The American Journal of Engineering and Technology
(ISSN – 2689-0984)
Published: February 20, 2021 | **Pages:** 42-46
Doi: https://doi.org/10.37547/tajet/Volume03Issue02-06

IMPACT FACTOR
2021: 5. 705
OCLC - 1121105677

Analysis Of The Results Of Natural Studies Of Hydraulic Turbines Of Hydroelectric Power Stations

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ABSTRACT

The paper deals with the issues of hydroabrasive wear of hydraulic turbines of hydroelectric power stations that arise in the river water of suspended and bottom sediments. Sediments, accumulating on water conduits and regulating tanks, significantly complicate and worsen the operation of hydroelectric power stations. The results of the impeller of hydroelectric power stations and measures to combat intensive wear of hydraulic turbines used under difficult operating conditions are presented.

KEYWORDS

Hydroelectric power stations, operation, efficiency, hydroabrasive wear, hydraulic turbine, equipment, sediment, impeller.

INTRODUCTION

Today in Uzbekistan and abroad, special attention is paid to ensuring the operational reliability of hydraulic turbines of hydroelectric power stations (HEPS). During the operation of HEPS, the stability of the main equipment and auxiliary structures, as well as working bodies, is disturbed. In the operation of HEPS, the most common is hydroabrasive wear in hydraulic turbines. Because this issue affects the operation of HEPS, some facilities are

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annually decommissioned and repaired at high cost under operating conditions. That is why it is required to develop optimal technical solutions to ensure the uninterrupted operation of HEPS [1,2].

Many HEPS in the republic are located on mountain rivers transporting large amounts of suspended and bottom sediments. Sediments, accumulating on water conduits and regulating tanks, significantly complicate and worsen the operation of HEPS. In addition, the turbines of such HEPS, to one degree or another, suffer from the abrasive effect of sediments, require significant expenditures of funds to combat the negative effects of sediments and to maintain the turbines in working order. When designing turbines for HEPS located on mountain rivers, it is necessary to assess the abrasive ability of sediments suspended in river water that will pass through HEPS, and to predict the degree of danger of these sediments for hydraulic turbines. With a sufficiently significant action of these sediments, the technical condition of the turbines is rapidly deteriorating, the efficiency of their efficiency decreases, and power losses at HEPS increase and, accordingly, the generation of electricity. Therefore, to ensure reliable and uninterrupted operation of HEPS on rivers with an increased content of abrasive sediments, there is a need for a theory of hydroabrasive wear, which makes it possible to realistically assess the abrasion capacity of river sediments and the degree of its hazard for hydraulic turbines.

RESEARCH METHODS

Hydroabrasive wear is usually understood as the destruction of parts of the flow path of hydraulic machines as a result of mechanical action of solid particles in water or other working fluid. In the process of destruction, the shape and linear dimensions of the parts change, and therefore, in relation to hydraulic machines, the total amount of destruction during abrasive wear is usually measured by a decrease in volume or weight. Sometimes wear of parts is characterized by the area and depth of damage to their surfaces. Destruction occurs due to continuous collisions, transported by the stream of solid particles with the surface of the part. At the moment of collision, the kinetic energy of the moving particle is converted into the work of deformation of the material of the streamlined part.

Abrasive wear of hydraulic turbines is quantitatively expressed usually in fractions or percent of the initial values of weight (volume) loss of parts of the flow path of a hydraulic turbine, which occur due to the abrasive effect of sediments suspended in water. The nature and intensity of such wear of a hydraulic turbine depends on many factors. Such as the flow rate, sediment concentration, the duration of the impact of a sediment-saturated flow on the turbine flow path, hardness, shape, roundness and sizes of sediment particles, geometry and wear resistance of materials of hydraulic turbine parts and others. [3-5].

RESEARCH RESULTS

As practice shows, when operating hydraulic turbines under conditions of hydroabrasive wear, the frontal parts of the impeller blades, the outer part of the guide vanes and the inner part of the housing are exposed to the most intense impact. Figure 1 shows the worn-

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out parts of the hydraulic units of the Cascade of Tashkent HEPS (Sheikhantakhur HEPS). Sheikhantakhur HEPS, which is a part of the Unitary Enterprise "Cascade of Tashkent HEPS ", is located within the fourth above-floodplain terrace of the Chirchik river on the Bozsu canal and is the second stage of the cascade of Tashkent HEPS. The nature of blade damage in these figures indicates fine-flaked wear with sparse, separately located, shallow flakes and a deep (deep) type of wear with long grooves. This indicates the presence of hydroabrasive wear of the parts of the hydraulic turbines of the Sheikhantakhur HEPS. Quantitatively and qualitatively, this waterjet wear can be attributed to low and medium activity. Despite the presence of the process of hydroabrasive wear, the main reason for the drop in energy efficiency should be considered the general physical wear associated with the long period of operation of the hydraulic units and their obsolescence (it was mentioned above about the outdated type of hydraulic turbines - rotary radial).

Let us consider the influence of these factors on the wear of the hydraulic turbine parts. The nature of the influence of some of these factors on them can be clarified on the basis of theoretical analysis. To assess the influence of other factors, empirical methods are used (using an experiment). The wear of turbine parts is influenced not only by the abrasive properties of the deposits, but also by the wear resistance of the materials from which these parts are made.

Figure: 1. The impeller of the hydroelectric power station

When identifying the main regularities of abrasive wear, we will proceed from the fact that abrasive wear manifests itself in the form of destruction of the material of the hydraulic turbine part, which consumes the kinetic energy of the sediment particles transported by the flow. The analysis makes the following assumptions:

1. The part subjected to hydroabrasive wear is a thin fixed plate and is flown around without separation of the boundary layer by a turbulent flow;
2. The flow moves in a steady state and is a uniform parallel-jet motion:
3. All sediment particles move in the flow in a suspended state and are evenly distributed over the entire section;
4. The nature and properties of the flow do not depend on the presence of sediments in them, since their relative content is small.

Under these conditions, the plate (part) will be subject to uniform wear over the entire area and the relative value of which will be mainly determined by the slurry regime (that is, it will not depend on the geometry - the length and width of the plate).

All the main and auxiliary equipment of HEPS is operating with a shortage of capacity, it is obsolete, physically worn out and must be replaced. All three turbines have reached their end of life, and maintaining them in working order requires significant funds. This is an outdated type used at the beginning of the last century, when, due to the lack of low-speed generators, to increase the speed without increasing the impeller diameters and energy parameters (pressure and flow rate), it was proposed to use a two-way water drainage from a pressure turbine conduit into symmetric impellers. It also causes difficulties when carrying out repair work, when restoring worn parts. Therefore, the modernization of equipment for HEPS is an urgent need at the moment.

The operational reliability is very low. The frequency of overhauls was on average 2 years, with a standard turnaround time for a hydraulic turbine of 5-7 years. Sheikhantakhur HEPS, as a result of physical and obsolescence of the equipment, produces capacity more than two times lower than the design.

CONCLUSION

Measures to combat intensive wear of hydraulic turbines used under difficult operating conditions at HEPS are quite diverse. The choice of a specific option is usually made on the basis of a technical and economic comparison of the options for these measures from the condition of the payback of additional capital investments for their construction. At the same time, for each of the compared options, one should take into account the values of one-time costs and annual operating costs, as well as the cost of electricity underdeveloped at HEPS per year due to turbine wear, water consumption for flushing a sump or sand trap, stoppages of hydraulic units for turbine repair, and the like. In accordance with this, for each option of measures it is necessary to determine the total amount of annual costs, and the option for which the total annual costs will be the smallest will be economically most profitable for practical implementation.

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