PROCESS CONTROL TRAINING SYSTEM BASED ON THE MIK 4000C

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The teaching and training of the students and specialists from the industrial plants, in the field of Distributed Control Systems (DSC) is very important, because it determines the safety and the quality of control. In order to improve the quality of teaching, the Process Control Training System (PCTS), based on the Bulgarian MIK 2000 C, was developed. PCTS enables to learn and train all possibilities of the DSC in "real" conditions of production. The training system is very useful for research and development in the field of the process control. It is a necessary instrument for development, debugging and testing of the specialized Process Oriented Language (POL) software.

Keywords: DCS, Process Control Training System, MIK 4000 C.

1. INTRODUCTION

MIK 4000 C is a hierarchical, Distributed Control System (DCS), able to control up to 4000 technological parameters. By the financial support of „Neftochim" AD, Bourgas, the laboratory of process control at University "Asen Zlatarov" in Bourgas, was equipped with the system MIK 4000 C, including four Operational Monitoring Stations (OMS) and one Basic Microprocessor Station (BMS). On this base, according to the contract with „Neftochim", the Process Control Training System (PCTS) for teaching and training of the students and specialists from industrial plants was developed. The aims of this project are:

1.1. To develop PCTS, enables teaching and training of the students and specialists in all possibilities and advantages of the DCS in the "real" production conditions.

1.2. To develop the necessary modules for using the PCTS for research and development in the field of process control.

1.3. To develop the necessary modules for developing, debugging and testing of the specialized Process Oriented Language (POL) software.

2. THE DESCRIPTION OF THE PCTS

Three different objects of control were realized and connected to the system MIK 4000 C - an exothermal reactor, Absorber and a tubular furnace, which are the most important part of the technological installations. The quality of control of these objects is very important for the safety and quality of the production and for saving energy and raw materials. The dynamic of the object of control were realized by two differential equations of the fourth degree in serial connection, as shown on the Fig. 1

and Fig. 2. The simplified mathematical models of the objects of control are taken from the literature [1]. The transfer functions of the objects of control are:

$$W1(s) = k1 / (T4 . s^4 + T3 . s^3 + T2 . s^2 + T1 . s + 1) ,$$
$$W2(s) = [k2 / (T8 . s^4 + T7 . s^3 + T6 . s^2 + T5 . s + 1)] * W1 (s),$$

For the exothermal reactor, W2(s) is the transmission function of the reactor temperature Process Value (PV2) as a function of the temperature of the heat exchanger. W1(p) is the transmission functions of the temperature of the heat exchanger (PV1) as the function of the flow of the heat exchanging medium through the valve Output Value (OV).

For the absorber, W2(s) is the transmission function of the concentration of the key component in the gas phase in the output of absorber (PV2) as a function of the pressure difference between the top and the bottom of the absorber (PV1). W1(p) is the transmission functions of the pressure difference (PV1) as the function of the flow of the of the liquid phase, through the valve (OV).

For the tubular furnace, W2(s) is the transmission function of the product temperature in output (PV2) as a function of the temperature of the flue gases (PV1). W1(p) is the transmission functions of the temperature of the flue gases as the function of the flow of the of the fuel flow, through the valve (OV).

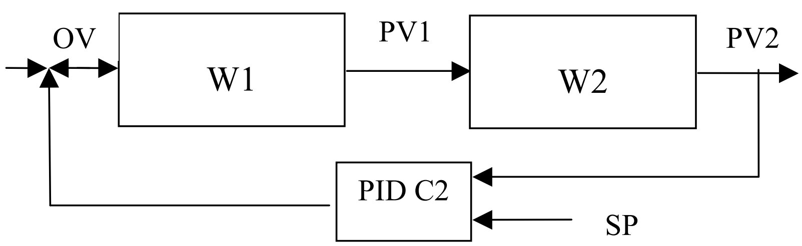

Fig. 1. The single closed loop control system.

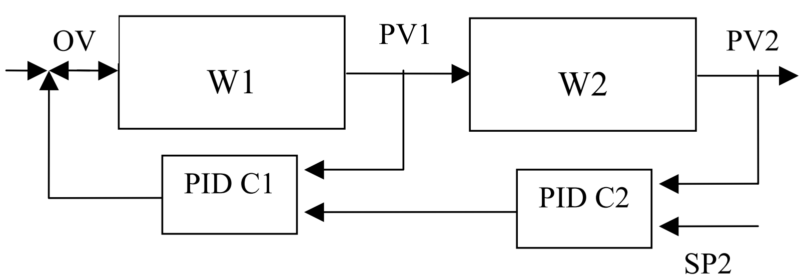

Fig. 2. The cascade closed loop control system.

The objects of control were realized by the electronic analog block, using operational amplifiers and RC circuits. According to the MIK 4000 C analog interface, the inputs and outputs of the electronic analog block are standard electrical signal 4 – 20 mA. The time constants T1, T2, T5 and T6 are adjustable and are realized by the variable resistors.

The control systems are configured and can be used as a single closed loop PID control, shown on the Fig. 1, or as a cascade PID control, shown on the Fig. 2.

Four different technological groups are configured – three for every control system and one group, including all three control systems. This way, the values of all technological parameters can be watched on one display. The technological parameters can be controlled, using different regimes – MANual, AUTOmatic, CASCade and others and the quality of control can be proved using the alarm system, events history and analog trends.

The mimic diagrams are created for all three control systems. The mimic diagrams include static and dynamics shapes. The static shapes show the apparatus, input and output connections, control system and other stationary elements. The dynamics shapes depict digitally and graphically the values of the technological parameters.

The analog trend groups are configured including all technological parameters. For every control system, two analog trend groups are configured, with scan time of 20 seconds and 60 seconds. This way, the dynamics of the object of control can be studied, using the transition characteristics.

Optimal tuning of the control system can be done by the different methods and the quality of the control can be evaluated, discussed also in [2, 3]. The single loop PID control systems and cascade PID control systems can be used and the investigation and comparison of the quality of the control can be done [4].

Another advantage of the DCS is the possibility to run up to 10 programs (called also program sequences) in every BMS, used for additional monitoring, control and safety of the technological processes. These programs are developed by means of Process Oriented Language, which has many advantages in the process control applications. The POL programs have access to all technological parameters and work in real time. Up to four emergency program sequences with different priority can be activated under defined conditions. In spite of all, the developing, debugging and testing of the POL programs is a task of great difficulty. The program units execute during the production in the industrial plants and should be debugged and tested very carefully before using. The PCTS enables to run the POL programs and to watch every step, using all resources of the system - technological groups, analog trends, mimic diagrams, alarm system and others [3].

3. CONCLUSION

The Process Control Training System was developed, enables teaching and training of the students and specialists in all possibilities and advantages of the distributed control systems in the "real" production conditions. The system is very useful for research and development in the field of the process control. The process control training system is a necessary instrument for developing and testing the Process Oriented Language software.

5. REFERENCES

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