

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. 

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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 insets 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 m³/h of the pulp.

The complete set of the battery unit involve:

- ◆ hydro-cyclone battery including;

Results of calculation of parameters of the hydro-cyclones

| Diameter of the hydro-cyclone, cm | Size of the nozzle, cm | | | Productivity of the hydro-cyclone (m ³ /h) under the pressure, MPa | | Nominal coarseness of discharge (μm) under the pressure, MPa | |
|-----------------------------------|------------------------|-------------|-------|---|------|--|------|
| | feeding | discharging | sandy | 0.1 | 0.15 | 0.1 | 0.15 |
| | | | | | | | |
| 100 | 22 | 20 | 25 | 380 | 465 | 105 | 96 |
| | 22 | 25 | 25 | 475 | 582 | 117 | 106 |
| | 22 | 30 | 25 | 570 | 698 | 128 | 116 |
| 70 | 17 | 16 | 16 | 245 | 300 | 93 | 84 |
| | 17 | 20 | 16 | 306 | 375 | 104 | 94 |
| | 17 | 24 | 16 | 368 | 450 | 114 | 103 |
| 50 | 12.5 | 10 | 6 | 119 | 145 | 99 | 92 |
| | 12.5 | 12.5 | 6 | 148 | 182 | 114 | 100 |
| | 12.5 | 16 | 6 | 190 | 232 | 125 | 113 |

- collapsible sand and discharge chute;
- distributive head with the cover;
- pressure feeding pipe-line;
- hydro-cyclones of the necessary diameter of the type GCR(K)-RIF with the sand nozzle made of the silicon carbide;
- ◆ pumps with electric drive;
- ◆ locking-adjusting fittings;
- ◆ control station with the two pumping units;
- ◆ system ASUGC with the software.

Choosing of the hydro-cyclones, pipe-lines, electric pumps for equipping of PHCU is carried out by means of the modern methods of computer calculations. The special-

ists of the corporation have worked up the program permitting to determine the number and the type of the hydro-cyclones, rational dimensions of the changeable nozzles and pressure in feeding of the hydro-cyclones.

Depending on intended tasks and productivity of comminuting cycle NPO "RIVS" produces the hydro-cyclone batteries of the "linear" and "round" type.

The *linear arrangement* is used for less than four hydro-cyclones per one pump, the *radial arrangement* — for greater number of the hydro-cyclones mounted in the battery (up to 16–18 units). The linear arrangement is expedient in the cycles of the

ore comminuting with usage of the hydro-cyclones more than 500 mm diameter (GCK-700, GCK-100). Lining of the hydro-cyclones and nozzles are made of silicon carbide.

Experience shows that the hydro-cyclones of the big diameter operate effectively with the plants of the first and second stages of comminuting with obtain of the discharge product with the coarseness 85% of the class –0.074 mm.

Conventional example of calculation is given in the table. It is shown that selection of the sizes of the changeable nozzles at the hydro-cyclones 500, 700 and 1000 mm diameter permits to obtain the discharge of the nominal coarseness –110 μm (it corresponds to about 85% of the class –0.074 mm). Productivity of the hydro-cyclones is 148, 368 and 475 m³/h correspondingly.

It is possible the two versions of operation of the battery of the "round" type. The distributive head is divided in two parts in the first version. Two sand baths and two discharging ones ensure auto-nomous operation of every half of the hydro-cyclones with its pump (fig. 1). It is recommended to use the first version in the ore comminuting units. Feeding of the battery in the second version is realized through the distributive head common for all installed hydro-cyclones. The head is divided in two too. The force pipe-line is equipped with the T-joint and with the two pumps. It allows exploit of the unit at the different products (fig. 2).

Apart from perfecting of construction of the hydro-cyclones, of increase of quality of making of the last ones, the specialists of the corporation pay great attention to working up of the system of automated control of equipment. Efficiency of operation of the system ensures

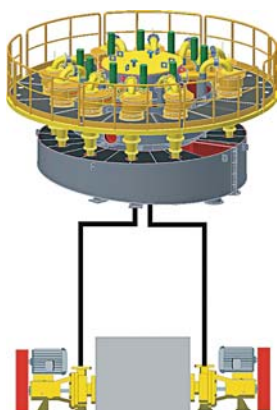


Fig. 1. Version of arrangement of the hydro-cyclone battery (one sump, one product, two pumps)

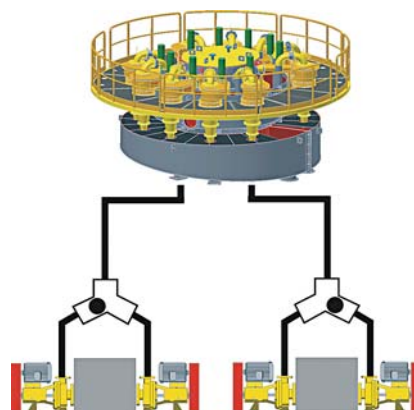


Fig. 2. Version of arrangement of the hydro-cyclone battery (two sumps, two products, four pumps)

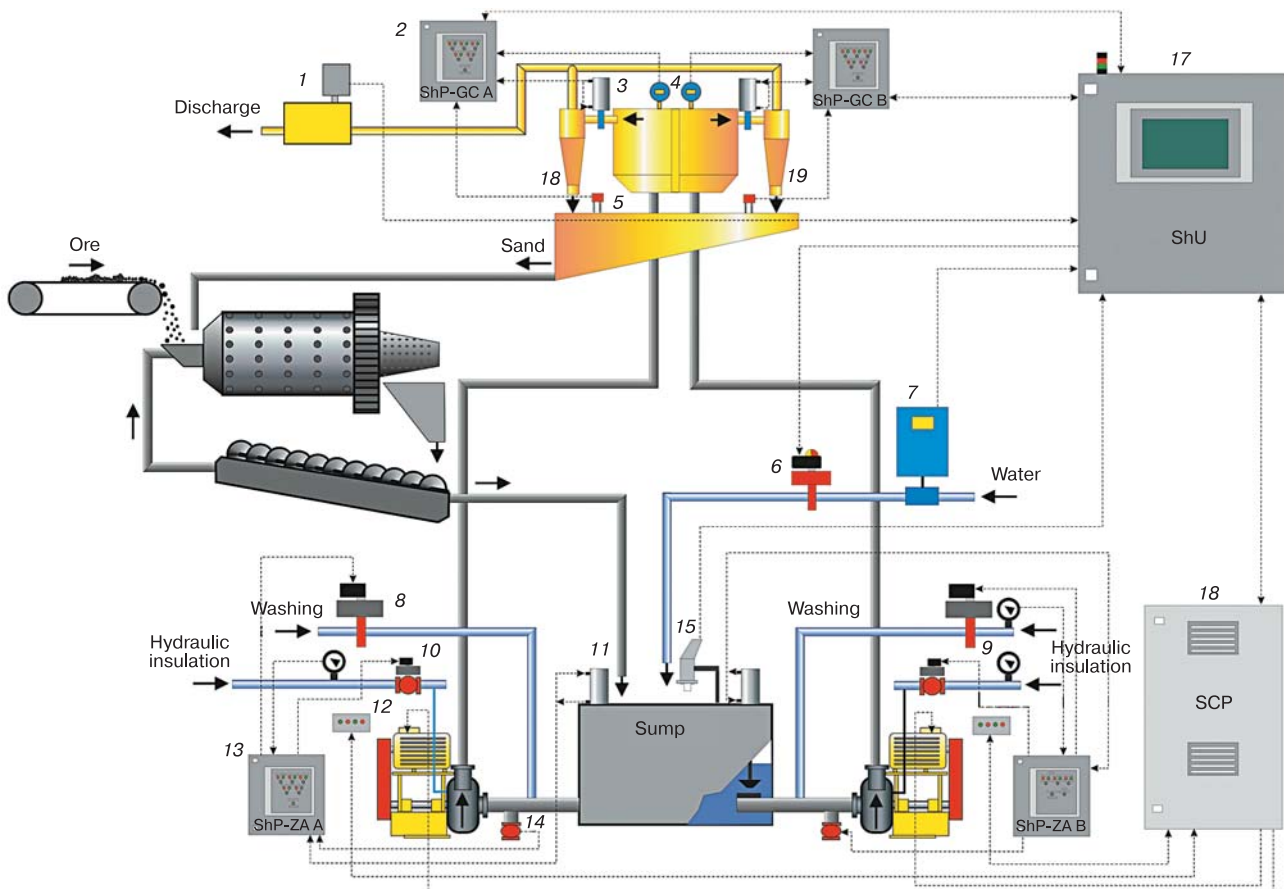


Fig. 3. Structural scheme of automated pump-hydro-cyclone plant

1 — density-meter; 2 — ShP-GC box of control of the slide-gates of the pumps A and B; 3 — slide-gates of the pumps A and B; 4 — change of pressure at the entrance of the hydro-cyclones of the pumps A and B; 5 — emergency level of the sand-bath of the pumps A and B; 6 — adjusting slide-valve; 7 — liquid-meter; 8 — slide-valve of washing of the pumps A and B; 9 — control of the water pressure; 10 — slide-valve of hydraulic insulation of the pumps A and B; 11 — bottom gate of the pumps A and B; 12 — local control panel of the pumps A and B; 13 — ShP-ZA box of control of the locking accessories of the sump of the pumps A and B; 14 — drainage of the pumps A and B; 15 — measurement of level in the sump; 16 — station of control of the pumps; 17 — ShU box of control of the hydro-cyclone unit; 18 — hydro-cyclone battery of the pump A; 19 — hydro-cyclone battery of the pump B.

directly achievement of the technical-economic parameters of work of PHCU and safety of the serving staff.

Automated system of control PHCU is destined for continuous measuring, control and adjusting of technological parameters of the classification process.

ASUGC ensures:

- continuous centralized control of PHCU in the regime of the real time;
- logical control of the operations of automatic starting and stopping of PHCU;
- maintenance of adjusted technological parameters within the set bounds of the values;

- remote control of the frequency-adjusted electric drive of the pump and drives of the locking-adjusting accessories;

- visualization of parameters of technological process and representation of the state of every unit of the system at the given moment with application of the modern soft-ware;

- control, registration and storage of the principal parameters of technological process and possibility of construction of the diagrams of changes of the parameters in the regime of the real time;

- automatic forming and conducting of the “history” of technological process with possibility of

construction of the diagrams of change of parameters of technological process within the last hour, day, month;

- automatic forming and issue of the reports about appearance of the emergency situations.

Approach to realization of the systems is illustrated by the example of automatic control of classification process in the hydro-cyclones in the ore comminuting cycle (fig. 3).

The tasks of the system of automation are:

- stabilization of level of the pulp in the sump by change of speed of rotation of the drives of the sand pumps;



Fig. 4. Pneumatic box of control ShP-GC with the elements of control and indication



Fig. 5. Pneumatic box of control ShP-ZA with the elements of control and indication



Fig. 6. Station of control of the pumping assembly

- stabilization of pressure of the pulp in feeding of the hydro-cyclones by means of change of the number of the last ones operating in the battery (switching of the pulp flows);
- stabilization of density of the pulp by regulation of feeding of the water in the sump of the sand pumps in accordance with the readings of the density-meter at the discharge of the hydro-cyclones;
- automatic starting and stopping of the sand pumps with ensuring of washing of the pumping pipes (in starting) and discharge of the rests of the pulp into the drain-pipes (in stopping).

It is foreseen the following technical means for realization of the enumerated functions:

1. Pneumatic boxes of control of the battery of the hydro-cyclones

ShP-GC (fig. 4) for placing of the blocks of preparation of the compressed air and elements of control of the slide-gates at the feeding branch pipes of the hydro-cyclones.

2. Pneumatic boxes of control of the sump ShP-ZA (fig. 5) includes the blocks of preparation of the air too and elements of control of the locking accessories:

- slide-valves for feeding of water for washing of the pipe-lines of the pumps;
- slide-valves for feeding of water for hydraulic insulation of the pump;
- bottom slide-valves of the sump with hydraulic drive;
- discharge drain valves of the pumps.

There are the switches of selection of the working regimes ("automatic — hand"), devices of control of the locking-adjusting accessories and indica-

tors of the limit positions ("open — close") at the front panel of the box. The boxes are placed near the hydro-cyclones and sump. It allows to observe the state of operation of equipment at the front panel of the box and to control locally the locking accessories in the hand regime.

3. Station of control of the pumps (SCP) (fig. 6) involves converter of frequency for frequency adjusting of speed of rotation of the drives of the sand pumps and power commutating plant for switching from the working pump to the reserve one and backwards. It allows to setting the pump in motion in automatic and hand regimes by the network or by the frequency drive. All commutating accessories send the information about every logical switching and about state of equipment to the box of control of ASUGC.

Since SCP is the power plant it is placed in electric premises inaccessible for technological personnel in accordance with the standards of safety. So, the information about the state of operation is depicted at the panel of the box of control.

4. Box of control ASUGC (fig. 7) is destined for collection of the information about technological and technical parameters of equipment,



Fig. 7. Box of control ASUGC

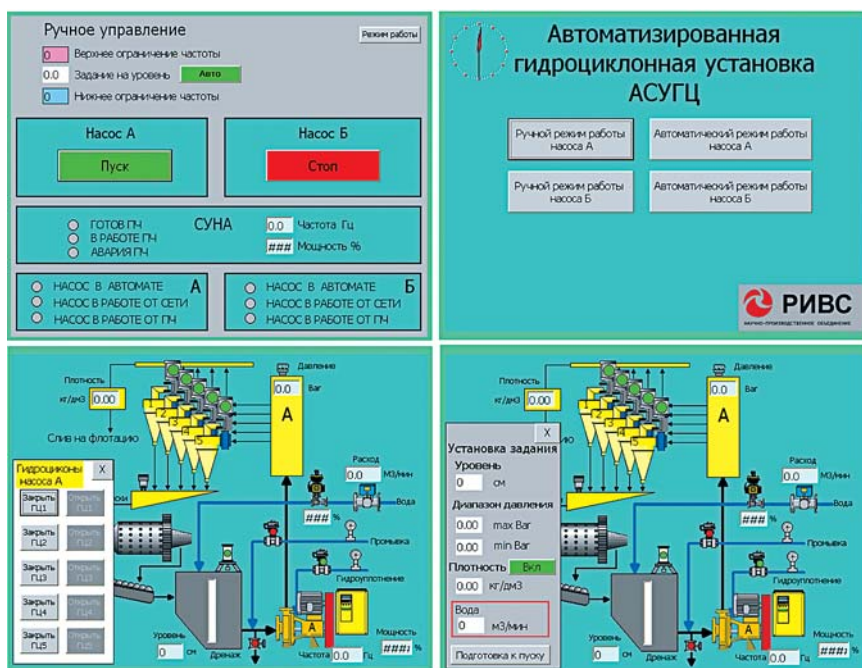


Fig. 8. Fragments of representation of the panel of the operator of the box of control ASUGC

for comparison the real parameters with the set ones and for generating of the entering signals of adjusting for pneumatic boxes of control and for station of control of the pumping assembly.

The sensor panel of the operator is installed at the front of the box of control. The panel is used for introducing and for representation of the all necessary parameters of automatized system of control PHCU. The sensor panel of the operators involves professional manning-machine interface with the sensor keyboard. It is equipped with protec-



Fig. 9. Sensor of pressure with the digital indication of the current value

tion IP65 and covered additionally by the vision screen.

The example of representation of the interface of the panel of the operator is given at the fig. 8. The devices of the light and sound signaling are located in the upper part of the box. The button of emergency disconnection of the sand pumps and the system of cooling of equipment are installed inside of the box. Besides, the box of control communicates with the pneumatic boxes and with the station of control of the pumping assemblies.

5. The sensors of technological parameters, controlling:

- level of the pulp in receiving sump;
- pressure of the pulp in feeding of the hydro-cyclones;
- density of the discharged products of the hydro-cyclones;
- consumption of the water, fed to the sump;
- pressure of the water, fed for washing of the pumping pipe-lines.

Realization of automatic control of the mentioned above parameters is carried out by the use of the following technical means:

- level of the pulp in receiving sump — by means of the level-meter;
- pressure of the pulp in feeding of the hydro-cyclones — by means of the sensor of pressure with ceramic diaphragm divider and digital indicator of pressure (fig. 9);
- density of the discharged products of the hydro-cyclones — by means of the density-meters of the radioisotope or piezometric type (fig. 10);
- granulometric composition — with the granulometers.

Locking-adjusting accessories include the bottom slide-valves with pneumatic drive, covering the discharge holes of the sumps. It allows to carry out automatic transition to the reserve pump or to carry out “urgent” replacement of the pump. The cylinders have corrugated protection of the rods. They are equipped with the system of braking for protection from the losses or sharp decrease of pressure of compressed air. Besides, the magnetic sensors of the ultimate positions are installed at the cylinders (fig. 11).

Adjusting of feeding of the water into the sump is carried out by means of the disc lock with pneumatic drive and electrical position-



Fig. 10. Pneumatic drive of the bottom slide-valve with the system of braking



Fig. 11. Indicator of density (PIP-RIF). The box with converter and measuring counter



Fig. 12. Clamping valve for discharge of drain of the pump

ing having the return communication by the signal.

It is foreseen the clamping valve with pneumatic control for discharge of the pulp into the drainage after stopping of the pump (fig. 12). Operation of the drain valve is united with operation of the drive of the bottom valve: in the case of closing of the drain valve the bottom valve is opened automatically.

Adjusting of the number of the hydro-cyclones operating in the battery is carried out by means of the slide-gates of the knife type with pneumatic drive (fig. 13). The constructive features of the slide-valves are the elas-

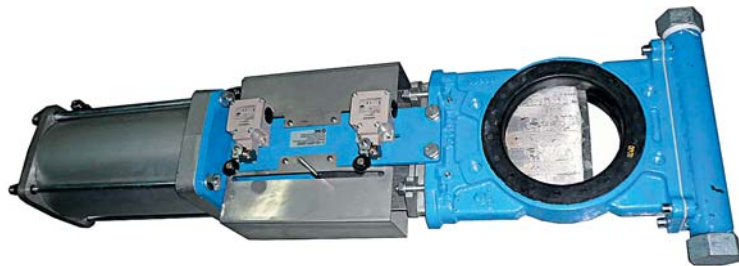


Fig. 13. Slide-gate with pneumatic drive installed in the entrance into the hydro-cyclone

tic guides. They permit to squeeze out of the slide-valve of the hard particles falling under the knife. It increases significantly reliability of operation of the accessories with the pulp.

Thus, application of the newest technical means of automation of the leading world producers, taking into account expediency of the technical solutions, permits to create the modern high efficient systems of control of classification in the hydro-cyclones.

Today more than ten PHCU produced by NPO "RIVS" operate or are prepared for putting into practice in the facilities of the ore comminuting or additional comminuting of the products at the concentrating factories of "Kol'skaya GMK" JSC, "Karel'sky okatysh" JSC, "Zangezursky MMK" JSC, Zhezkentsky GOK of "Corporation Kazakhmys", "Almalyksky GMK" JSC and others.

The results of industrial exploiting of the hydro-cyclone units in the cycles of comminuting of the concentrating factories show the high technological, technical and economic efficiency of the units and high operating reliability.

Usage of automated hydro-cyclone units allows increase extraction into concentrate of the set quality owing to increase of output of the classes of the optimum flotation coarseness. Increase of extraction may be 2–10%. Automated regime permits to minimize negative influence of the disturbances arising in the cycle of comminuting owing to changeable load on the mills and changeable level of the pulp in the sump of the pump.

Experience of application of the hydro-cyclone units shows that they permit to:

- ◆ maintain the process of classification in the regime of content up to 95% of the set class of coarseness in the discharged products of the hydro-cyclone;
- ◆ increase efficiency of classification by 5–10%;
- ◆ increase usage of the mills factor by 7–8%;
- ◆ decrease about three times electric power consumption;
- ◆ increase the life of wearing parts of the pumps and hydro-cyclones up to 4 thousand hours. **EM**