AUTOMATED CONTROL SYSTEM FOR THE OIL STATION CONTROLING THE HYDRAULIC DRIVE OF THE WATER PUMP IMPELLER BLADES

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Introduction

Currently, the level of industrial water volumes in the main channel required for production needs is maintained by a pump. The required pump performance needed to maintain a given water level in the channels is currently provided by the manual control mode of the oil station, which hydraulically ensures the rotation of the blades of the pump impellers. Moreover, the maintenance of industrial water volumes level can occur several times a day, thus surging the workload on personnel significantly. To reduce maintenance time, increase reliability and safety due to eliminating human factor, it is necessary to develop a system that will allow to perform the process automatically.

The developed system

The implementation of the system should provide both dispatching control on the operator's workstation and oil station management with appropriate algorithms.

Dispatching control on the operator's workstation is supposed to give information about:

- the condition of all executive modules (oil station pump, pressure supply valves to the control rod, the direction of the rod stroke);
- status of sensors (main pump current consumption, water level in the main channel, rod stroke length, impeller bearing temperature);
- setting the boundaries of water level regulation in the main channel.

The following algorithms for oil station management should be implemented:

- automatic control of the position of the control rod by turning on and off the pump of the oil station and pressure supply valves depending on the parameters of the water level in the channel;
- manual control of turning on and off the oil station pump and pressure supply valves from the operator's ARM.

The operator's ARM developed in the TRACE MODE IDE 6 software is shown in Figure 1 [1]. At the top left, there is a panel for switching control modes, while a panel for displaying information about automatic control (control step, direction of stroke of the rod and the state of the oil station pump) is located below it.

The central part of operator’s ARM contains the following elements: a mnemonic circuit with the main pump, the main channel, displaying information from sensors of the current consumed by the engine, the stroke length of the rod and the temperature of the impeller bearing. Below the sensor readings, it is also a strip of water level in the main channel with the possibility of changing the control boundaries. To the right of the sensor readings, the emergency stop button for all actuators is placed.

In the right part of the operator's ARM, there is a panel for manual control.

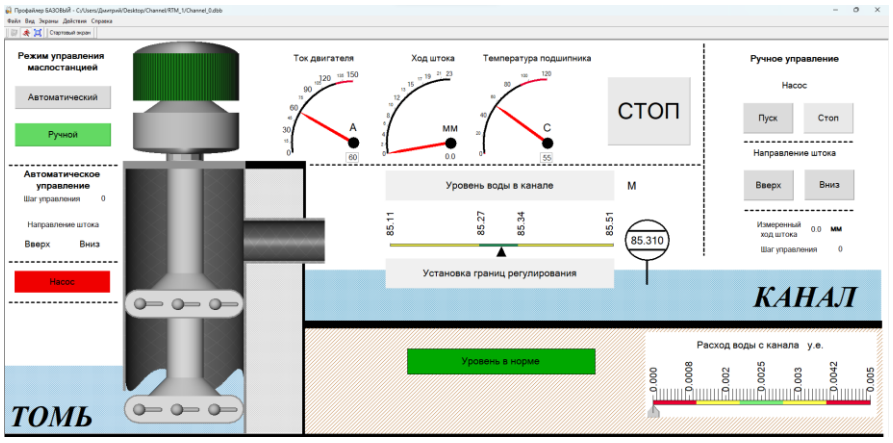

Fig. 1. The appearance of the operator’s ARM

The automated system is controlled by the PLC OWEN PR200-24.4.2.01 [2] in the master mode.

The programmable relay receives information about:

- the water level from the level sensor installed in the main channel and transmitted via the radio channel [3, 4];
- the current consumed by the engine from the digital ammeter;
- the stroke length of the rod from the linear motion sensor;
- bearing temperature from the temperature sensor.

The programmable relay controls:

- turning on and off the oil station pump with the help of starters;
- pressure supply valves by means of starters.

The general scheme of the control system is shown in Figure 2.

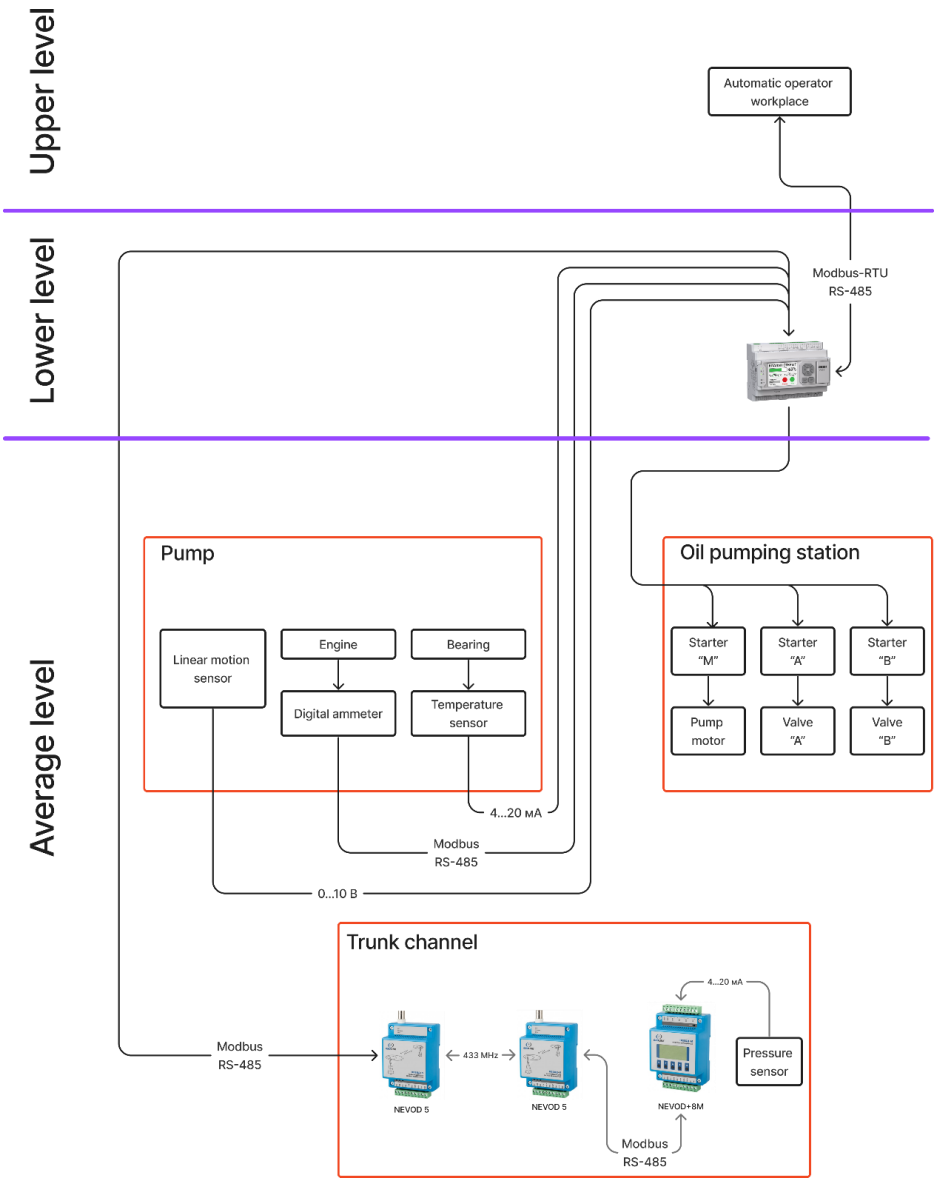

Fig. 2. Structure of the control system

To test and debug the system, a pump simulation model, an oil station simulation model and a channel simulation model were developed in the domestic TraceMode IDE 6 software.

Simulation models are simplified mathematical models written in the FBD language of the IEC 61131 standard, which take control action from the OWEN PR 200-24.4.2.0 PLC and send back data about models' conditions [5].

The model calculates the value of water supply from the pump to the channel and the water level in the channel depending on the set consumption value and water supply by the pump, taking into account the state of the stroke of the rod. The data are updated every second. It should be mentioned that the model is not close in physical properties to a real object since the functionality of the model already allows to evaluate the correctness of the programmed algorithms.

The model is connected to the operator's automated control system. The panel «Channel water consumption, c.u.» is designed to simulate the flow of water from the main channel by the consumer.

As a result of the tests, it was revealed that the developed oil station control system successfully manages the simulation model and performs all the assigned functionality.

Conclusion

In conclusion, the developed automatic control system will allow to adjust the water supply more efficiently, quickly and accurately. Automation will give an opportunity to redirect operational personnel to perform other tasks and minimize the human factor in work.

References

1. Mezentsev A.A., Pavlov V.M. CAD TRACE MODE 6: educational and methodical manual. – Tomsk: NI TPU, 2013. – 38 p.

2. PR200 programmable relay with display // ARIES – programmable devices: website. – 2023. – URL: https://owen.ru/product/pr200.

3. NEWOD +M8. Data collection module // GEOLINK. Modules of the NEWOD family: website. – 2023. – URL: https://www.geolink.ru/nevodm8.html.

4. NEWOD 5. Radio modem // GEOLINK. Modules of the NEWOD family: website. – 2023. – URL: https://www.geolink.ru/products/moduli-semejstva-nevod/nevod5.html.

5. Overview of SCADA TRACE MODE 6 // AdAstra TRACE MODE 6. – 2023. – URL: http://www.adastra.ru/products/overview/.