Automated Control System “Smart House” for Health and Entertainment Complex “Bliss”, Rivne

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Abstract— **The work is devoted to the development of an intelligent control system of the "Smart House" based on a programmable logic controller.**

Keywords— automated control system, program, programable logical controller, heating, ventilation, conditioning, smart house, pomp.

I. Introduction

The Health and entertainment complex “Bliss” - is one of the special places where residents and guests of Rivne can relax in the sauna, steam room, swim in the pool, relax in comfortable rooms, visit the restaurant, play billiards. Also, the Bliss complex has a gym, fitness room, fitness bar, relaxation room.

To control all the systems of life of this complex requires a centralized automated control system (ACS) type "Smart home" with an interface for the operator. This ACS is designed on the basis of the touch panel programmable logic controller (PLC) of Owen SPK-207, to which 11 remote I/O modules are connected. This controller performs both process control functions and real-time process flow display on a touch screen, as well as operator interaction functions [1]. The software was developed in CodeSys 3.5 SP5. For today 44 control programs in ST, LD, FBD, CFC languages and 16 graphics screens have been developed. A tree view of the project in the programming environment a

II. The basic control circuits

The following control circuits are considered in the paper: temperature control in different rooms by means of a warm floor, which supplies warm (winter) or cold (summer) water from the collector. Control is carried out under the PID law.

The temperature task is calculated automatically according to schedules depending on the ambient temperature, which is measured automatically by a sensor located on the shadow side of the building. The graphical dependencies for calculating the temperature set point are different for summer and winter. Switching between these periods is carried out by the operator from the touch panel.

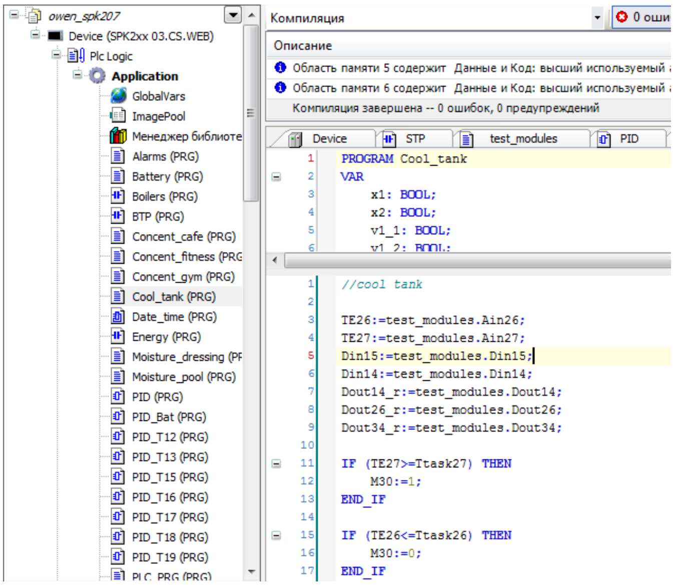

Figure 1. A view of the project

In this control circuit, it is important in the summer to ensure that dew does not fall out on the floor if the difference between indoor and outdoor water temperatures is too large. To do this, the program limits this difference.

Indoor CO2 control circuits. The permissible level of CO2 in the rooms is maintained by means of ventilation units which have the ability to control the rotation of the fans. In addition, it is possible to heat or cool the air supplied from the street for ventilation by a radiator of a ventilation system that supplies water of a certain temperature: hot in winter and cold in summer. Water temperature control is carried out according to the PID law.

The setpoint of water temperature supplied to the radiator is calculated depending on the difference between the set point of the air temperature and the actual measured room temperature. These graphical dependencies are different in winter and summer. Ventilation does not work in rooms where people are absent during non-working hours (gym, cafe, etc.) for saving electricity.

In winter, the batteries are used to supply additional hot water to the room by the pump. The pump is switched on in both automatic and manual modes. The temperature of the water, which supplied to the battery, is controled by the PID control law.

For forced servomotor movement, TEST mode is introduced, which switches on automatically every day from 5:50 to 6:00 AM or in manual mode. At this time, the signaling to the discrete analog outputs is stopped. This mode was introduced for the regular testing of the performance of all servo drives. To do this, the program keeps track of time. Also, the current date and time are displayed on the operator graphic screens. The program for reading the date and time from the controller is shown in figure 2.

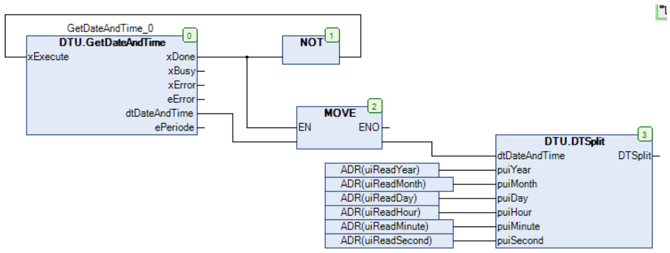

Figure 2. The program for reading the date and the time from the PLC

For water supply, either city water from a centralized water supply system or well water is used. Water from the well is first pumped into a so-called cold barrel from where it enters the pipelines through the filter system. The cold barrel is also used to cool water from radiators in summer. In winter, water from the cold barrel is fed into a separate radiator of the pool ventilation unit to cool the air drawn in from the pool. In this case, excess moisture is released from the air. A well pump is used to supply water from the well.

Small and large heat pumps are used for hot heat supply. large Hot water barrels with thermal insulation are used to accumulate hot circulating water. The heat source for the small thermal pump (STP) is glycol. The glycol is heated by the flue gas of the steam oven, which, together with the outside air, is sucked in by a fan located on the roof near the chimney. That is why STP only works when steam works or during the hot summer months for the hot water supply. Fan rotation is controled by the PID control law. The heated glycol is pumped to the first STP heat exchanger, where it transfers its heat to liquid freon. Freon boils and goes into a gaseous form. Then the freon enters the compressor, where it is compressed and heated more. The compressed freon enters the second STP heat exchanger, where it heats the circulating water, and condenses itself. Water enters the second heat exchanger from the bottom of the hot barrel, after heating it enters the system, and if there is no water consumption, it returns to the barrel. To control the work of STP is calculated time of his total work. Resetting the meter is done manually with a button on the control screen. For the correct operation of STP, the control of the freon pressure, the glycol temperature, the compressor temperature is performed by means of a thermal relay. The source of heat for a big thermal pump (BTP) is well water. In the first heat exchanger, the heat from the well is transferred to the freon, which boils due to heating. In the second BTP heat exchanger, the freon condenses and gives its heat to the circulating water.

Two hot water heaters are used for hot water supply. It is necessary to control the water temperature at three points in thire height. Hot-water circulating water from the hot barrels is supplied to the boiler coils. Water for heating is supplied to the lower parts of the boilers from a cold barrel or from a centralized water supply system, and is drawn from their upper parts. Only one boiler is heated at a time, and water is consumed from another. They are switched automatically according to the water temperature analysis. Boilers also have electrotens for additional water heating. For continuous maintenance of hot water in the pipes going to the consumers, a recirculation pump is used, which is manually switched on by the operator with a button on the control screen. To save electricity, the recirculation pump operates in pulse mode, with pulse and pause durations, that can be set. In addition to small and big thermal pumps, heat sources are gas boilers and electric boilers. The heat sources can be run in parallel, each with its own pump. If a particular source does not work, the water supply is blocked. Heat sources are put into operation sequentially depending on the demand of hot water and heat consumers. The heat source is skipped if there are alarms from it or if the source had worked before but did not heat the water enough. Messages, which heat sources are currently running, alarm messages from them are displayed on the monitoring screen.

III. Development of the Graphic Part of the Project

A number of graphic screens have been developed to control the process, change the settings, and interact with the operator. They show different sections of the process, graphic images of installations and units, data on technological parameters, buttons for manual remote control, forms for changing the settings of controllers. As a result, the operator can monitor the progress of the process, analyze the causes of emergencies, can correct the operation of controllers in real time, select automatic or manual modes. The operator can switch between screens using the menu screen (Figure 3).

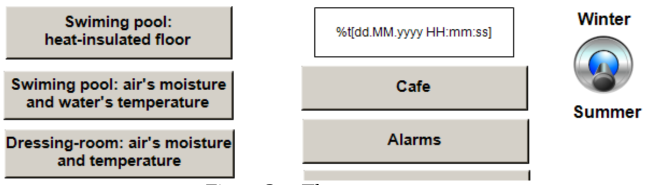

Figure 3. The menu screen

IV. Conclusion

Developed ACS of "Smart House" provides centralized operational control of all building's systems, provides a graphical representation of the process. Improving control accuracy allows you to save energy.

References

[1] Products of the company Owen / [Electronic resource.]. – Access mode: www.owen.ua.