Automated control system of floatation process

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Abstract. The generalized functional and integrated technical structures of the automated control system of floatation process at PJSC “TsOF “Berezovskaya” are presented. The description of the control modes, information, software and hardware systems are provided.

1. Introduction
The automated control system of flotation process at PJSC “TsOF “Berezovskaya” is intended for automation of control of the process and equipment at flotation compartment, including solution of the following main tasks [1-3]:

- centralized control, analysis and display of information on the state of the technological process and equipment of the flotation compartment;
- automatic control of the technological process and equipment of the flotation compartment.

The main goal of the system is to increase the efficiency of flotation process control and, as a result, to improve the technical and economic indicators of the functioning of the central processing plant “Berezovskaya”:

- reduction of concentrate losses during preparation in flotation machines;
- reducing the erroneous actions by staff;
- increase of reliability and trouble-free operation of technological equipment;
- improving the quality of preparation process control in flotation machines.

2. The functional structure of the integrated APCS
The designed APCS of flotation at the central processing plant “Berezovskaya” is being developed as an integral part of the newly created integrated automated process control system of the central processing plant (APCS CPP) “Berezovskaya”. The APCS of flotation is designed taking into account the maximum possible use of the resources of the already existing technical means of the APCS CPP, unification of the software and hardware of the designed APCS for the flotation and the existing APCS CPP [4]. The enlarged structure of the integrated APCS CPP “Berezovskaya” is shown in figure 1.
Figure 1. Diagram of the functional structure of the integrated APCS CPP “Berezovskaya”.

It consists of the following main systems:
1) the existing APCS CPP includes:
   • automation system of operational control and management of the technological complex of the factory;
   • systems of automatic control of the plant technological complex of the factory;
2) the designed APCS of flotation, including:
   • automation system for operational control of the flotation compartment;
   • a system for automatic monitoring and control of technological equipment of the flotation compartment.

The designed APCS of flotation is a three-level system:
1) the level of local control, which includes:
   • instruments and systems for measuring and monitoring current values of technological parameters;
   • electric actuators of stop and control valves;
   • starting, regulating and protective equipment of electric drives of process equipment, electric drives of stop and control valves;
   • local electric drive control stations;
   1) the level of automatic control of the flotation technological equipment;
   2) the level of operational control of the flotation facility.

Integration of the existing APCS CPP and the newly constructed flotation APCS and the creation of a complete automated technological complex of the processing plant is achieved through the partial use of software and hardware of the APCS CPP for the implementation of functional systems of flotation APCS.

3. Control modes
In the system of automatic control of the flotation technological equipment, the distribution of control functions between the software and hardware of the system and operating personnel is determined by the selected mode of the control functions realization.
The main mode is “Automatic”. All functions of control are performed automatically, including local and interconnected regulation of technological parameters, automatic planned start/stop of process equipment with observance of process regulations by teams of operating personnel, tracking and implementation of the logical dependence of interlocks of units and equipment of the entire technological section and its parts, continuous control of emergency stop switches and maintenance of devices ensuring personnel safety.

Auxiliary mode – “Remote”. All information and control functions are implemented automatically, similar to the main mode, with the exception of the scheduled start/stop and switching technological schemes. Switching on and off the technological equipment and mechanisms is carried out by the commands of the operator. At the same time, the system automatically ensures compliance with the requirements of the process regulations.

Auxiliary mode – “Remote without locks”. All information and control functions are implemented automatically, similar to the main mode, with the exception of planned start/stop and switching of technological schemes, emergency interlocking mechanisms and equipment. Switching on and off the technological equipment and mechanisms is carried out according to the commands of flotation operator.

Setup mode – “Local”. All information functions are performed automatically. All control functions are performed by production personnel. Switching on and off of electric drives is carried out according to control signals received from the push-button panel of the local control stations of each unit.

4. Technical structure of APCS

The scheme of the enlarged technical structure of the automated flotation process control system at CPP “Berezovskaya” is presented in figure 2.

The hardware implementation of the system is based on microprocessor-based programmable controllers, input/output devices, switches, interface converters, fanless computers and touch monitors. This set of hardware is sufficient to perform all automated functions.

All selected components of the system are technical means of mass production and are placed in compliance with the requirements in their technical, including operational, documentation, so that it is convenient to use them and perform maintenance.

Technical means of APCS are equipped with standard interfaces and exchange protocols, which allows their “seamlessly” integration with other systems of APCS CPP “Berezovskaya”.

5. Hardware and software

The hardware implementation of the automation system for the flotation facility operational control is based on the compact fanless computers RMatic produced by 5s Group company (Russia) with touchscreen monitors of Iiyama company (Japan).

Workplaces of flotation operators are created on the basis of RMatic-C2526J-1 fanless computers and Iiyama ProLite touchscreen monitors with a diagonal of 19” installed in sealed control panels. The control panels are realized on the basis of Rittal TP floor panels (Germany) with protection category not lower than IP55, equipped with uninterruptible power supplies, power switching devices, lighting lamps, etc. Control panels are located at workplaces of flotation operators in the flotation compartment of the main plant building.

The Unity Pro controller software from Schneider Electric (France), SCADA package the Wonderware InTouch [5] from Schneider Electric (France) and the OPC server KEPPServerEX from Kepware (USA) are selected as the base software of the APCS.

Information exchange in the APCS of flotation is carried out via the Ethernet information network, in which two subnets are allocated:

- subnet for network devices of the automatic control level, for example, programmable logic controllers, input-output devices, etc. (Ethernet 1);
• a subnet for network devices at the operational monitoring and control level, for example, WKSs (Ethernet 2).

**Figure 2.** Structural diagram of a technical means complex of flotation APCS at CPP “Berezovskaya”.

Improvement in the reliability of the designed APCS of flotation at PJSC “TsOF “Berezovskaya” is realized due to:

• the use of modern technical tools, methods and algorithms for automatic control, analysis, diagnostics of the condition and control of the technological process and equipment;

• comprehensive and detailed display of information on the status of equipment and units, changes in technological parameters, actions of operating personnel in the system [6];

• the use of modern microprocessor controllers with high reliability, long time between failures, easy replacement of failed elements, the possibility of expanding the technical structure and modification of mathware and software as a technical base at the automatic control level;

• minimization of the number of unreliable electromechanical devices in local systems of logical control and control of individual mechanisms and aggregates.

6. Conclusion
The design of the flotation APCS at central processing plant “Berezovskaya” was carried out in one stage (technical project) in a very short period of time – 3 months, with a standard design period of 9-12 months. This became possible due to the parallel, simultaneous execution of a number of design works, the use of typical design solutions and the use of computer-aided design environments.

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