NEW DESIGNS IN RECONSTRUCTING THE MECHANICAL EQUIPMENT OF HYDROELECTRIC STATIONS

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The special planning, design, and technological office (SPDTO) "Lengidrostal" has been functioning for more than 60 years and is part of the joint-stock company AO "Trest Gidromontazh" (All-Russian Trust for Installation of Hydromechanical Equipment). During the period of activity of the SPDTO the mechanical equipment of the majority of hydroelectric stations located in various regions of the former USSR and many foreign countries was designed.

Mechanical equipment of hydraulic structures include:

- various types of gates with embedded parts;
- trash racks and devices for cleaning them;
- hoisting mechanisms, special cranes, hydraulic drives for operating the gates and racks.

In recent years problems of reconstructing mechanical equipment have become quite urgent, since the equipment at many hydrostations has been operating for more than 30-40 years and its reliability requires reconstruction works. Drawing up reconstruction plans, designers have to solve a number of problems caused by the fact that the structural part of the structure, as a rule, does not change and it is necessary to "blend" elements of the mechanical equipment into the existing structure. The trash racks are the most vulnerable. This type of equipment is constantly in the flow and experiences static and dynamic loads. At present a large number of breaks of racks have been recorded. An analysis of the causes of the breaks showed that breaking occurs as a consequence of the large difference of levels on the racks caused by their clogging by shuga, various kinds of trash, as well as during operation of the trash-cleaning devices, when they catch the trash stuck in the racks (submerged logs and other objects) and break off elements of the racks. Cases were noted where long logs stuck between the bars, being rocked by the stream of water, break off the bars.

Dynamic breaks have the character of fatigue damages and occur during the frequent change in the operating regimes of the units.

On-site and laboratory investigations of trash racks at the All-Russian Hydraulic Engineering Research Institute (VNIIG) and SPDTO "Mosgidrostal" made it possible to come up with certain recommendations on reconstructing the racks entirely and individual elements.

Two types of rack frames are used: a frame of solid elements having a streamlined form and an open frame of a three-dimensional form. Racks designed earlier had solid frames, and the horizontal beams were occasionally made in the form of rolled H-beams with a wood filling (Pavlovka hydrostation and others). There are also other designs. The conditions of incidence of the flow, extent of trashiness of the stream, character of the breaks that occurred, and other factors are studied during reconstruction.

The open-type horizontal beams surpass beams of sheet construction in many indices: hydraulic resistance, dynamic properties (the more yielding and less rigid structure promotes damping of possible vibrations). As for the bars of the racks (trash-retaining strips), the design of their fastening to the frame, together, and to the end support props is essential here.

With consideration of the aforesaid, during reconstruction, where this is possible, racks with open-type frames and fastening of bars providing the maximum static and dynamic strength are planned.

At certain hydrostations of the Karelia power system (Karelenergo) and Kola power system (Kolenergo) trash racks with electric heating were designed. The induction method was used mainly. However, difficulties in acquiring a large quantity of cable and installing it under conditions of the hydrostations led to induction heating failing and being ineffective.
The design of a rack with an open-type frame and busbar heating of the strips of the upper section was developed for the newly installed trash rack of the additional fifth unit of the Niva-2 hydropower station (Fig. 1).

Effective operation of the cleaning devices is essential for normal operation of the hydropower station units under conditions of trashy streams. As was provided for earlier, clamshell grabs and "Polyp"-type grabs were used. These designs are constantly being modernized and their operating quality improved.

In individual cases, for example, on the Lower Tuloma hydropower station, where a vertical trash rack was installed instead of an inclined rack during reconstruction, it was necessary to clean it by means of a clamshell grab, grooves for guiding the movement of which are absent in the structure. This problem was solved by creating a design of a grab whose guides are located on the rack (Fig. 2). This design solution is protected by inventor's certificate No. 174957; the inventors are V. A. Voznesenskii, L. V. Nekipelova, and T. T. Akkuratina. The applicant is SPDTO "Lengidrostal'."

Reconstruction of slide and fixed-axle gates at hydropower stations is accomplished in connection with changing the design of individual elements — movable parts, seals, etc.

At present new antifriction materials have appeared, for example, ASMK-112, which is supplied according to specifications GM-015-84 and withstands a linear load of 3000 kg/cm with a coefficient of static friction of 0.13 and coefficient of kinetic friction of 0.09. This material can be used in the slides of slide gates instead of DSP-Bgt (lignofoil). During reconstruction it is necessary to make new slides which are installed on the existing steel members; the mounting dimensions of the support slide are unified with the dimensions of the support slide with a bushing of DSP-Bgt. A schematic diagram of the slide is shown in Fig. 3. The material ASMK-112 is supplied by the AO "Trest Gidromontazh."

In recent years the operating personnel of hydropower stations have had problems in acquiring rubber seals of various types, since the Ekaterinburg mechanical rubber goods plant has stopped their production. The AO "Trest Gidromontazh" restored the press molds and sent them to the plant. Now seals can be ordered through AO "Trest Gidromontazh."

Technical progress did not pass over fixed-axle gates. Such gates on balance carriages have been installed on many dams (Volga-Lenin hydropower station and others). To reduce the specific load on the sliding-contact bearings, it is suggested to reconstruct the balance carriages with the placement of two bushings instead of one central bushing. This considerably increases the life of the bushings and facilitates servicing the carriages. The bushing can be made of the aforementioned material ASMK-112 (Fig. 4).