Automated control system for coolant parameters with remote access

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Automated control system for coolant parameters with remote access

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Annotation. This article proposes an automated system for monitoring and controlling the parameters of the coolant in the housing and communal services as part of the energy saving program. The proposed system is based on industrial controllers with Ethernet 100 Base-T, RS-232 and RS-485 interfaces, as well as software created in the CoDeSys software environment.

Introduction

The use of automatic control systems in various branches of the national economy makes it possible to solve increasingly complex production problems. In particular, this is also true for automatic systems for maintaining the temperature in hot water supply, return water in air intake ventilation systems, heating systems to maintain the temperature graphs.

For such systems, there are many particular solutions that allow to change the parameters of the transported medium [1]. One of them is the analog automatic control system of the shut-off and regulating valve (SORV).

Description of the problem

In this kind of systems the actuator is controlled by analog signals. The actuator's adjustment factors may depend on the actuator manufacturer, on the position sensor integrated in the valve or on the external sensor of the controlled value [2]. This leads to the inseparability of the system. It is also worth noting that not all such systems have the ability to integrate remote control. They require the use of a multiple transforming blocks that complicate the structure of the system.

The use of modern automatic control methods allows us to solve this problem, which makes it possible to substantially simplify the system. One of the solutions to this problem is the use of a proportional-integral-differentiating-regulator (PID controller) for controlling a valve with an electric drive (Figure 1) [3].

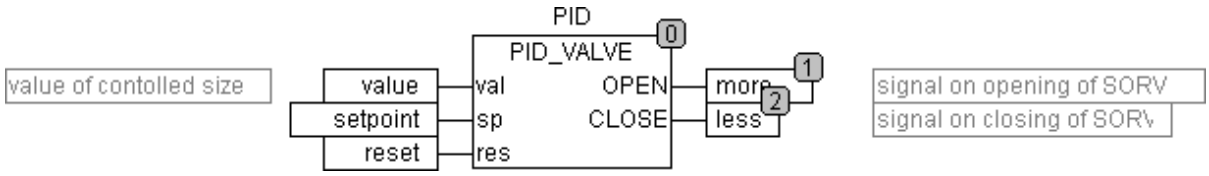

Fig. 1. PID controller for valve control

Relevance

The relevance of the proposed solution is that the system is universal and allows to remotely control the setpoint for a controlled value (temperature, drop, pressure, etc.), as well as adjusting coefficients of PID controller. This solution allows to integrate the system into the existing outdated SORV without rod position sensors by changing the program or adding a new programmable logic controller to the old system. That saves time and resources for system reinstallation. Another one advantage of this solution is fast and high-quality process control by using PID block.

Structure and description of system

The functional block (FB) PID_VALVE consists of OWEN libraries of Util.lib [5, p. 351] and PID_regulators.lib [5, p. 356] with a proprietary code (fig. 2).

By means of PID FB regulation of system's parameters is carried out. The LIN_TRAFO block linearly transforms values (range -100...100) from Y out of PID blocks to value that is acceptable for the VALVE_REG_NO_POS block by IN_VAL (range 0…100). The SORV control unit without rod position sensor VALVE_REG_NO_POS is block where instead of information about the time of rod's full speed of SORV [6] is used. DIG_FLTR is the digital filter for analog values of controlled value

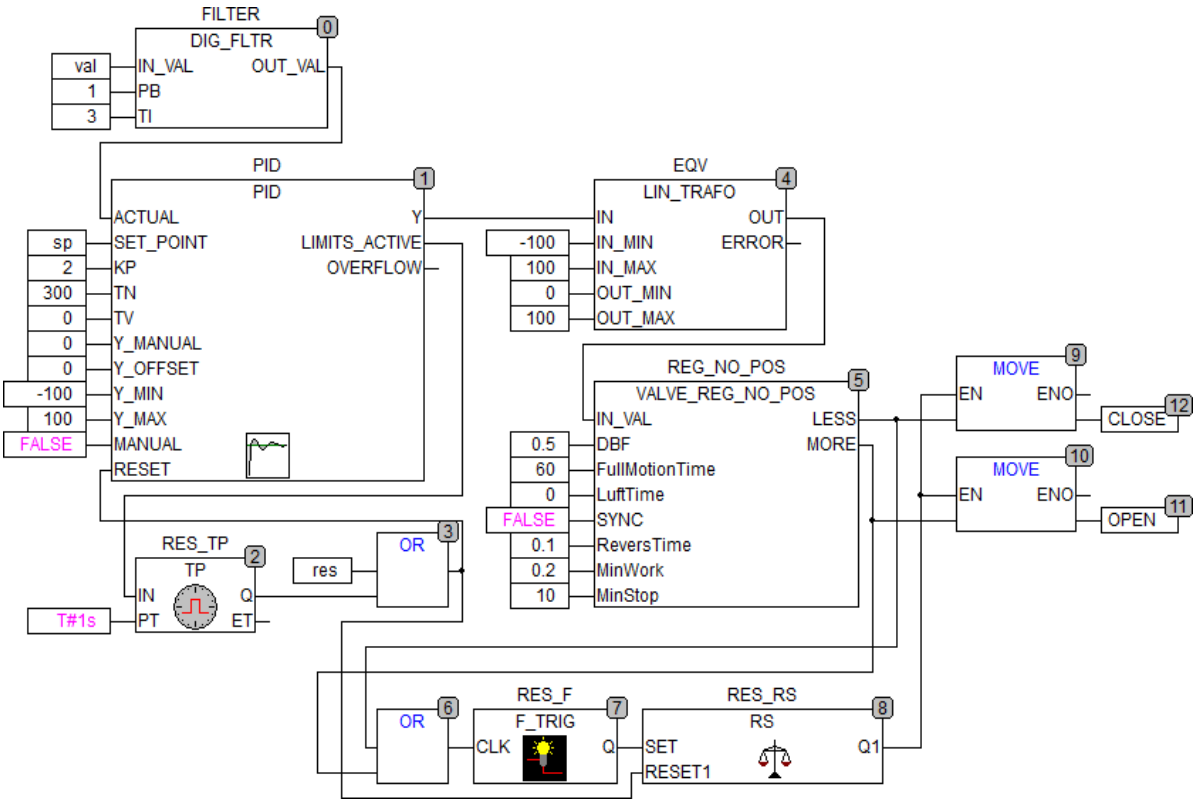

Fig. 2. Structure of the function block of PID_VALVE in the CFC editor

In fig. 3 the following variables are shown: val – the current value (pressure, temperatures, pressure difference etc); sp – setpoint (it is set in units of measure of controlled value); res – reset of an integral component of the PID-regulator.

```
0001    FUNCTION_BLOCK PID_VALVE
0002VAR_INPUT
0003    val, sp          :REAL; (*current value, SORV rod position, setpoint*)
0004    res              :BOOL;
0005END_VAR
0006VAR_OUTPUT
0007    OPEN, CLOSE      :BOOL; (*opening and closing signals sending to SORV *)
0008END_VAR
0009VAR
0010    PID              :PID;
0011    REG_NO_POS       :VALVE_REG_NO_POS;
0012    FILTER           :DIG_FLTR;
0013    EQV              :LIN_TRAFO;
0014    RES_F            :F_TRIG;
0015    RES_TP           :TP;
0016    RES_RS           :RS;
0017END_VAR
```

Fig. 3. Source code

Process of regulation of temperature in heating system where to the val input receives data from a temperature sensor that is sends the central heat distribution station (fig. 4) is simulated. The constant of proportionality, an integration constant and a constant of derivation of the PID block are individual and are selected empirically path [8]. The setpoint was 63 C °. Coefficients and values were taken from actual working system and used as input data.

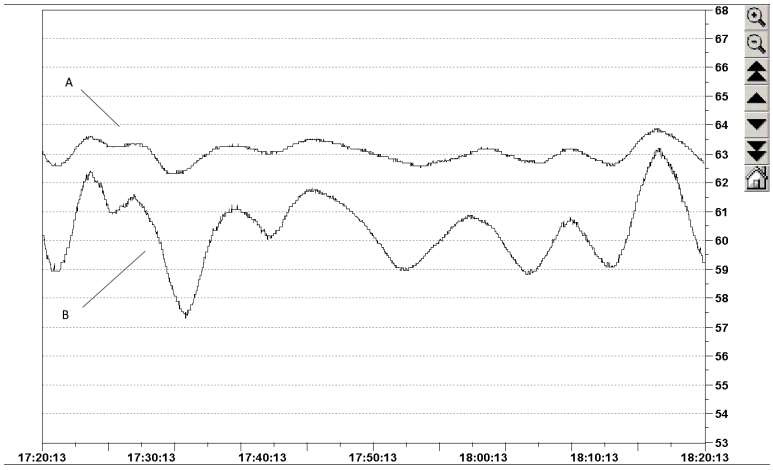

Fig. 4. The graph of temperature maintaining in the CoDeSys 2.4 environment (a counting discretization is d=250 ms) A – the output values received from a temperature sensor. B – input values

Economic justification of system

Table 1. Approximate expenses for modernization a system of one object

SORV is not changed			SORV is changed		
The required resources	Working hours	Payment (rub.)	The required resources	Working hours	Payment (rub.)
Engineer	3	600	Engineer	3	600
			Mechanic	6	1 200
			SORV		20 000
			Logistics	3	600
			Accounts department	3	600
Total		600			23 000

To calculate of compensation of the personnel participating in carrying out the following formulas was used:

$$\frac{A_S}{A_{WHM}} K_{SN} K_{AS}$$

where A_S is the average salary in the Republic of Tatarstan (31 500 rub.); A_{WHM} is average number of working hours in one month; K_{SN} is the coefficient of assignments on social needs; K_{AS} is the coefficient considering the additional salary.

Conclusion

Thus, proposed system allows to considerably reduce working personnel for serving one object (see tab. 1). Besides, the efficiency of monitoring significantly increases, and the access to data is no more than 3 minutes.

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