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USAGE OF TECHNICAL REMEDIES DEVELOPED BY "RIVS" SCIENTIFIC AND PRODUCTION CORPORATION IN UP-TO-DATE AUTOMATED CONTROL SYSTEMS FOR TECHNOLOGICAL PROCESSES IN CONCENTRATING PLANTS

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Automation of equipment and technological processes of the concentrating plants is one of the most important directions of the works carried out by the specialists of NPO "RIVS". Rapid perfecting of the technical means of automation permits to work out and to introduce into practice the more effective local systems of adjusting and developed automated systems of control. We can note few achieved results suitable to some technological facilities.

Crushing facility

Main attention in the course of working out of the systems of control of the crushing facility, apart from traditional tasks of the temperature protection and control of the system of the oil lubricating, was paid to complex control of the crushers of small and medium crushing, since they are the components of the crushing-transport section. It was taken into account that the crushers of the new generation, produced by "Uralmash" JSC, are equipped with devices of control of the level of filling of receiving funnel and with automated adjusting of the sizes of unloading slots.

The structure of automatic control systems for technological processes (ACSTP) of the crushing capacity is rather typical for such tasks. It involves: the central controller of the upper level of control with the stations of visualization (operator ARM), the local controllers of the some crushers and local boxes of control of the units of the crushers and line-transport system.

The control strategy has been chosen as the main goal. Criterions of efficiency of the last one are achievement of the maximum productivity and the least coarseness of the crushed ore. Statistical dependence of productivity of the crushers on the size of unloading slot and dependence of power consumption of electric drive of the crusher on productivity by initial ore were obtained in the course of study. The results of study are the basis for the program of control. It has been introduced conception "step'treatment". It permits to calculate necessary adjustment of size of the slot depending on quantity of processed ore.

Taking into account shortcomings of the control systems based on statistical methods it has been studied possibility of usage of the instrumental methods for control of coarseness of the crushed ore. There are some achievements in this sphere: it has been made the system of automatic analysis of coarseness of the ore in the moving ore-flow by means of mathematical working of the signal of the scanner video camera. Industrial tests have confirmed the perspective possibilities of the offered construction of the device.

Taking into account the high cost of the model of the granulometer NPO "RIVS" works up the simplified model that is the laser range finger that scanning of the surface of the moving ore-flow (fig. 1). The study has shown that the device produces the signals that differ in amplitude-frequency characteristics for different coarseness of the crushed product. It has been worked up the special mathematical methods for separation of the useful information from the signals. It is impossible to determine content of the separate classes of the coarseness on the base of above mentioned information, but it permits to estimate deviation of coarseness from the some scheduled value. Solution of the tasks may be useful for control of the screens efficiency, control of coarseness of the products at the outlets of the crushers and so on. Besides, mathematical working of the signals of the laser scanner permits to obtain simultaneously information about quantity of the passing material. It is valuably in itself in the case of impossibility to

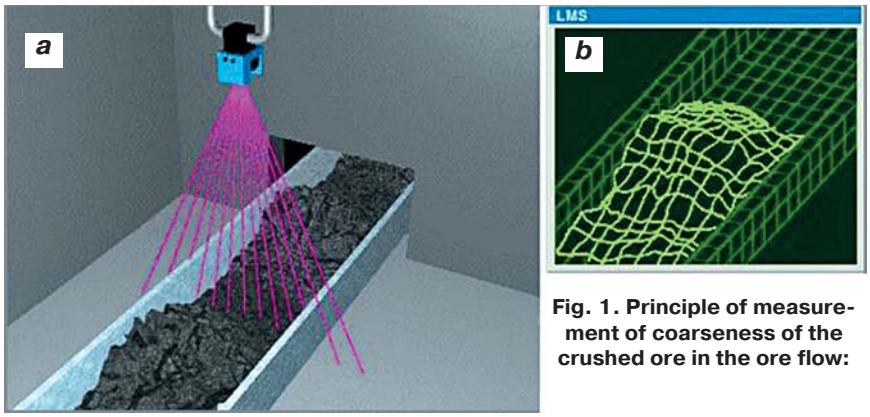

Fig. 1. Principle of measurement of coarseness of the crushed ore in the ore flow:

a — scheme of scanning of the ore flow by the laser range finger;
b — volumetric model of the ore flow

install the conveyor balance (lamellar feeders, short conveyors and so on).

Comminuting facility

Today it is worked up the number of the technical solutions for control of technological parameters of comminuting facility, depending on technological scheme, composition of equipment and others factors. Structure of ACSTP of comminuting facility is analogous to the structure of ACSTP of the crushing facility. Besides, the first one includes the controllers of the upper level and the local controllers for solution of the tasks of control of technological parameters.

Since the principal position in the range of comminuting equipment, produced by NPO "RIVS", is the pump-hydrocyclone units, the main efforts were directed to automation of the equipment.*

Flotation facility

In course of working up of the systems of automation of flotation facility the main attention was paid to the systems of automated adjustment (ASSUP-RV) of the pneumatic-mechanical flotation machines (RIF) and to devices for dosing of flotation reactants (UDR-RIF).

The standard complete set of the systems ASSUP-RV involves the boxes with the programmable controllers realizing functions of adjusting of level of the pulp in flotation machines and consumption of technological air fed to aeration (fig. 2).

Technical parameters of the system ASSUP-RV are given below

Diapason of adjusting of level of the pulp, mm	0–500
Precision of maintain of the level, %	±2
Diapason of adjusting of the air consumption, %	0–100
Precision of adjusting of the air consumption, %	± 2
Voltage of feeding of the box of control, V	~220
Pressure of the feeding air, MPa	0.6–1
Maximum consumption of the feeding air, l/min	50
Possibility of conjunction with the upper level	RS-422

Pneumatic components ensuring high reliability of operation of the systems of automation in the heavy industrial conditions are used widely in forming of ASSUP-RV.

Depending on requests of the customers ASSUP-RV may be equipped with the level sensing elements of the different types — piezometric, ultrasonic, hydrostatical. Every sensing element is characterized by enough precision and high reliability. Diaphragm fluid-meters are used as a standard solution for measurement of the air consumption. At the same time NPO "RIVS" has successful experience of application of the thermometrical fluid-meters produced by the firm Sierra Instrument (the USA). The advantage of this type of the fluid-meters is the simplicity of installation and high reliability.

ASSUP-RV may work as the local system or as a unit of ACSTP of the concentrating plants. Connection between the systems may be realized by means of the control cables or by means of the lines of interface communication. If the system of automation works as a part of ACSTP it may be additionally equipped with the different control sensing elements for increase of volume of information. The sensing elements control different technological parameters: temperature of the pulp, value of pH, residual concentration of flotation reactants, density of the

Fig. 2. Flotation machine RIF 16 equipped with the system ASSUP-RV

*The more detailed information is given in the article Sedov A. V. and others "Development and putting into practice the automatic pump-hydrocyclone units, manufactured by "RIVS" scientific and production corporation, at the concentrating plants" published in the present issue of "Eurasian Mining".

pulp, its consumption and so on. So, it may be interesting to use worked up by the corporation sensors for measurement of the foam layer. The contactless sensors were worked up on the base of ultrasonic level meters. Usage of the sensor permits to change traditional approach to adjusting of level of the pulp, since it allows carry the process directly by intensity of the foam output. Fig. 3 shows the example of the comparative testing on the base of the known solution of control of the foam output by means of inclination of the sensing elements and contactless sensor worked up by NPO "RIVS". It is evident that the both sensors give the same information and work synchronously. Advantages of the contactless sensor in comparison with the contact one are evident, since it is removed some shortcomings: overgrowing of the sensing elements, sticking of the foreign objects on the sensing element and so on.

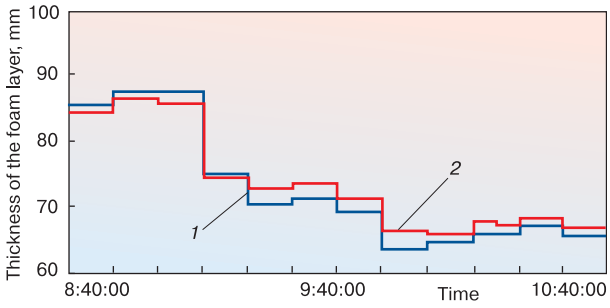

Fig. 3. Change of the outgoing signal of the different sensors depending on the foam output in the time (ten-minutes intervals)
1 — with the contact sensing elements;
2 — with the contactless sensor

Dosing of flotation reactants is another important direction of the work of NPO "RIVS" in the field of automation. The standard structure of the unit for dosing of the reactants is given at the fig. 4. It involves the dosing tables with the feeders of the reactants, the box of the control with the programmed controller, the working station ensuring possibility of the visual control and remote control of operation of the system.

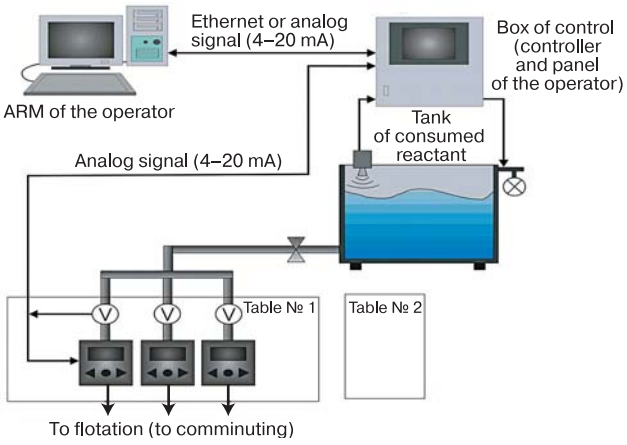

Fig. 4. Structural scheme of the plant UDR-RIF

The system permits to solve the following tasks:

- setting of consumption of the reactants for every point of dosing;
- calculation of consumption of the reactants for every point of dosing;
- diagnostics of the feeders refusal by the balance of the set and real consumption of the reactants;
- calculation of reserve of the reactant in the tank and forecasting of the rest to the end of the shift.

The corporation has worked up the different versions of the dosing units.

The simplest unit includes the set of the impulse electrical, electrical- pneumatic or pneumatic valves mounted on the table of the feeders of the reactants, controlled by the controller. In accordance with arrangement of the dosing table the distributive collector is located in the upper portion of the table. It ensures the best conditions for the reactants flow through the feeders. Advantage of the version of the unit is its low price and simplicity of maintenance.

The more complex and more expensive version of the feeder (fig. 5) is the monobloc of the stainless steel. The monobloc may be mounted without the special table. The feeder involves the segmental rotary oven-door with the pneumatic drive. The oven-door is joined consecutively with the electromagnetic liquid-meter. Construction permits to fulfill easily washing of the feeding channel with the water in the case of need. The feeders are the most effective in dosing of the big volumes of consumed reactants.

Dosing diaphragm pumps are another perspective type of the reactants feeders (fig. 6). The working units of the pumps are made of the corrosion-resistant materials. So, the pumps are rather long-lived and simple in operation. If the pumps are used in the systems of automated control they are controlled by means of the current signals 4–20 mA. It is possible to carry out control of the pumps by the interface network.

Besides, above mentioned feeders permit additionally dosing of the reactants from the vessels installed directly near the points of feeding. It is very important for dosing of the small portions of the reactants. The arrangement decreases considerably the time of the reactants transportation and favors increase of efficiency of control of technological process.

Technical parameters of the units UDR-RIF are given below:

Diapason of dosing of flotation reactants per minute	from 1 ml to 50 l
Precision of the level maintenance	±1
Diapason of adjusting of the reactants consumption, %	0–100
Diagnostics of the channel of the reactants	Option
Number of the points of dosing	Not limited
Voltage of the power supply of the box of control, V	~ 220
Possibility of conjunction with the upper level	RS-485

Summing up the review of the systems of the reactants dosing it is possible to mark their following common advantages:

- presence of the programmable controllers with the sensor panel of the operator, simple and obvious process of adjusting of the systems of adjusting and control of technological process;
- application of corrosion-protected materials for dosing elements;
- large range and high precision of dosing;
- possibility of operation both in the regime of local adjusting and in ASUTP of the concentrating factory;
- lexible configuration in accordance with conditions of operation and requirements of the customers.

Now the corporation works out the complex systems of control on the base of accumulated experience of creating of the local and complex systems of control of technological processes at Almalyksky concentrating factory (Uzbekistan), Kadzharansky concentrating factory (Armenia) and some Russian factories.

Information system "Working place of flotation operator" is one of the elements of the systems. The system is realized at the monitors placed in the working zones of

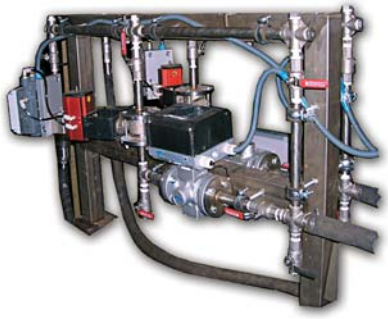

Fig. 5. Reactant feeder constructed by NPO "RIVS"

flotation operators. They are the user's points of the computer net of ACSTP. The system is intended for assignment by inquiry of the necessary information (without possibility of entering of the controlling influence) about technological process. The information includes:

- current values of the controlled parameters of flotation;
- consumption of the reactants by the points of dosing;
- results of express-analysis of flotation products;
- parameters of operation of the current shift in the passed period.

Efficiency of the systems worked up on the base of above mentioned principles is confirmed by successful experience of their exploiting at Uchalinsky concentrating factory and at the concentrating factory of JV (Joint Venture) "Erdenet" (Mongolia).

Fig. 6. Table of the feeders of the reactants with the dosing pumps

For increase of efficiency of the works it has been made the analog-digital test-bench. It is supplemented with the new tasks now. Equipment of the test-bench permits to simulate technological equipment and tasks as the objects of automation, to adjust and to perfect different versions of the software for complex systems of control in the regimes approximated to the real operation, to carry out training of the specialists. It is possible to connect the physical models, imitation systems or models of the systems of automated control to the test-bench.

Automation of the laboratory flotation machine and the pilot flotation plant is the example of the practical application of possibilities of the test-bench.

The laboratory pneumatic-mechanical machine with the chamber volume 3 liters is equipped with the following means of control:

- sensor of the pulp level in flotation machine on the base of the laser level-meter;
- thermo-anemometric device for calculation of consumption of the air, fed into flotation machine;
- potentiometer sensors for pH-values and oxidation-reduction potential;
- frequency-adjusting drive of the impeller;
- reactants feeders on the base of the peristaltic dosing pumps;
- regulator of the pulp level in flotation machine keeping up the pulp level owing to change of the working volume of the chamber;
- box with the programmable controller, performing the role of the active device communication with the object of control; the controller ensures collection of the information from automatic sensors,

forming of the controlling influence on the executive units and connection with the central computer of the analog-digital test-bench.

The listed above technical equipment permits to solve the following tasks:

- to maintain the set conditions of flotation tests in automatic regime;
- to analysis obtained data without halt of the process and carry out opportune correction of conditions of the experiment depending on obtained results;
- to set the program of change of the regimes in the time, i. e. to automate the process of researches;
- to obtain the worked results of the tests in the form of the tables, diagrams and others kinds of visual present of the information.

The possibilities of the test-bench are realized with the highest efficiency jointly with the pilot plant.

Apart from automation of the experiments, carried out at the pilot plants directly at industrial areas or experimental facilities, it is possible to pass the information at the distance by means of the channels of the digital communication to the scientific-technical center to analog-digital test-bench. The obtained data are worked here and obtained results will be returned to researchers by the same way.

Conclusion

Gained experience and modern stores of the technical means permit to specialists of NPO "RIVS" to solve efficiency the traditional tasks of automation of the equipment and adjusting of the some parameters of concentration and to create the complex systems of automation of technological facilities as a whole. EM

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DEVELOPMENT AND PUTTING INTO PRACTICE THE AUTOMATED PUMP-HYDROCYCLONE UNITS, MANUFACTURED BY "RIVS" SCIENTIFIC AND PRODUCTION CORPORATION, AT THE CONCENTRATING PLANT

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Today application of the complex automated pump-hydrocyclone units (PHCU) is indispensable condition of projecting of comminuting cycles at the new and at reconstructed concentrating plants. Till recently the main suppliers of the equipment were different foreign firms.

In 2000 NPO "RIVS" has begun to produce its own hydro-cyclones of the different types. The distinctive peculiarities of the last ones are the evolvent input of feeding and usage of easily removable insets lined with resistance rubber. The inserts permit to change the height of cylindrical part of the hydro-cyclone. Depending on the properties of classified material the hydro-cyclones have the completely rubber or combined lining: the cylindrical parts — of the resistance rubber, the conic parts — of the silicon carbide.

Today NPO "RIVS" produces the hydro-cyclones diameters 1000, 700, 500, 380, 250 and 150 mm with the conicity angle 20° and 12°. The battery units were designed and made on the base of the hydro-cyclones. Productivity of the battery units is 200–1000 m^3/h of the pulp.

The complete set of the battery unit involve:

- hydro-cyclone battery including;