Fundusze Europejskie
Wiedza Edukacja Rozwój

Unia Europejska
Europejski Fundusz Społeczny

Teaching materials for the subject

„*Control engineering - project*”

developed as part of the project

„Modification of dual degree studies in Mechanics and Machine Design at the Faculty of Mechanical Engineering at the Silesian University of Technology”

Project Task No. 1

Design an algorithm for controlling the central heating furnace (Fig. 1).

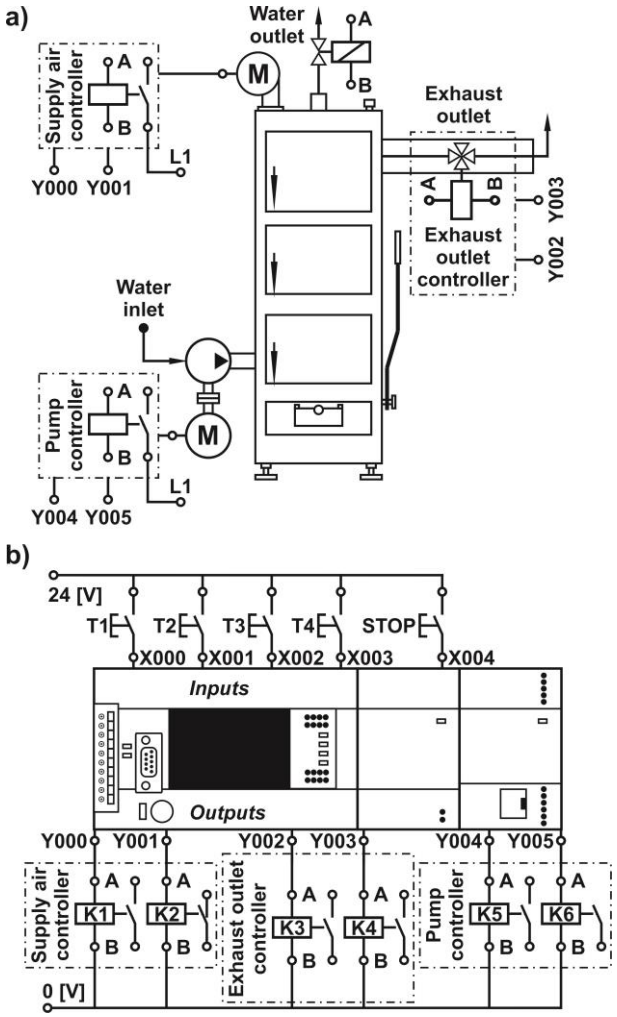


Fig. 1.1 An example of: a) the control object under consideration, b) PLC I/O connections

The control process should be carried out according to the indications of Table 1.

Tab. 1.1. Controller states depending on the temperature of the furnace

Temperature value	0÷30 ºC	30÷60 ºC	60÷70 ºC	above 70 ºC
Bottom air inlet (furnace door)	ON	ON	ON	OFF
Upper (supply) air inlet	OFF	OFF	OFF	ON
Chimney outlet (exhaust)	ON	ON	OFF	ON
Chimney outlet (gap width)	1	0	0	1
Water circulation pump	OFF	ON	ON	ON
Pump operating condition	0	0	0	1

List of inputs / outputs:

X000 - temperature range 0÷30ºC (lighting)

X001 - temperature range 30÷60ºC

X002 - temperature range 60÷70ºC (normal condition)

X003 - temperature above 70ºC

Y000 - bottom air inlet (0 - closed, 1 - open)

Y001 - upper air inlet (0 - closed, 1 - open)

Y002 - chimney outlet (0 - closed, 1 - open)

Y003 - chimney outlet, gap width (0 - standard, 1 - wider opening)

Y004 - water circulation pump (0 - off, 1 - on)

Y005 - water circulation pump (0 - slow run, 1 - fast run)

Guidelines

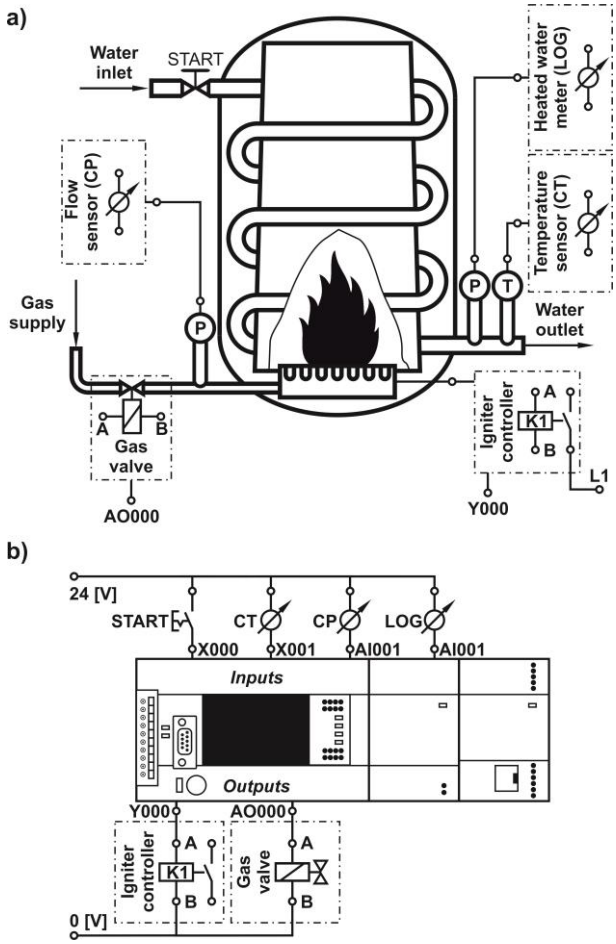
To develop the algorithm, use CODESYS software (available at: https://www.codesys.com/download.html).

Tasks to be performed (content of the report):

- develop a control algorithm for the specified object,
- develop the task in one text language (to choose: Instruction List, Structured Text) and one graphic language (to choose: Ladder Diagram, Function Block Diagram),
- perform a visualization for the purposes of changing the states of the developed model,
- present the states of inputs / outputs depending on the controlled variables,
- present the conclusions.

Project Task No. 2

Design an algorithm for controlling a flow-through gas water heater, according to the diagram in the Figure 2.1.



Rys. 2.1. An example of: a) the control object under consideration, b) PLC I/O connections

When the hot water tap is unscrewed, the sparker (igniter) is activated and remains switched on until the gas ignites (i.e. the temperature in the burner chamber does not reach 100ºC, which is signaled by input X000).

Depending on the stream of water flowing through the stove, the stream of gas supplied to the water-heating flame should change. When the tap is turned off, the gas supply should be shut off and the spark gap may be turned off.

List of inputs / outputs:

- X000 - signal from the sensor that determines reaching 100ºC in the burner chamber,
- the first analog input channel - the value of the water flow rate,

- analog output - gas flow rate value.

Guidelines

To develop the algorithm, use CODESYS software (available at: https://www.codesys.com/download.html).

Project development

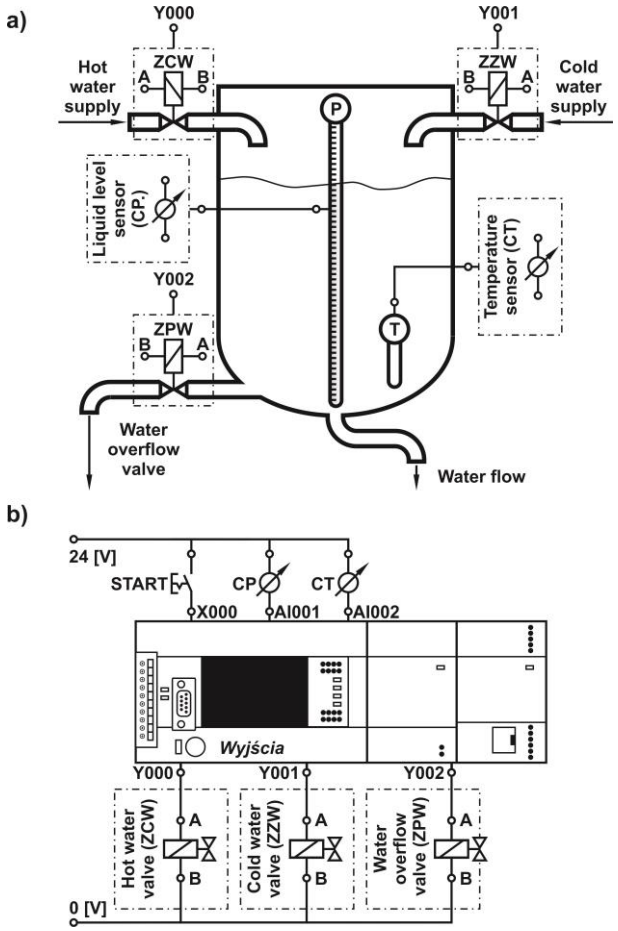
Consider and write a program. In the initial phase of opening the water tap opening the gas valve at 3/4 of its total capacity. After 1 second, ignition occurs, gas is supplied in proportion to the liquid flow.

Tasks to be performed (content of the report):

- develop a control algorithm for the specified object,
- develop the task in one text language (to choose: Instruction List, Structured Text) and one graphic language (to choose: Ladder Diagram, Function Block Diagram),
- perform a visualization for the purposes of changing the states of the developed model,
- present the states of inputs / outputs depending on the controlled variables,
- present the conclusions.

Project Task No. 3

Design an algorithm to control the inflow and outflow of liquid to and from the tank so that the output receives the liquid with the appropriate parameters (Fig. 3.1).



Rys. 3.1. An example of: a) the control object under consideration, b) PLC I/O connections

The control of the liquid level and tank temperature is realized automatically. The liquid level is read with a level sensor and the temperature with a Pt100 sensor. The liquid level should be maintained at level of the total capacity of the tank with a temperature equal to the ambient temperature (when the controller is turned on temperature increased by 2ºC; the temperature of the sensor - that measures the temperature of the liquid in the tank - is assumed equal to the ambient temperature).

If the liquid temperature is too low and the level is low, the tank fills with hot water. If the liquid temperature is too high and the level is low, the tank fills with cold water. If the liquid parameters are correct but the level is low, the tank is filled with hot and cold water simultaneously.

If there is enough liquid in the tank but it has incorrect parameters, the relief valve opens additionally.

If there is excess liquid in the tank, the overflow valve opens until the liquid is at the set level.

List of inputs / outputs:

- Liquid temperature in the tank,
- First analog input channel - liquid level value,
- Y000 - signal controlling the cold liquid supply valve (+ 2ºC),
- Y001 - signal controlling the hot liquid inlet valve (+ 80ºC),
- Y003 - signal controlling the liquid overflow valve.

Project development

- Consider and write a program. Temperature measurement takes place from two places in the tank (the temperature value of 2 places comes from the 2nd channel of the analog input). If there is a temperature difference, start the mixer; the mixer should remain running until the temperatures are the same,
- modify the controller program and prepare the program for the HMI so that it is possible to display the current value of the liquid temperature in the tank and the temperature setpoint; use display to the current liquid level and the liquid level set point; use signal lamps to indicate the current state of all controlled devices; adopt objects enabling changing the set point temperature and liquid level.

Tasks to be performed (content of the report):

- develop a control algorithm for the specified object,
- develop the task in one text language (to choose: Instruction List, Structured Text) and one graphic language (to choose: Ladder Diagram, Function Block Diagram),
- visualize for the purposes of changing the states of the developed model,
- present the states of inputs / outputs depending on the controlled variables,
- present the conclusions.
- develop a mathematical model of the tank, determine the transfer function and perform a block diagram,
- add a PID controller to the system that supports the heater (the feedback signal is the temperature of the liquid in the tank),
- design the automatic control system and adjust the controller settings,
- present the states of inputs / outputs depending on the controlled variables,
- present the conclusions.

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Supplementary literature (in Polish)

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