INTERNATIONAL MULTIDISCIPLINARY JOURNAL FOR RESEARCH & DEVELOPMENT
SJIF 2019: 5.222 2020: 5.552 2021: 5.637 2022:5.479 2023:6.563 2024: 7,805
eISSN :2394-6334 https://www.ijmrd.in/index.php/imjrd Volume 11, issue 03 (2024)

INCREASING THE EFFICIENCY OF AUTOMATION AND CONTROL SYSTEMS FOR SMALL GEN COMPRESSOR DEVICES

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Abstract: The article presents an analysis of the reduction in economic and technological waste achieved through full automation of operating modes of compressor devices and increasing the efficiency of the control system while ensuring stable operation of the main and auxiliary devices of small hydroelectric power plants in Uzbekistan.

Key words: Power station, hydroelectric power station, renewable energy sources, diversification, electrohydraulic speed, power regulator, hydraulic turbines, automation systems .

Renewable energy, diversification of sources of electricity production, reducing the use of natural gas in electricity production, as well as attracting foreign direct investment in power grids, O According to the decision of the President of the Republic of Uzbekistan dated May 2, 2017 No. PQ-2947 "On the program of measures for the further development of hydropower for 2017 -2021 » 2017 by the unitary enterprise "TO PALANG HPD BUILDING" on the basis of the decision " On measures" for the implementation of the investment project "Cascade of small hydroelectric power plants with a capacity of 12 MW with the supply of equipment from the People's Republic of China" on the Fergana Canal . In July, the first stone for the construction of the "Cascade of Small Hydroelectric Power Stations" on the Great Fergana Canal was laid and construction work began on PC-14 km of the "Great Fergana Canal" [1].

The President signed a decree on the development of hydropower until 2030. By 2030, the capacity of hydroelectric power stations in the republic will be increased to 3,416 megawatts [2].

Accordingly, an analysis of the reduction of economic and technological waste achieved through full automation of operating modes of compressor devices and increasing the efficiency of the control system in ensuring stable operation of the main and auxiliary devices of small hydroelectric power plants in Uzbekistan has been studied.

The hydraulic turbine automatic control system must consist of [3]:

- electrohydraulic speed regulator, power regulator;
- hydraulic turbine automation systems;
- equipment emergency shutdown systems .

The hydraulic turbine automatic control system must perform the following functions [4]:

- automatic program start of the unit, bringing it to the frequency of subsynchronous rotation;
- normalization of rotation speed during operation: at idle, in isolation, including in parallel with other units;
- maintaining a given power during operation of a hydraulic unit in the power system;
- active power control from group control systems;
- Work in SC mode;
- normal wear and tear of equipment;
- stopping the device;
- high (collective) level of management;
- starting and stopping the hydraulic unit.

When formulating requirements for a control system [5]:

- frequency indifference zone no more than 0.02%;
- frequency measurement accuracy is no worse than 0.02%;
- delay time no more than 0.2 s;
- operating oil pressure, MPa;
- accuracy of maintaining frequency Fnom % (when working in an isolated place and at different load levels) - no less than 0.1%;
- accuracy of maintaining a given power level (in power mode)% - not less than 1.0%;
- frequency generator settings change interval %;
- range of change of the set value of the electric generator;
- input voltage.

The control system must ensure that the hydraulic device is turned on in the absence of alternating current voltage in the auxiliary system of the hydroelectric power station and in the presence of pressure in the oil injection device [5].

Hydraulic turbine automation equipment must ensure the performance of protection, control and monitoring functions of turbine units and devices, namely [6]: turbine shaft failure; water flow through the bearing and pressure; state of servo motor breakers ; water level in the turbine cover; water flow through the shaft seal; water pressure in the shaft seal; Water supply to the wheel seal in SC mode; air pressure in the repair seal ; Compressed water level in SC mode; water flow from the turbine; water pressure in the spiral chamber; water pressure under the turbine cover; The turbine automation system or its individual components must be adapted to work in the harsh industrial operating conditions of hydroelectric power plants. For example: low or high temperature, dust, moisture, harmful impurities, strong electromagnetic fields, vibration. The electrical equipment cabinet must be equipped with a device for measuring the rotation speed of the hydraulic unit in the range of 0 - 200% [7]. The following should be used as signal 1:

- AC voltage 220 V (permissible heavy duty - from minus 15% to +10%);
- duty allowed - from minus 15% to + 10%).

The electrical equipment panel must ensure the generation of control signals for the hydraulic turbine controls in accordance with commands to change the operating mode of the hydraulic device and the measured values of frequency and active power, water pressure in the suction pipeline, vibration of hydraulic turbine units, and temperature of turbine mechanisms [8].

Should consist of sensors and devices that control the operation of the turbine, as well as actuators that generate commands for automatic control of the operating mode and protection of the turbine.

The introduction of an automatic control system for the compressor unit of the MNU hydraulic turbine complex will allow solving the following problems [9]:

- Fully automatic compressor control system, which does not require human intervention during its operation, resulting in the release of workers working on the L-24/6;
- Reduced frequency and complexity of maintenance;
- Promotion reliability systems management;
- Reducing downtime associated with technological maintenance.

Feature of the L-24/6 (hydroturbine MNU device) ensures a continuous production cycle.

The entire complex cannot operate without a working compressor unit, this causes more than 10 billion losses due to the non-production of conventional L-24/6 raw materials during the day. In this way, the compressor installation can reduce the frequency of maintenance and its tolerance to reduce losses caused by equipment failure.

In the widely developed energy processing industry, technical development is at the forefront. special attention is paid to this, the enterprise owners are interested in increasing the energy consumption of their enterprises . Keep in mind that the entire operating mechanism is based on the principle of a highly organized automatic system. Here, each node has its own norms and rules - under operational control. Long-term practice of operating compressor units (CU) shows that emergency shutdown of compressor units, associated with low-tech equipment, lack of equipment self-diagnosis and low critical limit of operating accuracy, appears 4-6 times a year, in this case usually from 4 to 24 hours. To quickly restore operation, the installation of compressor equipment requires the constant participation of repair personnel. And this costs a lot, because employees are almost not involved, After all, the maintenance of mechanisms is carried out at the appointed time and does not require more than 400 hours of work per year. Simplification of maintenance and use of self-diagnosis functions allows you to quickly determine the cause of opening, principle of modular design, allows you to replace faulty system components. Using an early warning system about emerging problems allows you to eliminate them in time and not stop compressor equipment due to an accident. Before the introduction of automatic control systems, the operator had to periodically monitor the operation of the device and correct its changes . The faults were identified by a specially trained specialist over a long period of time . and usually during the day the mountain was rilan. Emergency breakdowns are usually detected after a KI emergency stop. It was not possible to diagnose problems (only deviations from technical parameters) during operation of the control system. We had to use a repair crew and several operators. Now all control of the compressor unit is carried out from the central control panel or control cabinet or placed directly into the control network. In addition, if an emergency occurs, the operator is notified in time, which allows the problem to be resolved. Diagnostics were carried out by the control system before the emergency occurred. This allows you to reduce the number of employees involved in its management and maintenance. To repair several compressor units, one repair team can be formed to serve several stations. For the compressor station to operate, it is necessary that at least one operator is constantly present at the station to control and maintain the operation of the KI. This approach allows one person to centrally receive and process all information about the operation of the station, which improves the quality of management decisions [10].

In the context of the rapid development of technology, the issue of compliance of the equipment introduced at the enterprise with productivity standards and equipment indicators is relevant. Therefore, it is necessary to accurately calculate the costs of purchasing and installing equipment offered on the market, which allows you to select it correctly [12].

In our case, 1 operator and 3 employees of the automatic control system service are released (automation of control and measuring equipment - 2; electronic workers - 1; adjusters - 1).

The average annual salary of an operator is 3924 thousand rubles. (3270 thousand soums *12). The average annual salary of KIP is 4,708 thousand soums. (3924 thousand sum *12) The average annual salary of an electronics engineer is 7326 thousand sum. (6105 thousand soums *12). The average annual salary of an adjuster is 3,139 thousand sum [11].

The wage savings released as a result of the implementation of automatic control system employees can be determined by the following formula:

$$Z_{osb} = k_1 k_2 k_3 Z_{sr.r} N_{osb.r} \quad (1)$$

where k_1 k_4 are workers and technical workers (MTH), respectively, bonus coefficients are equal to 1.4; k_2 – coefficient taking into account additional wages is 1.2; k_3 - social insurance contribution coefficient is 1.356; $Z_{avg.}$ - average annual wages of dismissed workers; $N_{osb.r}$ - number of dismissed workers,

$$Z_{osb.operator} = 1.4 \cdot 1.2 \cdot 1.365 \cdot 39240 \cdot 1 = 89985.168 \text{ thousand sum} \quad (2)$$

$$Z_{osb.kip.avt} = 1.4 \cdot 1.2 \cdot 1.365 \cdot 47088 \cdot 2 = 215964.4 \text{ thousand sum} \quad (3)$$

$$Z_{osb.elektrik} = 1.4 \cdot 1.2 \cdot 1.365 \cdot 73260 \cdot 2 = 335999.66 \text{ thousand sum} \quad (4)$$

$$Z_{osb.sozlovchi} = 1.4 \cdot 1.2 \cdot 1.365 \cdot 31392 \cdot 2 = 143976.27 \text{ thousand sum} \quad (5)$$

$$Z_{osb.umumiy} = 785925.5 \text{ thousand with mind} \quad (6)$$

Annual salary savings – 785925.5 thousand sum.

T_{prost} = 52 hours due to an emergency shutdown of the conventional ABT type. The developed system should be at least 60% less empty. and he has less than 21 hours of free time. In our calculations we use the average annual compressor performance. We get 31 hours of compressor overtime per year. This is due to the reliability of the advanced compressor control system. Therefore, knowing the cost of one ruble/m^3 of product KQ a ku is equal to 0.034 rub /m^3 and the average annual load factor (0.8) of the *Kz* station can be used to calculate the economic effect of increasing reliability. We calculate it using the following formula:

$$E_{p2} = V_{yil.p2} \cdot a_{ku} \cdot k_1 \quad (7)$$

where $V_{year.p2}$ – annual production of compressed air by the compressor station, taking into account the reduction of downtime:

$$V_{year.p2} = V_{kc} \cdot k \cdot t \cdot 3600 = 11 \cdot 0.8 \cdot (3840 + 21) \cdot 3600 = 122316480\ m^3 \quad (8)$$

$$a = \frac{C^{r}_{ATK}}{V_{year}} = \frac{4136688.6}{121651200} = 0.034 \quad (9)$$

$$V_{year} = V_{KC} \cdot k \cdot t \cdot 3600 = 11 \cdot 0.8 \cdot 3840 \cdot 3600 = 12165120 \quad (10)$$

where: V_{KS} is the work of the compressor station, m^3/s; k - unevenness coefficient; t – device operating time.

$$E_{p2} = 122316480 \cdot 0.034 \cdot 0.8 = 3327008 \quad \text{(eleven)}$$

Reducing maintenance complexity reduces scheduled maintenance time. KI annual maintenance takes 42 hours less time than a traditional control system. This is due to a decrease in the number of objects. Simplifies the request for service provision and its implementation, In addition, the system for preventing the breakdown of the spacecraft in an emergency condition will be prevented and the time for major repairs will be reduced. Annual savings due to a reduction in the volume of repair work can be considered as additional working time. By reducing the amount of renovation work, the annual savings can be considered as overtime. It is determined by the following formula:

$$E_{p2} = V_{yil.p1} \cdot a_{ku} \cdot k_1 \quad (12)$$

here $K\,z$ - average annual load factor KI 0.8, $V_{year,\ p\ 1}$ – annual production of compressed air by the compressor station, taking into account the reduction in maintenance time, ^{m3} .

$$V_{yillik.p1} = V_{kc} \cdot k \cdot t \cdot 3600 = 11 \cdot 0.8 \cdot (3840 + 42) \cdot 3600 = 122981760\ m^3 \quad (13)$$

$$E_{p1} = 122981760 \cdot 0.034 \cdot 0.8 = 3345103.9 \quad (14)$$

The service life of the CC is 3345103.9 thousand sum per year .

From this calculation and analysis of technical and economic indicators, we conclude that it is advisable to introduce an “automated compressor station control system.” As a result, the annual savings from system automation amount to 3,347,839.05 thousand sum. This is achieved by saving labor and increasing the duration of capital and repair work.

As a result of work on the project, the compressor device was analyzed as an automation object. The most suitable concept for the development of the management system was selected. A logical model has been implemented, and its performance tables confirm the correctness of the selected control algorithms. The order of the control system has been developed based on the structural information model of the object’s behavior. The hardware required to implement the system was selected, and the operating principle of the control environment was developed. An economic analysis of the effectiveness of creating and implementing the system was carried out, which showed that its implementation is profitable and expedient due to good returns and efficiency. Based on this, we can say that the introduction of a control system increases the efficiency of the hydraulic turbine complex due to the optimal operating mode of the compressor device.

In the production process, opportunities are created to reduce the influence of the human factor and at the same time improve the production culture, increase the efficiency of equipment and increase the efficiency of process control, reduce energy consumption, as well as reduce accidents and increase the service life of equipment.

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