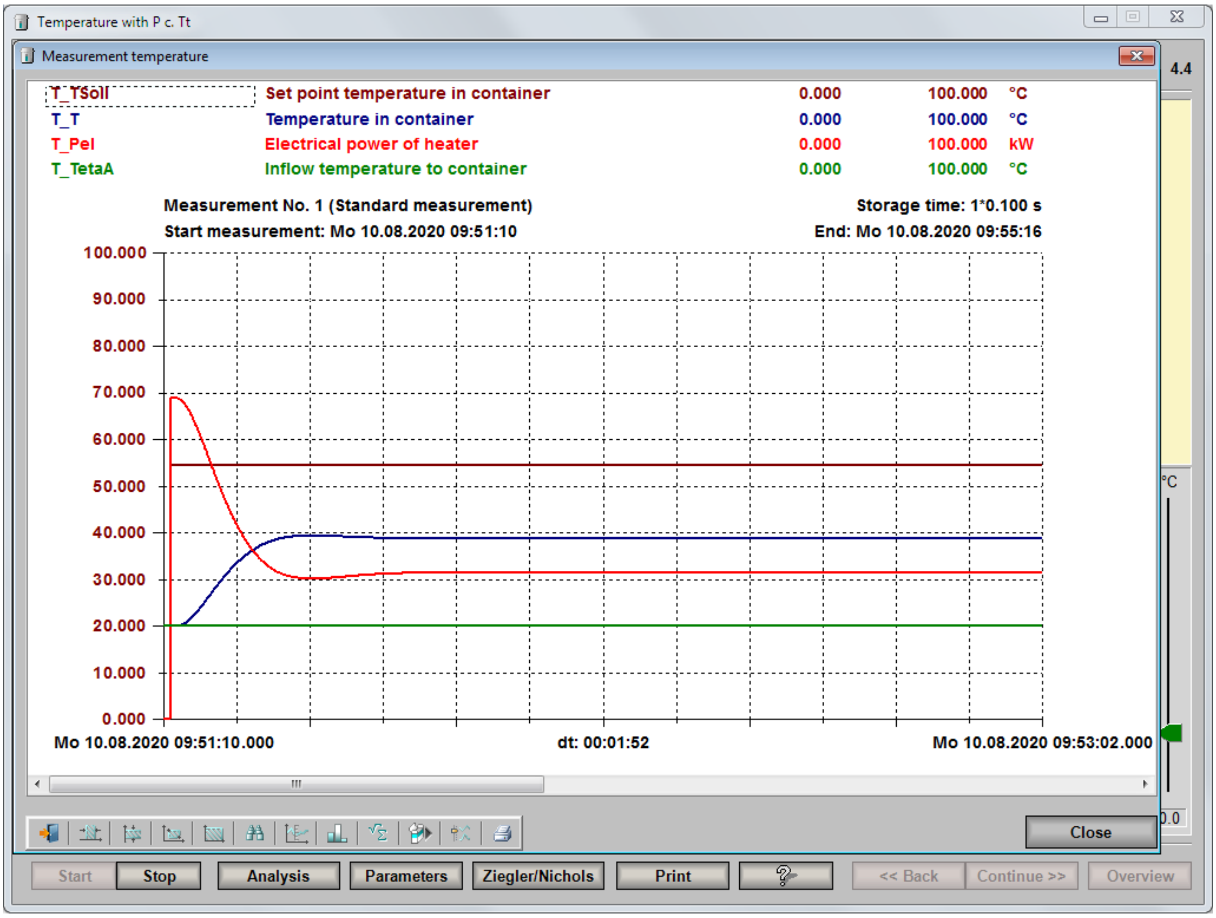


Start the simulation by clicking on the "Start" button. The current values of the setpoint temperature, the actual temperature and the inlet temperature are indicated in the diagram. The setpoint and the inlet temperature (as a disturbance) can be changed with the shift buttons or the display fields below the shift buttons or the bar displays. By clicking on the "Manual control" button, the controller is switched to manual operation. It is now possible to adjust the actuating signal (the heater output) with the shift button or by entering values in the display fields. By clicking on "Manual control" again, the controller is automatically reset to automatic operation.

When you click on "Trend Stop", the current trend diagram is stopped. The calculation continues.

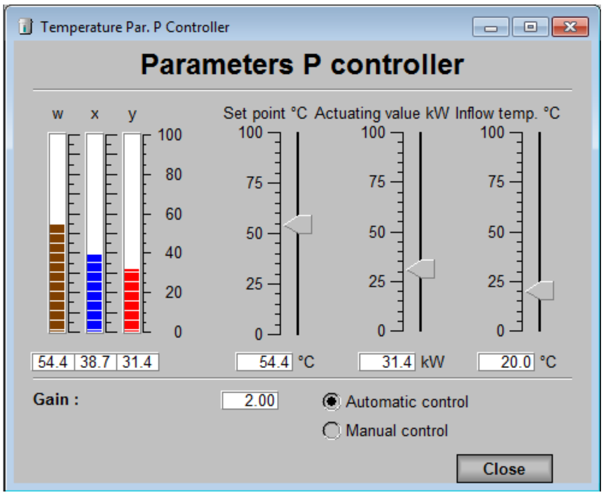
The system deviation box shows the integrated squared system deviation. When the setpoint value or the disturbance value changes, the system deviation is set to 0 and restarts to integrate.

The values for all the signals are automatically saved and can later be viewed and analyzed in a diagram. When you click on "Analysis", a timing diagram containing the saved measured values opens up.

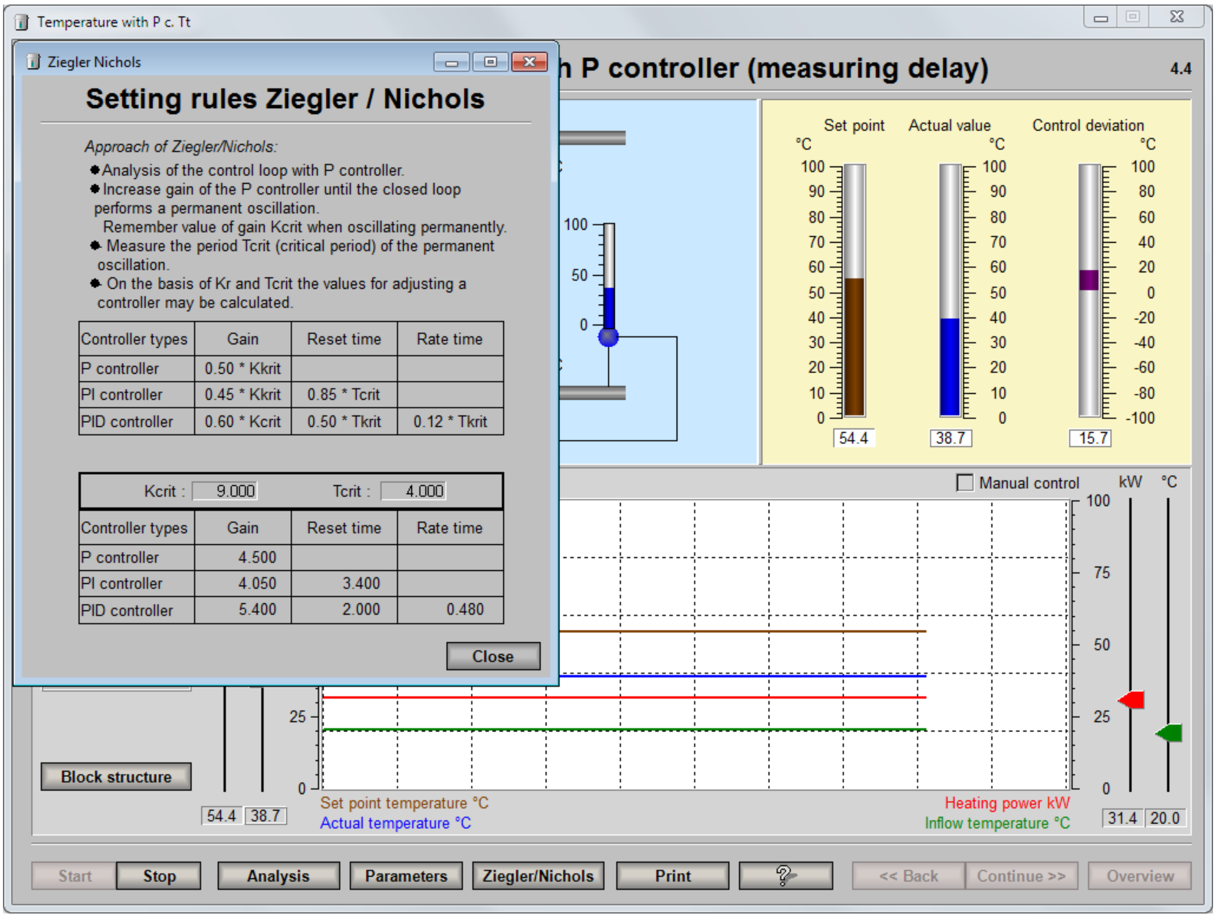


Here you have several choices for an analysis. By clicking on the signal names, the Y scale is changed over. By clicking on the signal curves, the value of the active signal will be indicated and by holding and dragging the difference in value and time will be displayed. When you click on the buttons below, various analysis methods will be available, such as zoom, change time view, change value range, ruler function, methods to export the signal values into a text file, statistic analyzing methods

When you click on the "Parameter" button, another window opens up in which you can change the controller parameters, the setpoint temperature and the inlet temperature. The controller can also be switched from manual to automatic operation and vice versa, so that the actuating signal can be set manually.



When you click on the "Ziegler/Nichols" button, another window opens up, which describes the setting rule of Ziegler/Nichols according to the stability limit method. It is also possible to enter the self-defined critical gain factor Kcrit and the critical time factor Tcrit to calculate the gain, the reset time and the rate time according to Ziegler/Nichols for the respective controllers. These parameters can then be tested on the pages with the respective controllers.



Terminate the simulation by clicking on the "Stop" button. The defined initial states are reset and you may get to other process images by clicking on the buttons "Continue >>", "<< Back" and "Overview".

4.5 Closed-Loop Control with I Controller

Here you can study the performance of the control loop when the setpoint and the disturbance change. For this purpose, an I controller is used.

The block structure of the control loop can be viewed by clicking on the "Block structure" button.

Start the simulation by clicking on the "Start" button. The current values of the setpoint temperature, the actual temperature and the inlet temperature are indicated in the diagram. The setpoint and the inlet temperature (as a disturbance) can be changed with the shift buttons or the display fields below the shift buttons or the bar displays. By clicking on the "Manual control" button, the controller is switched to manual operation. It is now possible to adjust the actuating signal (the heater output) with the shift button or by entering values in the display fields. By clicking on "Manual control" again, the controller is automatically reset to automatic operation.

When you click on "Trend Stop", the current trend diagram is stopped. The calculation continues.

The system deviation box shows the integrated squared system deviation. When the setpoint value or the disturbance value changes, the system deviation is set to 0 and restarts to integrate.

The values for all the signals are automatically saved and can later be viewed and analyzed in a diagram. When you click on "Analysis", a timing diagram containing the saved measured values opens up. Here you have several choices for an analysis. By clicking on the signal names, the Y scale is changed over. By clicking on the signal curves, the value of the active signal will be indicated and by holding and dragging the difference in value and time will be displayed. When you click on the buttons below, various analysis methods will be available, such as zoom, change time view, change value range, ruler function, methods to export the signal values into a text file, statistic analyzing methods

When you click on the "Parameter" button, another window opens up in which you can change the controller parameters, the setpoint temperature and the inlet temperature. The controller can also be switched from manual to automatic operation and vice versa, so that the actuating signal can be set manually.

Terminate the simulation by clicking on the "Stop" button. The defined initial states are reset and you may get to other process images by clicking on the buttons "Continue >>", "<< Back" and "Overview".

4.6 Closed-Loop Control with PI Controller

Here you can study the performance of the control loop when the setpoint and the disturbance change. For this purpose, a PI controller is used.

The block structure of the control loop can be viewed by clicking on the "Block structure" button.

Start the simulation by clicking on the "Start" button. The current values of the setpoint temperature, the actual temperature and the inlet temperature are indicated in the diagram. The setpoint and the inlet temperature (as a disturbance) can be changed with the shift buttons or the display fields below the shift buttons or the bar displays. By clicking on the "Manual control" button, the controller is switched to manual operation. It is now possible to adjust the actuating signal (the heater output) with the shift button or by entering values in the display fields. By clicking on "Manual control" again, the controller is automatically reset to automatic operation.

When you click on "Trend Stop", the current trend diagram is stopped. The calculation continues.

The system deviation box shows the integrated squared system deviation. When the setpoint value or the disturbance value changes, the system deviation is set to 0 and restarts to integrate.

The values for all the signals are automatically saved and can later be viewed and analyzed in a diagram. When you click on "Analysis", a timing diagram containing the saved measured values opens up. Here you have several choices for an analysis. By clicking on the signal names, the Y scale is changed over. By clicking on the signal curves, the value of the active signal will be indicated and by holding and dragging the difference in value and time will be displayed. When you click on the buttons below, various analysis methods will be available, such as zoom, change time view, change value range, ruler function, methods to export the signal values into a text file, statistic analyzing methods

When you click on the "Parameter" button, another window opens up in which you can change the controller parameters, the setpoint temperature and the inlet temperature. The controller can also be switched from manual to automatic operation and vice versa, so that the actuating signal can be set manually.

Terminate the simulation by clicking on the "Stop" button. The defined initial states are reset and you may get to other process images by clicking on the buttons "Continue >>", "<< Back" and "Overview".

4.7 Closed-Loop Control with PID Controller

Here you can study the performance of the control loop when the setpoint and the disturbance change. For this purpose, a PID controller is used.

The block structure of the control loop can be viewed by clicking on the "Block structure" button.

Start the simulation by clicking on the "Start" button. The current values of the setpoint temperature, the actual temperature and the inlet temperature are indicated in the diagram. The setpoint and the inlet temperature (as a disturbance) can be changed with the shift buttons or the display fields below the shift buttons or the bar displays. By clicking on the "Manual control" button, the controller is switched to manual operation. It is now possible to adjust the actuating signal (the heater output) with the shift button or by entering values in the display fields. By clicking on "Manual control" again, the controller is automatically reset to automatic operation.

When you click on "Trend Stop", the current trend diagram is stopped. The calculation continues.

The system deviation box shows the integrated squared system deviation. When the setpoint value or the disturbance value changes, the system deviation is set to 0 and restarts to integrate.

The values for all the signals are automatically saved and can later be viewed and analyzed in a diagram. When you click on "Analysis", a timing diagram containing the saved measured values opens up. Here you have several choices for an analysis. By clicking on the signal names, the Y scale is changed over. By clicking on the signal curves, the value of the active signal will be indicated and by holding and dragging the difference in value and time will be displayed. When you click on the buttons below, various analysis methods will be available, such as zoom, change time view, change value range, ruler function, methods to export the signal values into a text file, statistic analyzing methods

When you click on the "Parameter" button, another window opens up in which you can change the controller parameters, the setpoint temperature and the inlet temperature. The controller can also be switched from manual to automatic operation and vice versa, so that the actuating signal can be set manually.

Terminate the simulation by clicking on the "Stop" button. The defined initial states are reset and you may get to other process images by clicking on the buttons "Continue >>", "<< Back" and "Overview".

4.8 Closed-Loop Control with Two-Position Controller

Here you can study the performance of the control loop when the setpoint and the disturbance change. For this purpose, a two-position controller is used.

The block structure of the control loop can be viewed by clicking on the "Block structure" button.

Start the simulation by clicking on the "Start" button. The current values of the setpoint temperature, the actual temperature and the inlet temperature are indicated in the diagram. The setpoint and the inlet temperature (as a disturbance) can be changed with the shift buttons or the display fields below the shift buttons or the bar displays. By clicking on the "Manual control" button, the controller is switched to manual operation. It is now possible to adjust the actuating signal (the heater output) with the shift button or by entering values in the display fields. By clicking on "Manual control" again, the controller is automatically reset to automatic operation.

When you click on "Trend Stop", the current trend diagram is stopped. The calculation continues.

The system deviation box shows the integrated squared system deviation. When the setpoint value or the disturbance value changes, the system deviation is set to 0 and restarts to integrate.

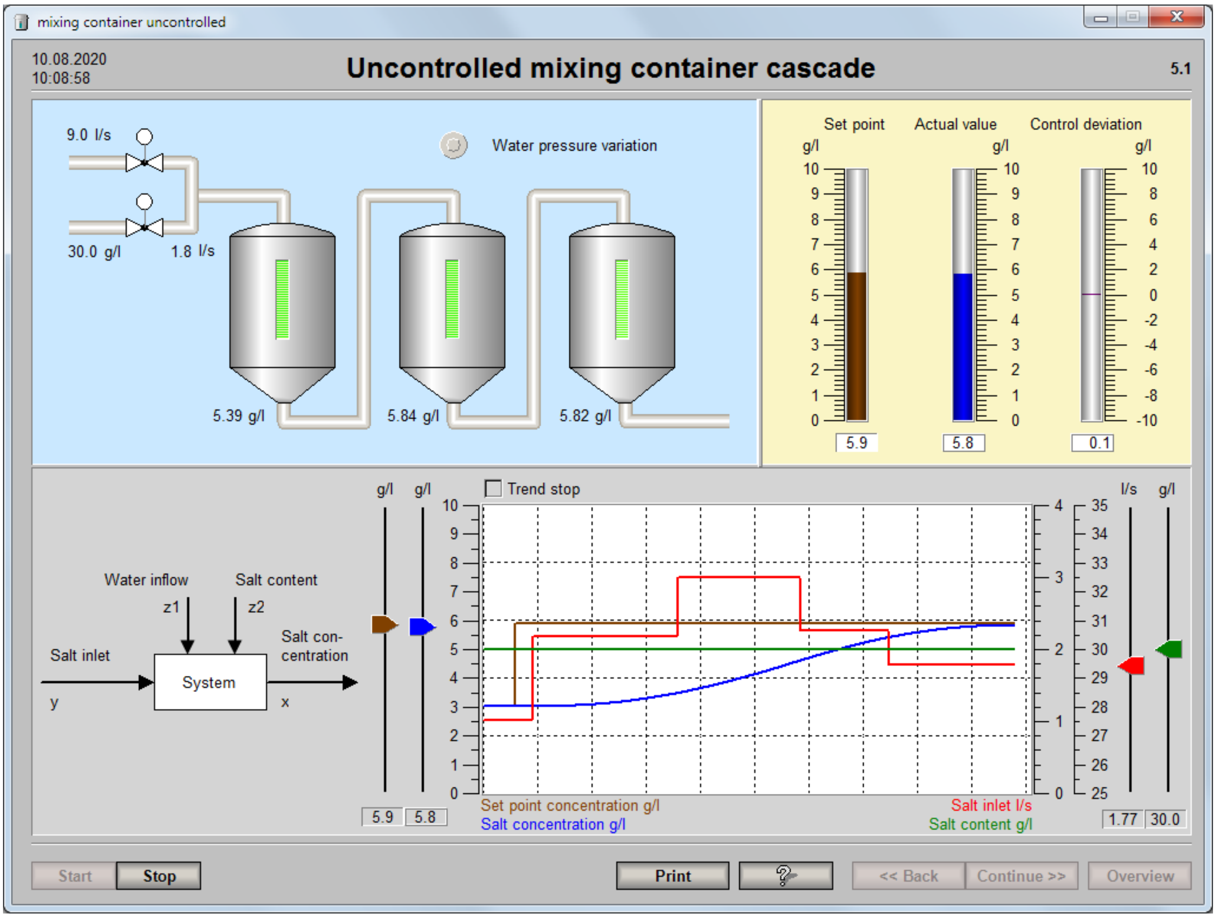
The values for all the signals are automatically saved and can later be viewed and analyzed in a diagram. When you click on "Analysis", a timing diagram containing the saved measured values opens up. Here you have several choices for an analysis. By clicking on the signal names, the Y scale is changed over. By clicking on the signal curves, the value of the active signal will be indicated and by holding and dragging the difference in value and time will be displayed. When you click on the buttons below, various analysis methods will be available, such as zoom, change time view, change value range, ruler function, methods to export the signal values into a text file, statistic analyzing methods

When you click on the "Parameter" button, another window opens up in which you can change the controller parameters (hysteresis), the setpoint temperature and the inlet temperature. The controller can also be switched from manual to automatic operation and vice versa, so that the actuating signal can be set manually.

Terminate the simulation by clicking on the "Stop" button. The defined initial states are reset and you may get to other process images by clicking on the buttons "Continue >>", "<< Back" and "Overview".

5 Mixing Container Cascade

5.1 Uncontrolled System



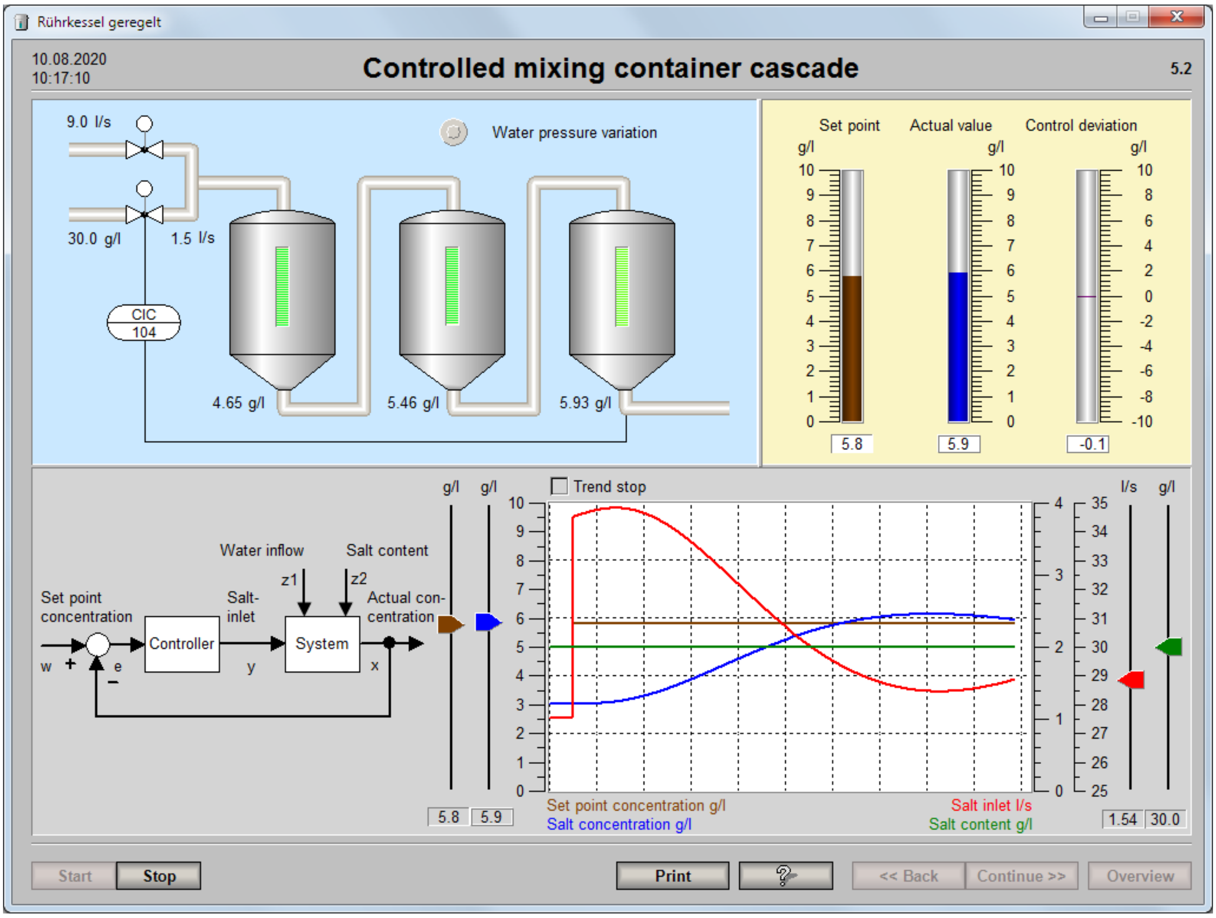
The design of the system mainly consists of three mixing containers, each of which is equipped with an inlet and an outlet. The outlet of the first container is connected to the inlet of the second container, and the outlet of the second container to the inlet of the third container.

In this simulation example, a salt solution is mixed with water. The first container is filled with a mixture of water and salt solution. The individual flow rates can be varied with valves. The exercise on control engineering is to control the salt concentration in the third container, so that it corresponds to a certain setpoint value. Therefore, the flow rate of the salt solution constitutes the input variable, and the salt concentration of the liquid outlet from the third container is the output variable of the system. Varying flow rates of the water inlet and changing concentrations of the salt solution act as disturbances.

Start the process simulation by clicking on the "Start" button. A defined initial state is automatically set. Try to manually correct the salt concentration to the setpoint value by changing the flow rate of the salt solution with the shift button, the up/down counter or by entering the numeric values below the up/down counters. Changing the flow rate of the salt solution and clicking on the "Admission pressure variation" button causes an interference, which is to be controlled.

Terminate the simulation by clicking on the "Stop" button. Click on the "Continue >>" or "<< Back" button to get to other process images.

5.2 Closed-Loop Controlled System



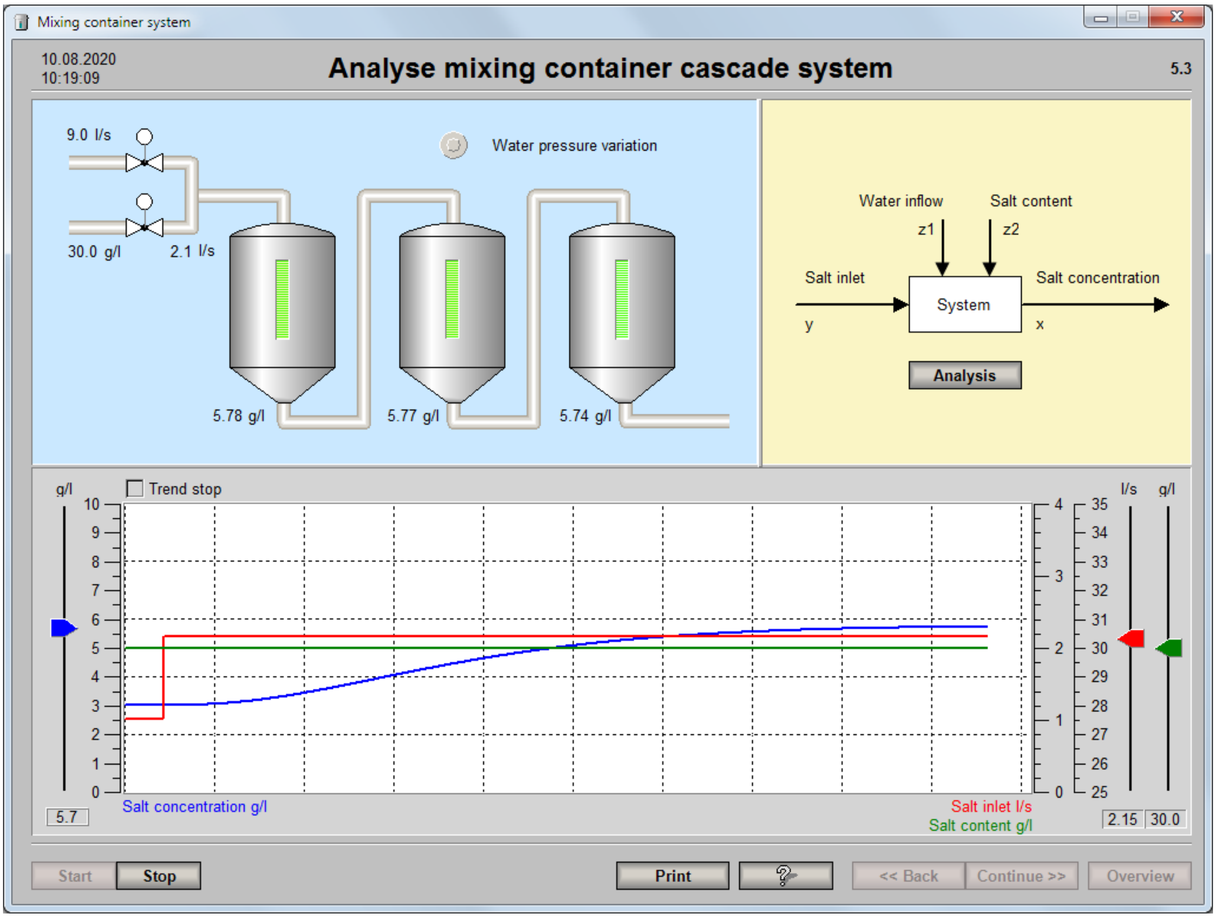
Contrary to the last page *Uncontrolled System*, the closed-loop control process for the salt concentration is not actuated manually, but with a PI controller.

Start the process simulation by clicking on the "Start" button. Defined initial states are set automatically. A PI controller starts to reach the setpoint value by regulating the inlet of the salt solution.

You may change the setpoint and the water inlet via the respective shift buttons, the up/down counters or by entering values above the up/down counters. Clicking on the "Admission pressure variation" button causes interference to the water flow. The salt concentration in the inlet flow of the salt solution can be changed via the salt content flow.

Terminate the simulation by clicking on the "Stop" button. Click on the "Continue >>" or "<< Back" button to get to other process images.

5.3 Examine Controlled System

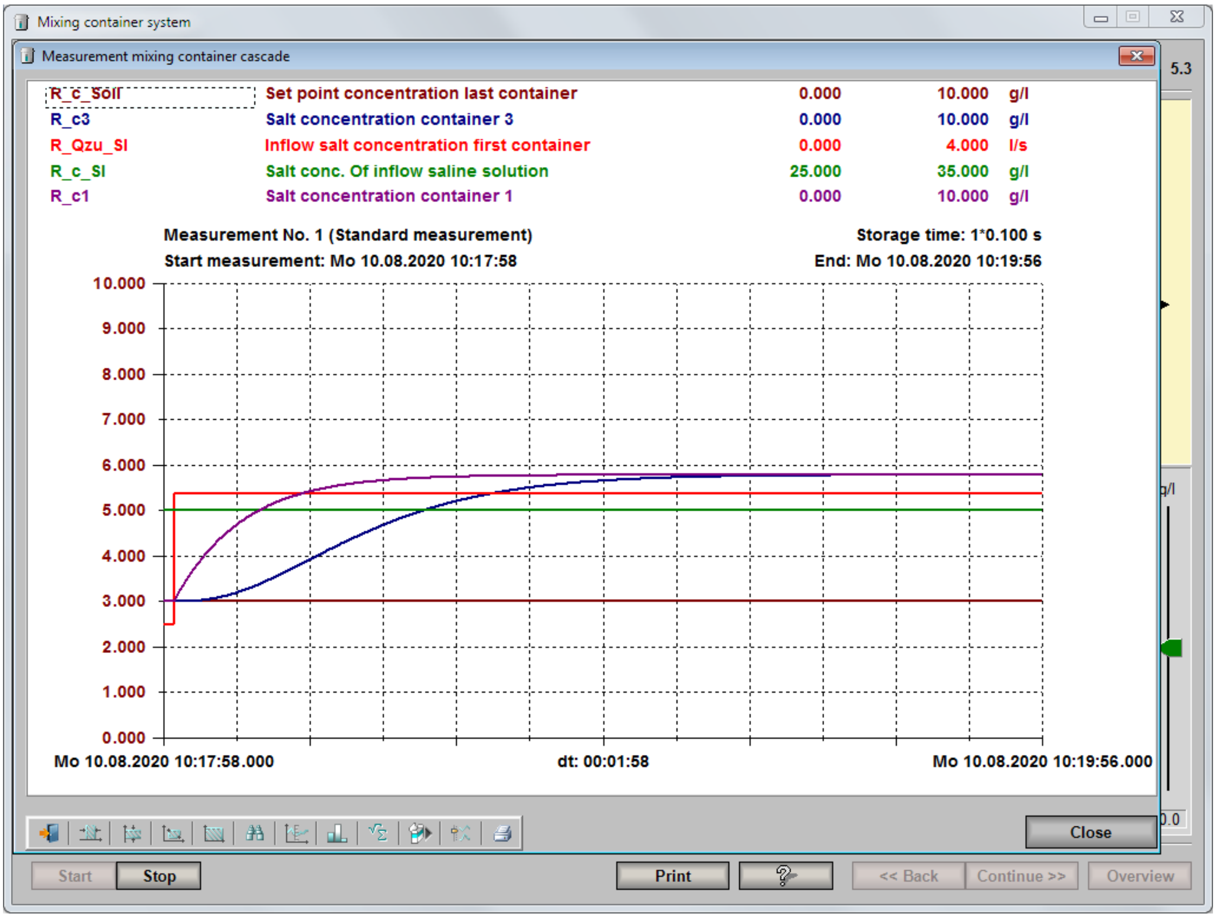


Here you can study the response of the uncontrolled system to interference (admission pressure variation, salt content) and to changing values of the manipulated variable (salt flow).

Start the simulation by clicking on the "Start" button. The salt content and the salt inlet can be changed with the shift buttons or the display fields below the shift buttons or below the bar diagrams. An admission pressure variation is achieved by clicking on the button.

The current values for the salt content in the third container, the salt content in the inlet and the salt solution flow are graphically indicated in a diagram. The values of the signals are automatically saved, so that they can later be analyzed in a diagram, e.g. to determine the time constant for the controlled system.

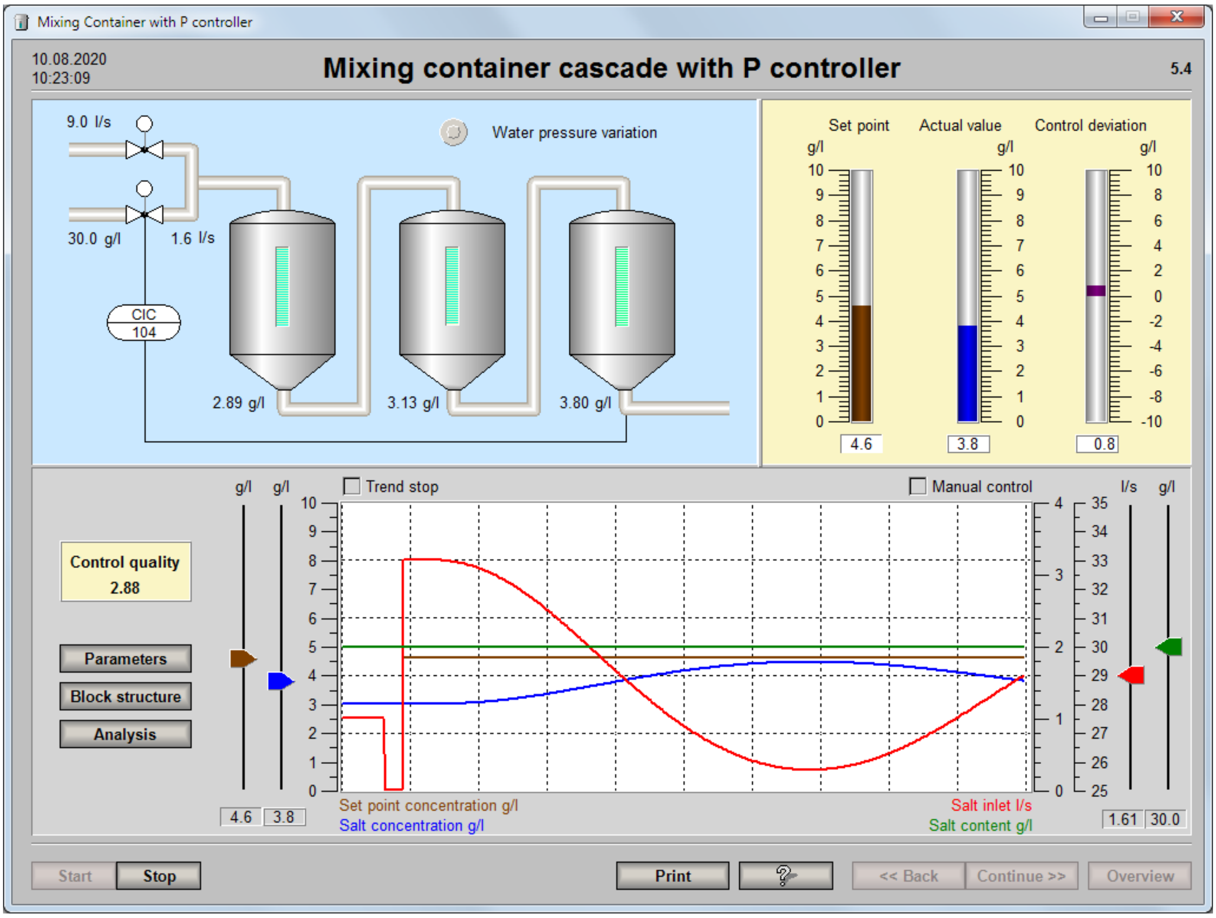
When clicking on "Analysis", the stored measured values are indicated in a timing diagram.



Here you have various methods of analysis. By clicking on the signal names, the Y scale is changed over. By clicking on the signal curves, the value of the active signal will be indicated and by holding and dragging the difference in value and time will be displayed. When you click on the buttons below, various analysis methods will be available, such as zoom, change time view, change value range, ruler function, methods to export the signal values into a text file, statistic analyzing methods

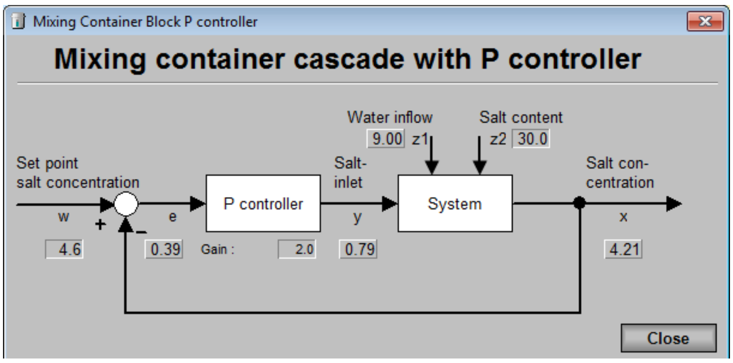
Terminate the simulation by clicking on the "Stop" button. The defined initial states are reset and you may get to other process images by clicking on the buttons "Continue >>", "<< Back" and "Overview".

5.4 Closed-Loop Control with P Controller



Here you can study the performance of the control loop when the setpoint and the disturbance change. For this purpose, a P controller is used.

The block structure of the control loop can be viewed by clicking on the "Block structure" button.



Start the simulation by clicking on the "Start" button. The current values of the setpoint for the salt concentration, the actual concentration, the salt solution inlet and the salt content in the inlet are indicated in the diagram. The setpoint value and the salt content in the inlet (as a disturbance) can be changed with the shift buttons or the display fields below the shift buttons or the bar displays. By clicking on the "Manual control" button, the controller is switched to manual operation. It is now possible to adjust the actuating signal (the salt solution inlet) with the shift button or by entering values in the display fields. By clicking on "Manual control" again, the controller is automatically reset to automatic operation.

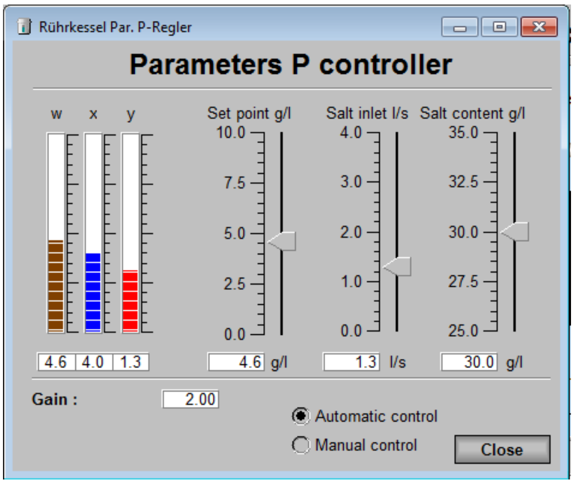
When you click on "Trend Stop", the current trend diagram is stopped. The calculation continues.

The system deviation box shows the integrated squared system deviation. When the setpoint value or the disturbance value changes, the system deviation is set to 0 and restarts to integrate.

The values for all the signals are automatically saved and can later be viewed and analyzed in a diagram. When you click on "Analysis", a timing diagram containing the saved measured values opens up.

Here you have several choices for an analysis. By clicking on the signal names, the Y scale is changed over. By clicking on the signal curves, the value of the active signal will be indicated and by holding and dragging the difference in value and time will be displayed. When you click on the buttons below, various analysis methods will be available, such as zoom, change time view, change value range, ruler function, methods to export the signal values into a text file, statistic analyzing methods

When you click on the "Parameter" button, another window opens up in which you can change the controller parameters, the setpoint concentration and the salt content in the inlet. The controller can also be switched from manual to automatic operation and vice versa, so that the actuating signal can be set manually.



Terminate the simulation by clicking on the "Stop" button. The defined initial states are reset and you may get to other process images by clicking on the buttons "Continue >>", "<< Back" and "Overview".

5.5 Closed-Loop Control with I Controller

Here you can study the performance of the control loop when the setpoint and the disturbance change. For this purpose, an I controller is used.

The block structure of the control loop can be viewed by clicking on the "Block structure" button.

Start the simulation by clicking on the "Start" button. The current values of the setpoint for the salt concentration, the actual concentration, the salt solution inlet and the salt content in the inlet are indicated in the diagram. The setpoint value and the salt content in the inlet (as a disturbance) can be changed with the shift buttons or the display fields below the shift buttons or the bar displays. By clicking on the "Manual control" button, the controller is switched to manual operation. It is now possible to adjust the actuating signal (the salt solution inlet) with the shift button or by entering values in the display fields. By clicking on "Manual control" again, the controller is automatically reset to automatic operation.

When you click on "Trend Stop", the current trend diagram is stopped. The calculation continues.

The system deviation box shows the integrated squared system deviation. When the setpoint value or the disturbance value changes, the system deviation is set to 0 and restarts to integrate.

The values for all the signals are automatically saved and can later be viewed and analyzed in a diagram. When you click on "Analysis", a timing diagram containing the saved measured values opens up. Here you have several choices for an analysis. By clicking on the signal names, the Y scale is changed over. By clicking on the signal curves, the value of the active signal will be indicated and by holding and dragging the difference in value and time will be displayed. When you click on the buttons below, various analysis methods will be available, such as zoom, change time view, change value range, ruler function, methods to export the signal values into a text file, statistic analyzing methods

When you click on the "Parameter" button, another window opens up in which you can change the controller parameters, the setpoint concentration and the salt content in the inlet. The controller can also be switched from manual to automatic operation and vice versa, so that the actuating signal can be set manually.

Terminate the simulation by clicking on the "Stop" button. The defined initial states are reset and you may get to other process images by clicking on the buttons "Continue >>", "<< Back" and "Overview".

5.6 Closed-Loop Control with PI Controller

Here you can study the performance of the control loop when the setpoint and the disturbance change. For this purpose, a PI controller is used.

The block structure of the control loop can be viewed by clicking on the "Block structure" button.

Start the simulation by clicking on the "Start" button. The current values of the setpoint for the salt concentration, the actual concentration, the salt solution inlet and the salt content in the inlet are indicated in the diagram. The setpoint value and the salt content in the inlet (as a disturbance) can be changed with the shift buttons or the display fields below the shift buttons or the bar displays. By clicking on the "Manual control" button, the controller is switched to manual operation. It is now possible to adjust the actuating signal (the salt solution inlet) with the shift button or by entering values in the display fields. By clicking on "Manual control" again, the controller is automatically reset to automatic operation.

When you click on "Trend Stop", the current trend diagram is stopped. The calculation continues.

The system deviation box shows the integrated squared system deviation. When the setpoint value or the disturbance value changes, the system deviation is set to 0 and restarts to integrate.

The values for all the signals are automatically saved and can later be viewed and analyzed in a diagram. When you click on "Analysis", a timing diagram containing the saved measured values opens up. Here you have several choices for an analysis. By clicking on the signal names, the Y scale is changed over. By clicking on the signal curves, the value of the active signal will be indicated and by holding and dragging the difference in value and time will be displayed. When you click on the buttons below, various analysis methods will be available, such as zoom, change time view, change value range, ruler function, methods to export the signal values into a text file, statistic analyzing methods

When you click on the "Parameter" button, another window opens up in which you can change the controller parameters, the setpoint concentration and the salt content in the inlet. The controller can also be switched from manual to automatic operation and vice versa, so that the actuating signal can be set manually.

Terminate the simulation by clicking on the "Stop" button. The defined initial states are reset and you may get to other process images by clicking on the buttons "Continue >>", "<< Back" and "Overview".

5.7 Closed-Loop Control with PID Controller

Here you can study the performance of the control loop when the setpoint and the disturbance change. For this purpose, a PID controller is used.

The block structure of the control loop can be viewed by clicking on the "Block structure" button.

Start the simulation by clicking on the "Start" button. The current values of the setpoint for the salt concentration, the actual concentration, the salt solution inlet and the salt content in the inlet are indicated in the diagram. The setpoint value and the salt content in the inlet (as a disturbance) can be changed with the shift buttons or the display fields below the shift buttons or the bar displays. By clicking on the "Manual control" button, the controller is switched to manual operation. It is now possible to adjust the actuating signal (the salt solution inlet) with the shift button or by entering values in the display fields. By clicking on "Manual control" again, the controller is automatically reset to automatic operation.

When you click on "Trend Stop", the current trend diagram is stopped. The calculation continues.

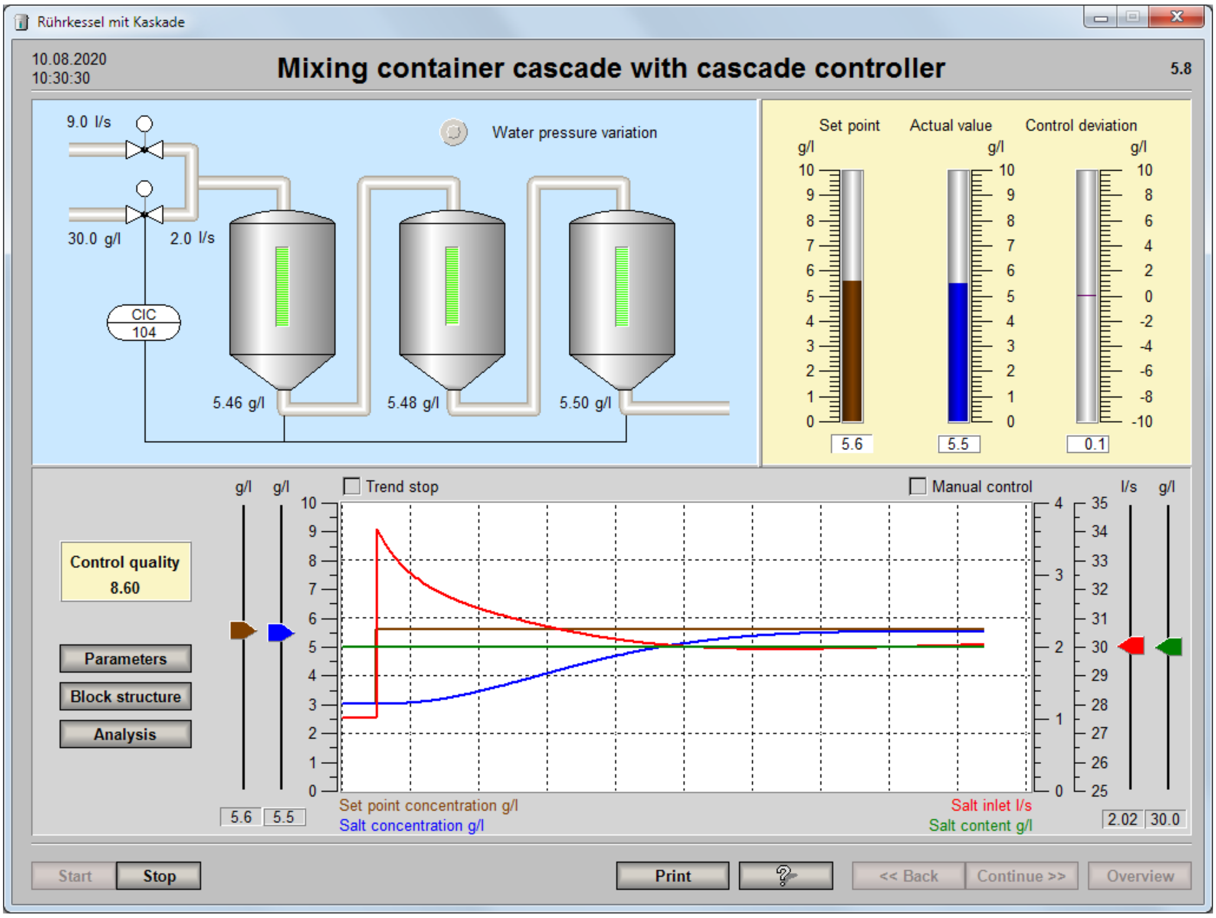
The system deviation box shows the integrated squared system deviation. When the setpoint value or the disturbance value changes, the system deviation is set to 0 and restarts to integrate.

The values for all the signals are automatically saved and can later be viewed and analyzed in a diagram. When you click on "Analysis", a timing diagram containing the saved measured values opens up. Here you have several choices for an analysis. By clicking on the signal names, the Y scale is changed over. By clicking on the signal curves, the value of the active signal will be indicated and by holding and dragging the difference in value and time will be displayed. When you click on the buttons below, various analysis methods will be available, such as zoom, change time view, change value range, ruler function, methods to export the signal values into a text file, statistic analyzing methods

When you click on the "Parameter" button, another window opens up in which you can change the controller parameters, the setpoint concentration and the salt content in the inlet. The controller can also be switched from manual to automatic operation and vice versa, so that the actuating signal can be set manually.

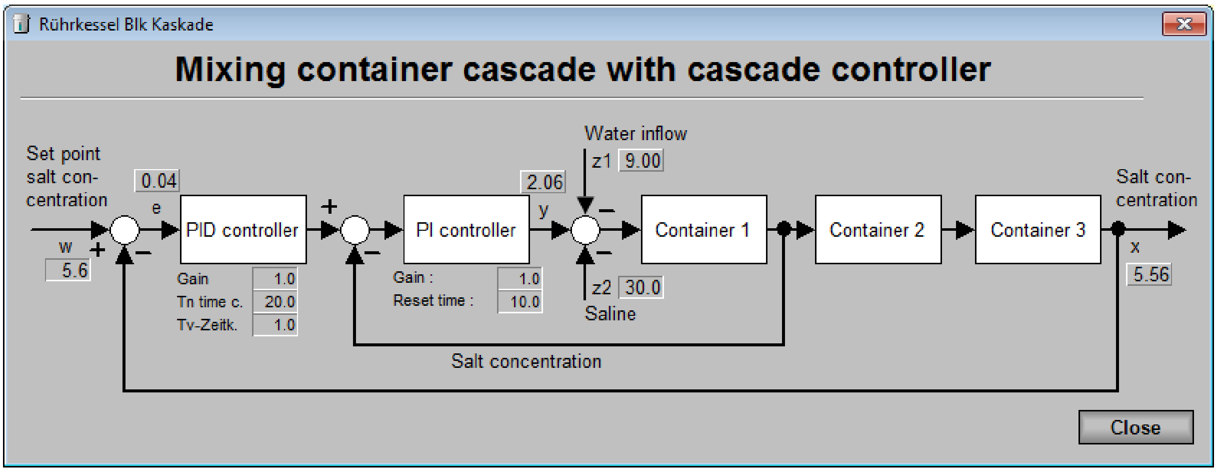
Terminate the simulation by clicking on the "Stop" button. The defined initial states are reset and you may get to other process images by clicking on the buttons "Continue >>", "<< Back" and "Overview".

5.8 Cascade Control



Here you can study the performance of the control loop when the setpoint and the disturbance change. For this purpose, a cascade control is used.

The block structure of the simulated control loop can be viewed by clicking on the "Block structure" button.



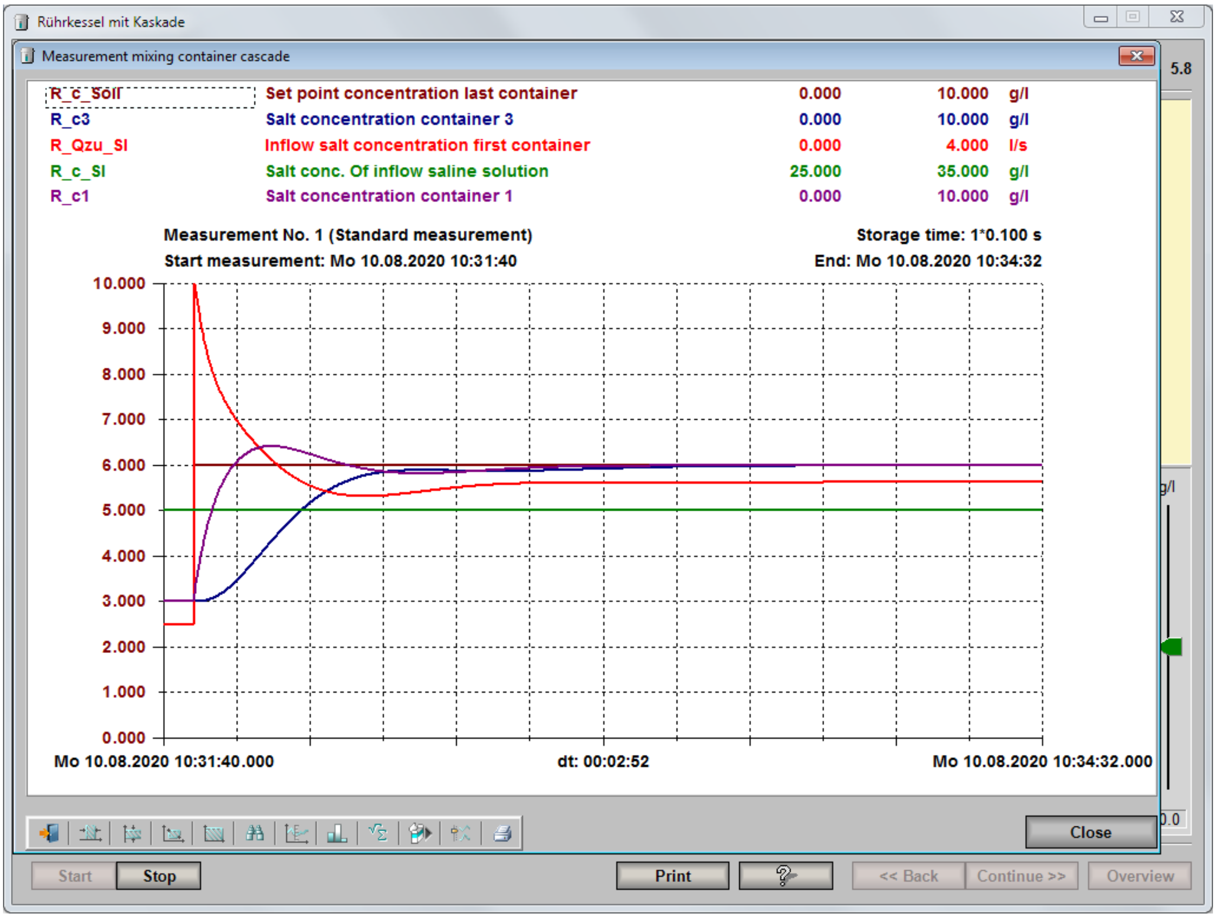
The cascade control consists of two control loops. The external primary control loop with a PID controller has a secondary internal control loop with a PI controller. Since the controlled system has a relatively large time constant, it takes a long time until a changing input variable has an effect on the output. In a single control loop, this is disadvantageous for the velocity of the control. In a cascade control, the output variable of the first container is used. Changes (disturbances) of the inlet concentration are measured much earlier in the first container than in the third container. Therefore, the internal control loop acts upon system deviations much faster, so that the entire control process is accelerated. It is another advantage that large system deviations in the first container, as they occur in a single control loop, are eliminated due to the internal loop.

Start the simulation by clicking on the "Start" button. The current values of the setpoint for the salt concentration, the actual concentration, the salt solution inlet and the salt content in the inlet are indicated in the diagram. The setpoint value and the salt content in the inlet (as a disturbance) can be changed with the shift buttons or the display fields below the shift buttons or the bar displays. By clicking on the "Manual control" button, the controller is switched to manual operation. It is now possible to adjust the actuating signal (the salt solution inlet) with the shift button or by entering values in the display fields. By clicking on "Manual control" again, the controller is automatically reset to automatic operation.

When you click on "Trend Stop", the current trend diagram is stopped. The calculation continues.

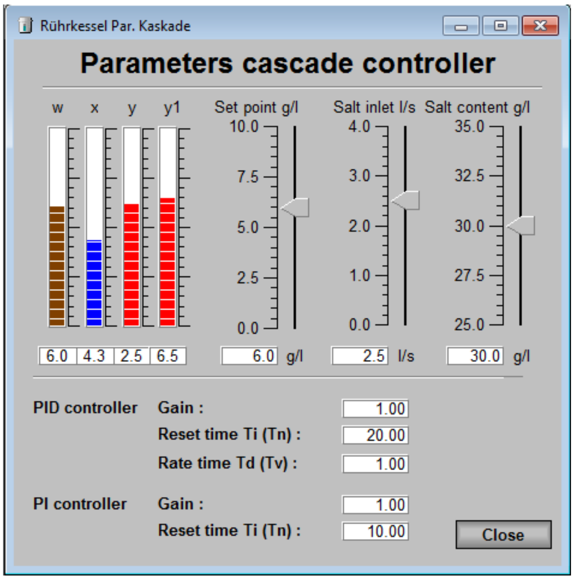
The system deviation box shows the integrated squared system deviation. When the setpoint value or the disturbance value changes, the system deviation is set to 0 and restarts to integrate.

The values for all the signals are automatically saved and can later be viewed and analyzed in a diagram. When you click on "Analysis", a timing diagram containing the saved measured values opens up.



Here you have several choices for an analysis. By clicking on the signal names, the Y scale is changed over. By clicking on the signal curves, the value of the active signal will be indicated and by holding and dragging the difference in value and time will be displayed. When you click on the buttons below, various analysis methods will be available, such as zoom, change time view, change value range, ruler function, methods to export the signal values into a text file, statistic analyzing methods

When you click on the "Parameter" button, another window opens up in which you can change the controller parameters, the setpoint concentration and the salt content in the inlet. The controller can also be switched from manual to automatic operation and vice versa, so that the actuating signal can be set manually.



Terminate the simulation by clicking on the "Stop" button. The defined initial states are reset and you may get to other process images by clicking on the buttons "Continue >>", "<< Back" and "Overview".

6 Ptn Controlled System

6.1 Introduction and Selection

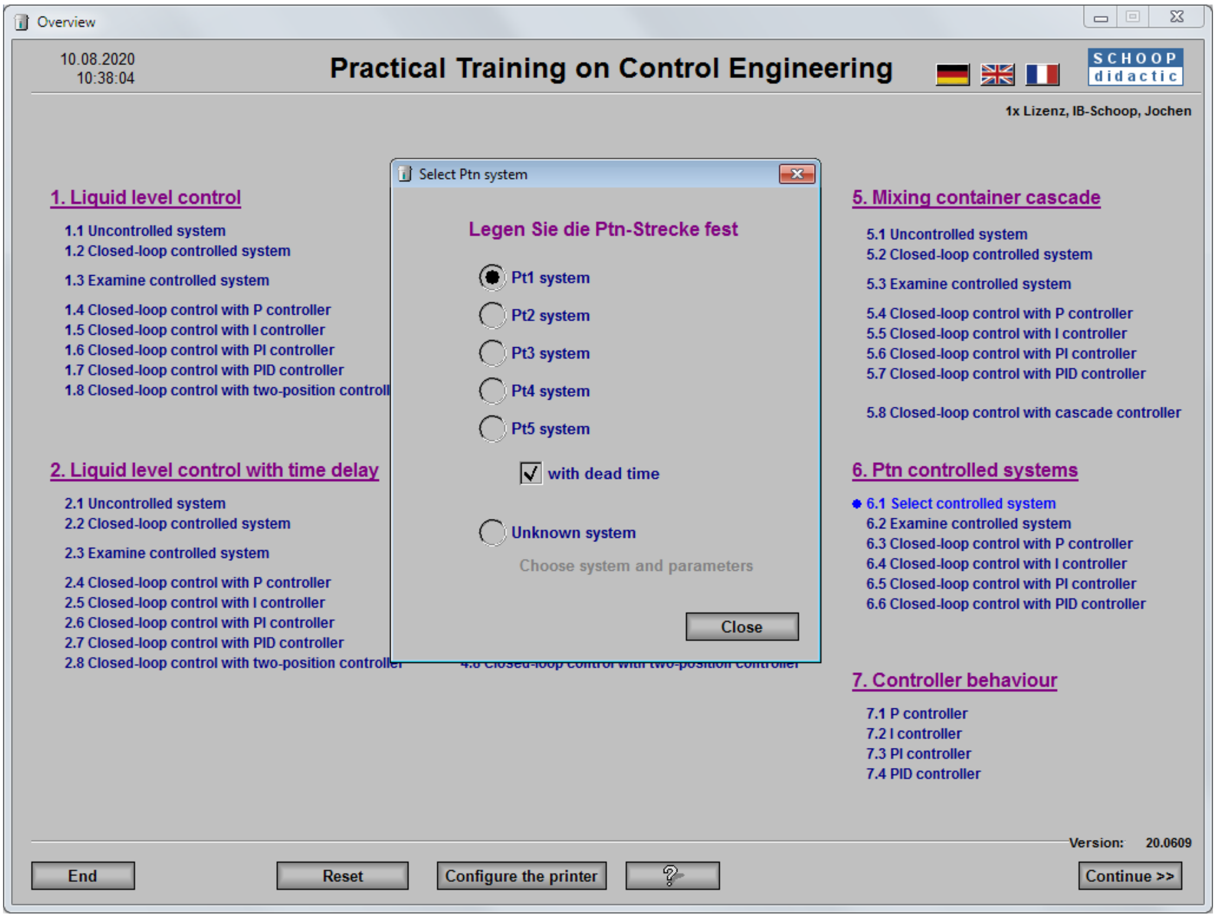
With this project, two methods of exercises can be carried out:

1) The analysis of the input/output response in various controlled systems

2) The examination of the response to setpoint changes and disturbances in control loops with various types of controllers and controlled systems

First-order to fifth-order Ptn elements are used for the controlled system. The parameters of these controlled systems are freely adjustable when you select "unknown system". A dead time can also be integrated in the systems.

Click on "Select system" to select the system.



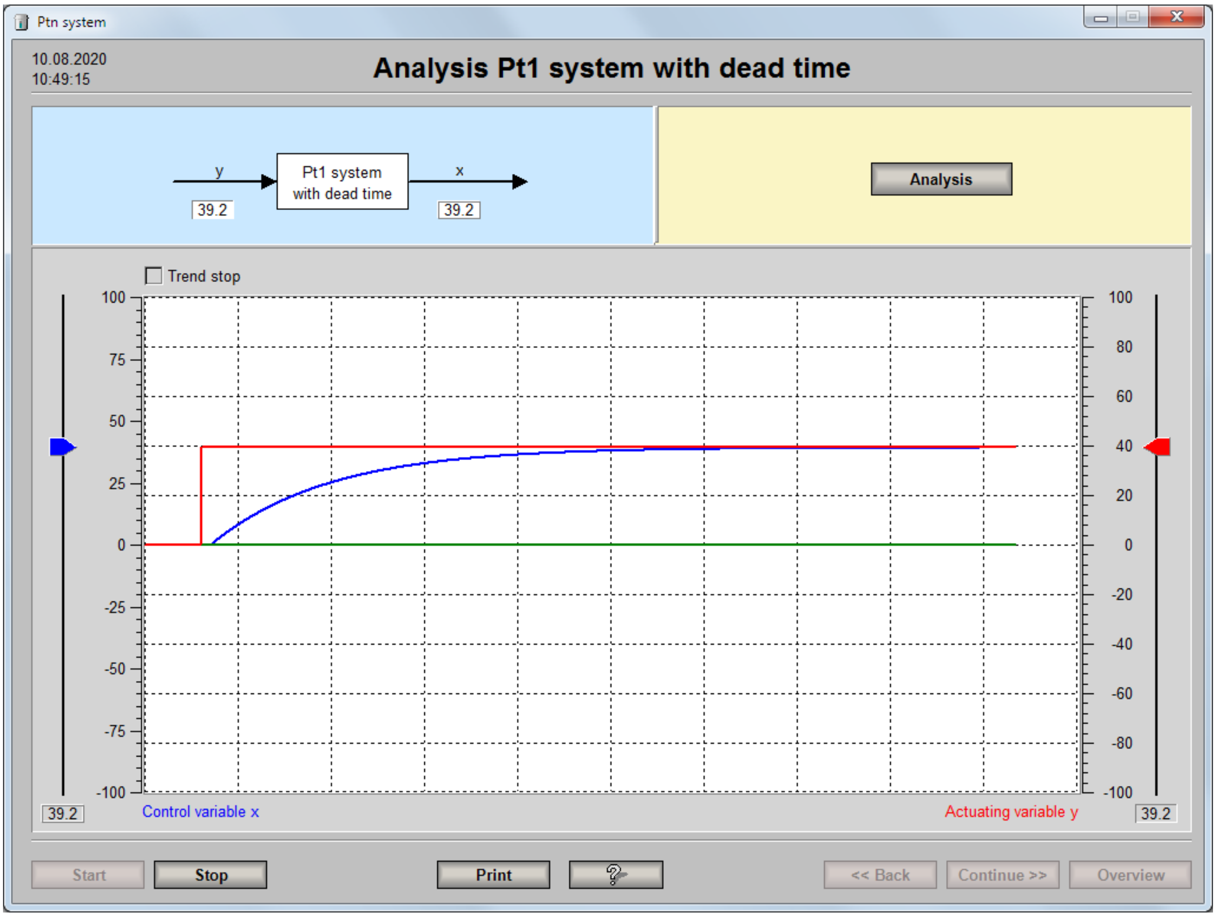
Select a system from the controlled systems Pt1 to Pt5 by selecting the respective option button. When you mark the check box, a dead time is added to the selected system.

If you have selected the option button in front of an unknown system, for the following exercises a Ptn-type system is used, whose order, parameters and dead time can only be changed with an access code. When you select "Change system and parameters", a dialog window opens up asking for a password. When you have entered the correct password and clicked on "Set unknown system", a dialog window opens up, in which you can set the system (Pt1 - Pt5 with and without dead time) and the system parameters (gain and time constants).

The password can be found on the CD in the “Doku” subdirectory in the “BriefDescription.pdf” file.

By selecting the respective items you may now examine the system or the control loop with the selected controller.

6.2 Examine Controlled System

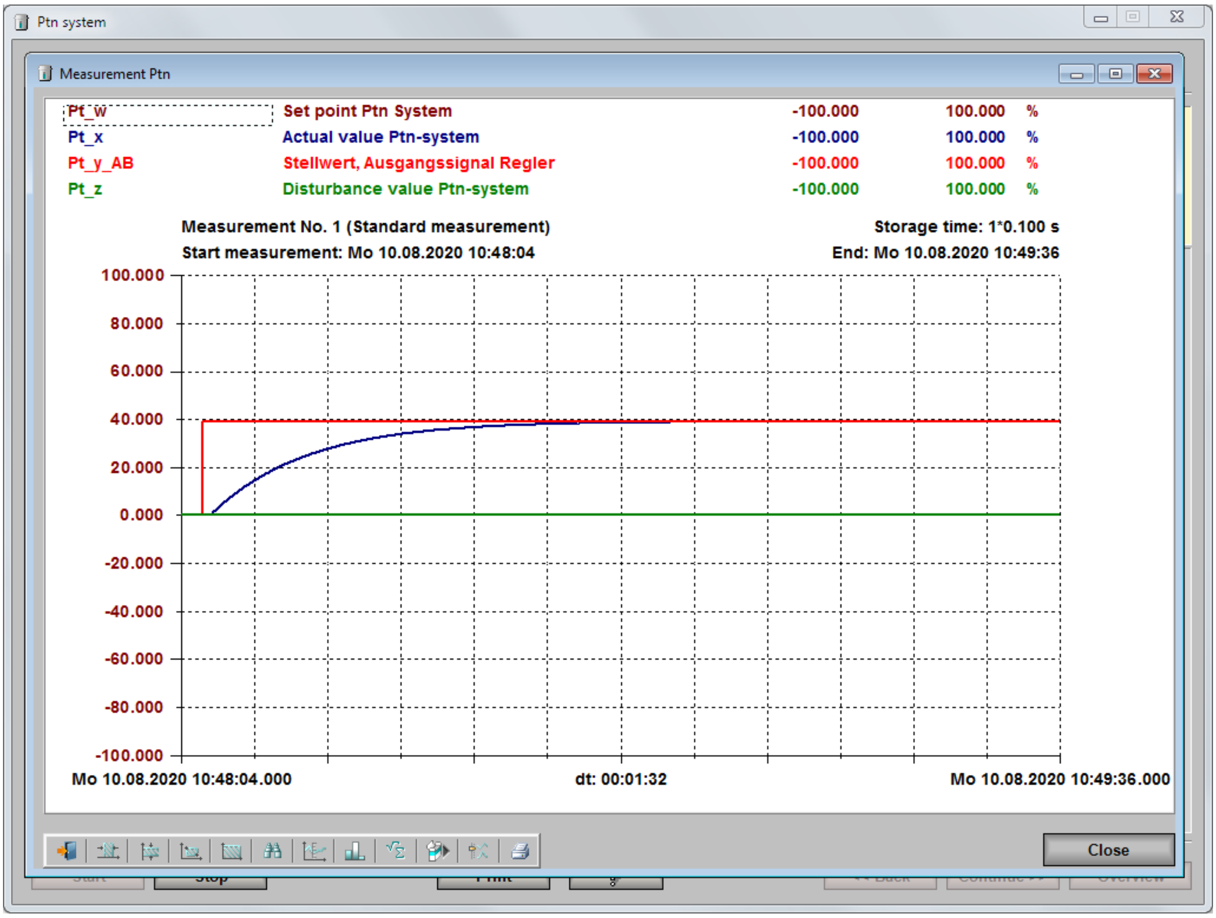


On this process image you can examine the input/output response of the selected system by applying a step signal to the system input. The input and output variables are displayed online in the graphical output window. These signals are also saved with the measured-value acquisition and may later be analyzed.

First, activate the simulation of the controlled system by clicking on "Start".

With the shift button or by entering the value below the shift button you can adjust the dimension of the jump, which you intend to apply to the system input. By clicking on the "Apply jump" button, the adjusted jump is applied to the input.

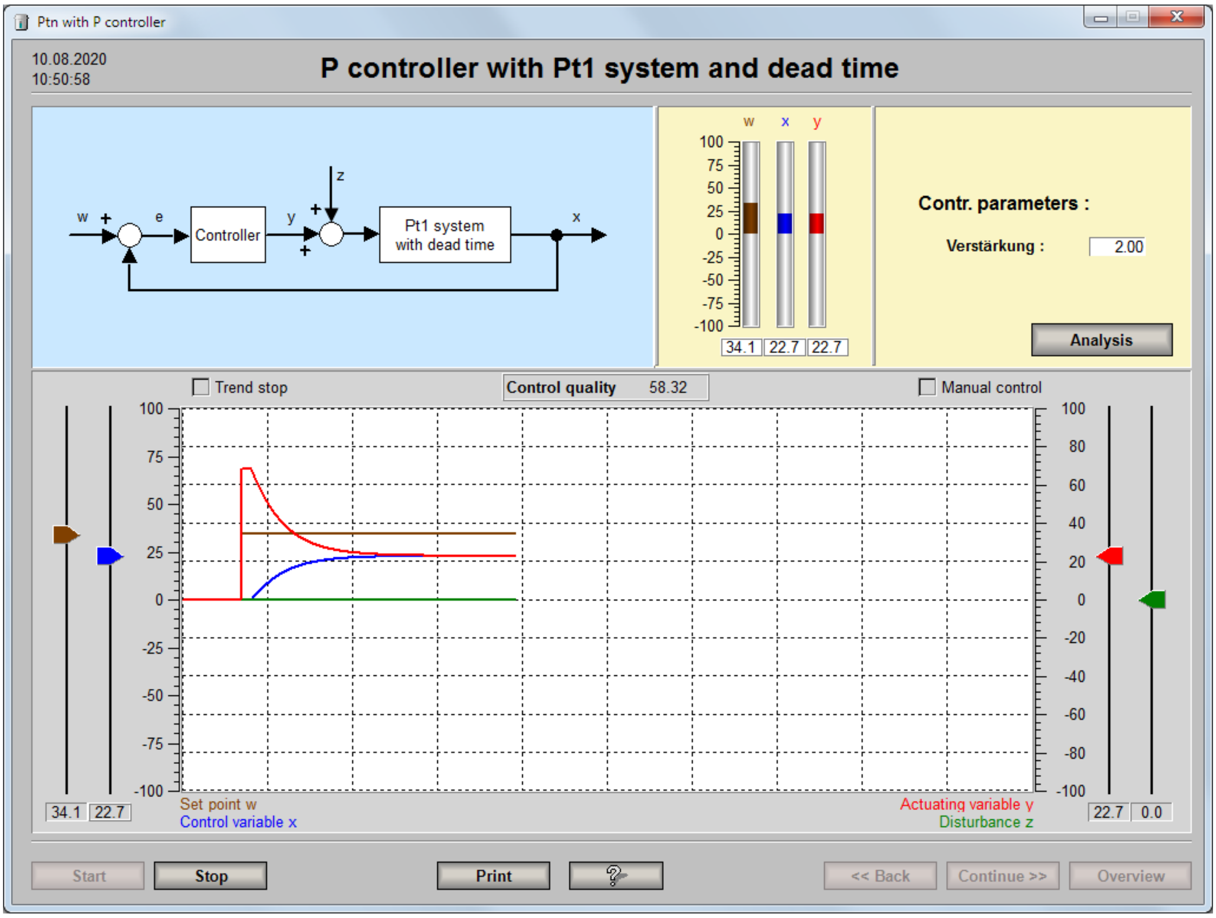
When you click on "Analysis", a timing diagram containing the saved measured values opens up.



Here you have several choices for an analysis. By clicking on the signal names, the Y scale is changed over. By clicking on the signal curves, the value of the active signal will be indicated and by holding and dragging the difference in value and time will be displayed. When you click on the buttons below, various analysis methods will be available, such as zoom, change time view, change value range, ruler function, methods to export the signal values into a text file, statistic analyzing methods.

Terminate the simulation by clicking on the "Stop" button. The initial states are reset. With the "Continue >>", the "<< Back" or "Overview" buttons you will get to other process images.

6.3 Closed-Loop Control with P Controller



On this process image you can examine the input/output response of the selected control loop. A step signal can be applied to the reference and the disturbance variable. The manipulated, output and reference variables and the disturbance are displayed online in the graphical output window. It is possible to analyze these signals with the WinErs measured-value acquisition.

For this purpose, a P controller is used.

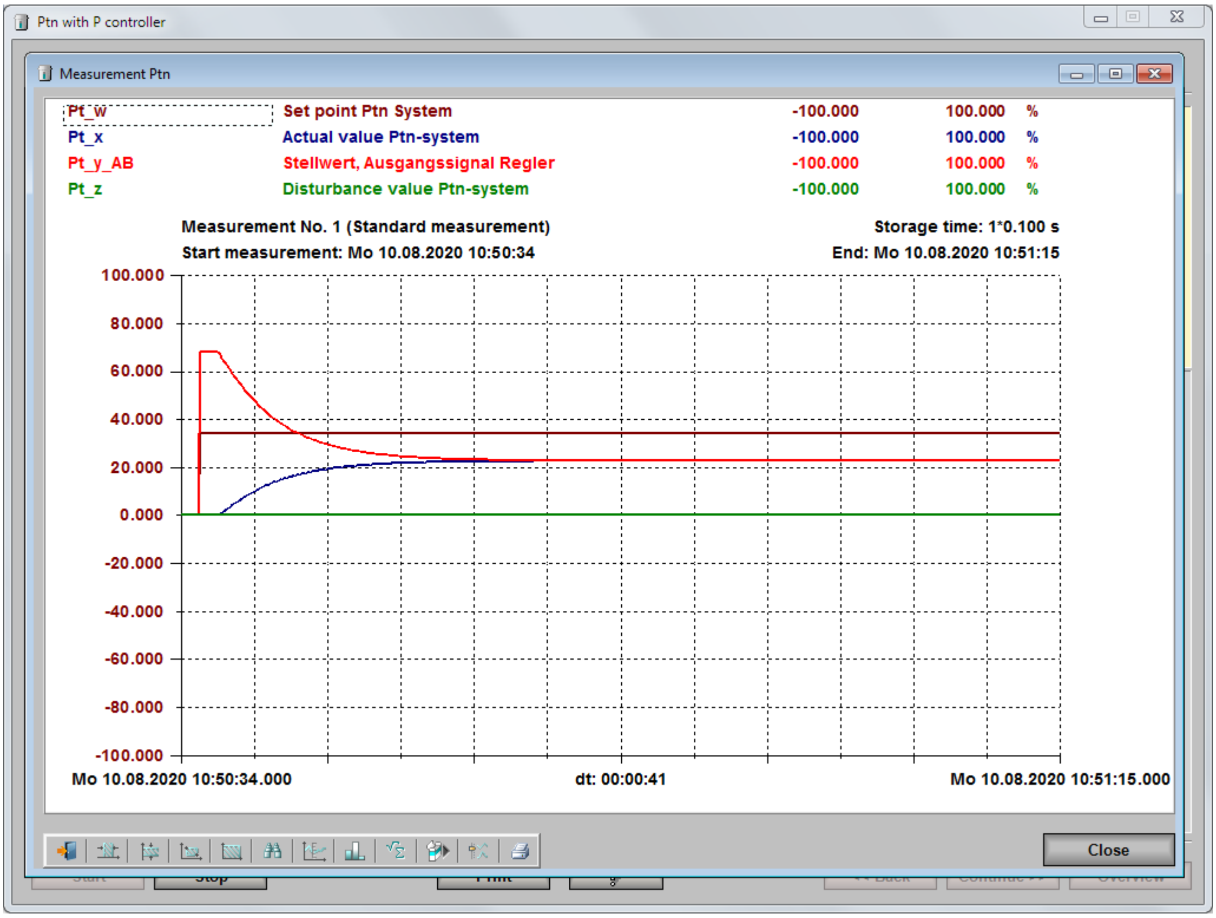
The block structure of the control loop is displayed on this page.

Start the simulation by clicking on the "Start" button. With the shift buttons for the jump level, you can set the level of the jump to the reference variable w and to the disturbance z. By clicking on the "Reference jump" or the "Disturbance jump" button, the set jump is applied to the control loop.

The controller parameters can be set by clicking on the "Controller parameter" button or the controller in the block structure.

The system deviation box shows the integrated squared system deviation. When the setpoint value or the disturbance value changes, the system deviation is set to 0 and restarts to integrate.

The values for all the signals are automatically saved and can later be viewed and analyzed in a diagram. When you click on "Analysis", a timing diagram containing the saved measured values opens up.



Here you have several choices for an analysis. By clicking on the signal names, the Y scale is changed over. By clicking on the signal curves, the value of the active signal will be indicated and by holding and dragging the difference in value and time will be displayed. When you click on the buttons below, various analysis methods will be available, such as zoom, change time view, change value range, ruler function, methods to export the signal values into a text file, statistic analyzing methods

Terminate the simulation by clicking on the "Stop" button. The defined initial states are reset and you may get to other process images by clicking on the buttons "Continue >>", "<< Back" and "Overview".

6.4 Closed-Loop Control with I Controller

On this process image you can examine the input/output response of the selected control loop. A step signal can be applied to the reference and the disturbance variable. The manipulated, output and reference variables and the disturbance are displayed online in the graphical output window. It is possible to analyze these signals with the WinErs measured-value acquisition.

For this purpose, an I controller is used.

The block structure of the control loop is displayed on this page.

Start the simulation by clicking on the "Start" button. With the shift buttons for the jump level, you can set the level of the jump to the reference variable w and to the disturbance z. By clicking on the "Reference jump" or the "Disturbance jump" button, the set jump is applied to the control loop.

The controller parameters can be set by clicking on the "Controller parameter" button or the controller in the block structure.

The system deviation box shows the integrated squared system deviation. When the setpoint value or the disturbance value changes, the system deviation is set to 0 and restarts to integrate.

The values for all the signals are automatically saved and can later be viewed and analyzed in a diagram. When you click on "Analysis", a timing diagram containing the saved measured values opens up. Here you have several choices for an analysis. By clicking on the signal names, the Y scale is changed over. By clicking on the signal curves, the value of the active signal will be indicated and by holding and dragging the difference in value and time will be displayed. When you click on the buttons below, various analysis methods will be available, such as zoom, change time view, change value range, ruler function, methods to export the signal values into a text file, statistic analyzing methods

Terminate the simulation by clicking on the "Stop" button. The defined initial states are reset and you may get to other process images by clicking on the buttons "Continue >>", "<< Back" and "Overview".

6.5 Closed-Loop Control with PI Controller

On this process image you can examine the input/output response of the selected control loop. A step signal can be applied to the reference and the disturbance variable. The manipulated, output and reference variables and the disturbance are displayed online in the graphical output window. It is possible to analyze these signals with the WinErs measured-value acquisition.

For this purpose, a PI controller is used.

The block structure of the control loop is displayed on this page.

Start the simulation by clicking on the "Start" button. With the shift buttons for the jump level, you can set the level of the jump to the reference variable w and to the disturbance z. By clicking on the "Reference jump" or the "Disturbance jump" button, the set jump is applied to the control loop.

The controller parameters can be set by clicking on the "Controller parameter" button or the controller in the block structure.

The system deviation box shows the integrated squared system deviation. When the setpoint value or the disturbance value changes, the system deviation is set to 0 and restarts to integrate.

The values for all the signals are automatically saved and can later be viewed and analyzed in a diagram. When you click on "Analysis", a timing diagram containing the saved measured values opens up. Here you have several choices for an analysis. By clicking on the signal names, the Y scale is changed over. By clicking on the signal curves, the value of the active signal will be indicated and by holding and dragging the difference in value and time will be displayed. When you click on the buttons below, various analysis methods will be available, such as zoom, change time view, change value range, ruler function, methods to export the signal values into a text file, statistic analyzing methods

Terminate the simulation by clicking on the "Stop" button. The defined initial states are reset and you may get to other process images by clicking on the buttons "Continue >>", "<< Back" and "Overview".

6.6 Closed-Loop Control with PID Controller

On this process image you can examine the input/output response of the selected control loop. A step signal can be applied to the reference and the disturbance variable. The manipulated, output and reference variables and the disturbance are displayed online in the graphical output window. It is possible to analyze these signals with the WinErs measured-value acquisition.

For this purpose, a PID controller is used. The block structure of the control loop is displayed on this page.

Start the simulation by clicking on the "Start" button. With the shift buttons for the jump level, you can set the level of the jump to the reference variable w and to the disturbance z. By clicking on the "Reference jump" or the "Disturbance jump" button, the set jump is applied to the control loop.

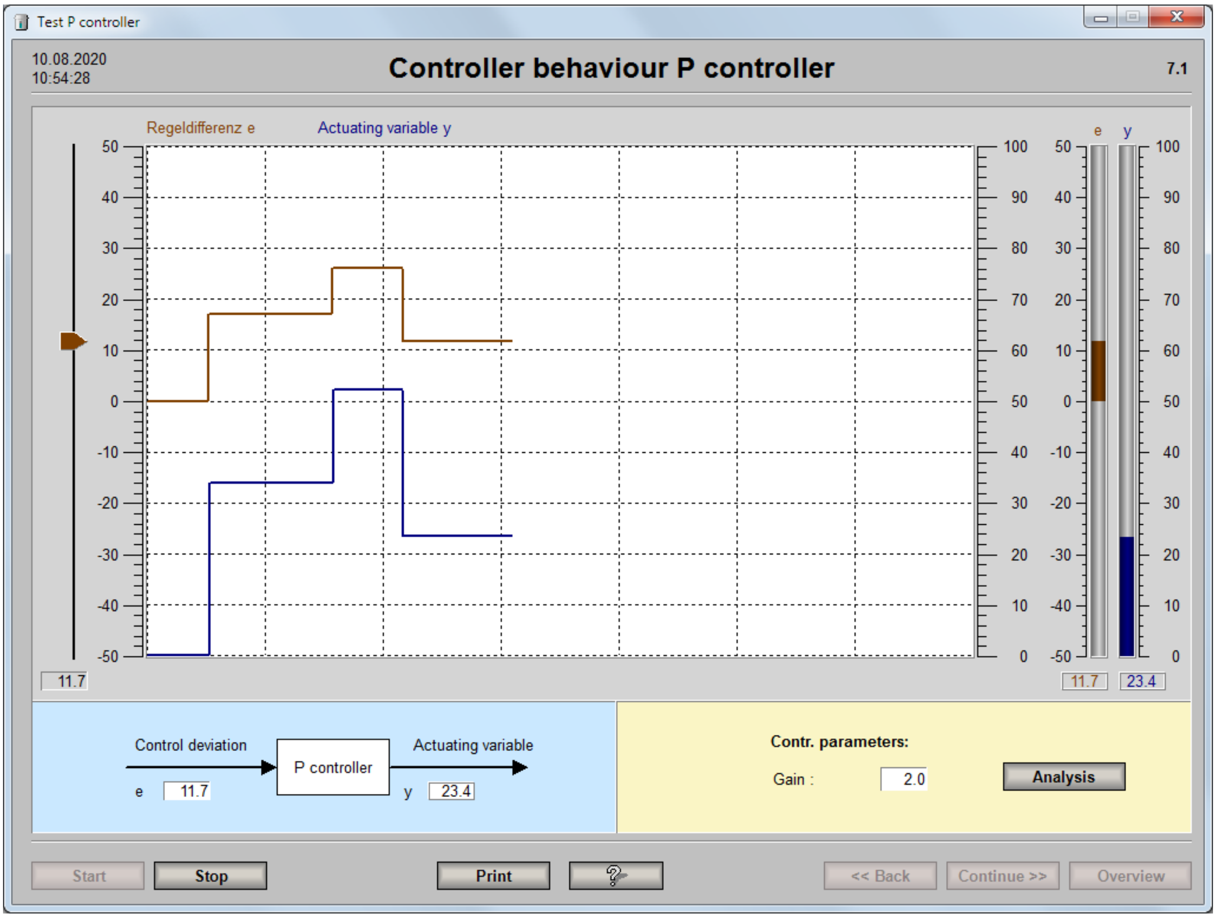
The controller parameters can be set by clicking on the "Controller parameter" button or the controller in the block structure.

The system deviation box shows the integrated squared system deviation. When the setpoint value or the disturbance value changes, the system deviation is set to 0 and restarts to integrate.

The values for all the signals are automatically saved and can later be viewed and analyzed in a diagram. When you click on "Analysis", a timing diagram containing the saved measured values opens up. Here you have several choices for an analysis. By clicking on the signal names, the Y scale is changed over. By clicking on the signal curves, the value of the active signal will be indicated and by holding and dragging the difference in value and time will be displayed. When you click on the buttons below, various analysis methods will be available, such as zoom, change time view, change value range, ruler function, methods to export the signal values into a text file, statistic analyzing methods

Terminate the simulation by clicking on the "Stop" button. The defined initial states are reset and you may get to other process images by clicking on the buttons "Continue >>", "<< Back" and "Overview".

7 Controller Response



Here you can study the response of standard controllers P, I, PI and PID controllers to input jumps.

First, click on the "Start" button. The text "Apply jump" will be displayed next to the button. By clicking on the button, you will apply a step signal to the controller input. The input and output signals are displayed in the diagram. The signal values are automatically saved. By clicking on the "Analysis" button, you may later view them in a diagram, for example to verify the controller parameters. Here you have various methods of analysis. By clicking on the signal names, the Y scale is changed over. By clicking on the signal curves, the value of the active signal will be indicated; finally, by holding and dragging, the difference in value and time will be displayed. When you click on the buttons below, various analysis methods will be available, such as zoom, change time view, change value range, ruler function, methods to export the signal values into a text file, statistic analyzing methods.

The controller parameters can be changed in the respectively marked edit fields.

Terminate the simulation by clicking on the "Stop" button; with the "Continue >>" or the "<< Back" button you will get to Overview or to the next process images.