BRIEF DESCRIPTION OF THE COMPUTER PROGRAM FOR THE OPTIMIZATION OF INTERNAL REGIMES OF HYDRO POWER PLANTS

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Brief description of the computer program for the Optimization of Internal Regimes of Hydro Power Plants has been given. The program is based on dynamic programming method. Therewith it includes a set of sub-programs that is oriented on analytic solution of simplified variants of regime problems, which gives possibility to control the correctness of solutions with numerical methods.

The computer program created by us is based on the algorithm, which is mainly processes by using the method of dynamical programming and consists of two parts: the first part - creating power characteristics of hydro power plants and the second one - creating the management plan of HPP structures and regimes for the whole period of considering limitations Below is given a description of the program structure based on the mentioned algorithms.

Generally, hydro power plant characteristics can have any form, falling at certain zones and shelves. Such characteristic features are non-differentiated, they do not increase monotonously, which complicates their use, but such circumstances for the dynamic programming methods are not obstacle.

Drawing of the HPP energetic characteristics includes analysis of the conditions of HPP structures and the internal regime optimization task and the methods of solving this task influence general type and regulation of these features.

Generally we can determine HPP structures and their capacity for any interval of the period of optimization on the basis of energy features created by using dynamical programming method.

Characteristic features of the first step of optimization are given as a feature of one of the aggregates, for example i=1. Then it shall be corrected by the optimal one. On the second stage it is necessary to create equivalent features of aggregates operating simultaneously. In the case correlation of the first step feature and the feature of the next aggregate, or i=2 shall be considered.

Optimization equation provides equivalent discharge and equivalent capacity for these tw aggregates, or

$$Q^{e}_{i=1.2}\left(N^{e}_{i}\right)=\min\left[Q_{2}\left(N_{2}\right)+Q_{1}\left(N_{i}-N_{2}\right)\right], \qquad (1)$$

Where the first member in the brackets is - i=2 - or the aggregate feature and the scond member represents the feature of the first step.

By varing N_2 capacity under the conditions of $N_j = \mathrm{const}$ we could have such a distribution, for which the function of the aim shall have its minimum. If we perform such calculation for different N_j- withn the capacity range of two aggregates, we could receive the second step feature of the optiization $Q^{e}_{i=1.2}\left(N^{e}_{i}\right)$, which shall be the value of $i = 1,2$ aggregates. The values will have the points, in which one of the aggregates function and the

points where the aggregates functions simultaneousely. Everything is determined by water discharge minimum. After this an equivalent value shall be created for three i=1,2,3 aggregates by usung the following equiation:.

$$Q^{e}_{i=1.2.3}\left(N^{e}_{i}\right)=\min\left[Q_{3}\left(N_{3}\right)+Q_{i=1,2}\left(N_{i}-N_{3}\right)\right]. \quad (2)$$

Here the third aggregate i=3 will be included and its usage with hypothesis aggregate will be considered, having $Q^{e}_{i=1.2}\left(N^{e}_{i}\right)$ value. By N_3 capacity variation we could find an optimal solution for each N_j in the functioning range of all three aggregates and it is possible to create the value equivalent to $Q^{e}_{i=1.2.3}\left(N^{e}_{i}\right)$. As a result of calculations we could receive the functioning regimes for one of the aggregates, or for the cobinatiion of two aggregates or for the functioning of all three aggregates. Then the calculations are repeated after every step by increasing the number of aggregates by one. It is clear, that for creating equivalent values it is necessary to carry out a wide range of calculations. But generally the calculation value will be:

$$m=\sum_{i}(ki+1)ki,$$

where $k-\Delta N$ is a number of capacity increment steps, based on which the calculations are actually carried out; i - number of step.

These caculations are simple arithmetical operations, though multiple, which is not difficut for the computer processo at all.

During the optimization of the intrnal plant structures, special aggregate structures are selected, which can generally operate in the generator and synchronical compensator regime under the condition of economical and feasible usage of the enrgy resources of the active and reactive capacity stations.

Task solutions can be determined in the plan of usaing aggregates and their active capacitities, for eac interval of the plaaning period.

The regime optimization algorithm can be generaly divided into three parts. In the first part calculations are made, which are related to the preparation of the initial information, for example, calculations of aggregate values, as the values are changed due to wearing and differences in the aggregate and station regimes. In the second part optimization of aggregate structures and regimes is carried out bby using any of the mathematical models, but during the optimization only preliminary programs are being created. In the third part the preliminary program is corrected, the corrections are related to the limitations, which will be considered during the program preparation.

On the basis of the HPP energy values created by using dynamical programming method, we could generally determine aggregate structures and capacity for the each time interval of the optimization period. Whole complex of limitations could not be considered, due to which the first part result should be corrected in the second part result. Correction is usually achieved by means of compromising. For example, if the number of functionig aggregates is less than the given number, the number of preliminary plan aggregates is increased. If the requirements towards the capcity reserve are not met, additional aggregates will be included. For minimizing the inclusion and exclusion operations, some of the aggregates remain in the function process, or are excluded earlier than it is required by the first part plan, meanwhile the discharge it also to be considered. In such case, the aggregate structures which are functioning, cannot be favorable, but in those cases, when

we have no limitations or when they cannot possibly infuence the feasibility of the decision, the algorithm in this case can be successfully used.

In the first block admissible regime area of the HPP is determined, including the station value parameter or pressures.

In the second block the first part of the task is being resolved, or optimal values are created by using dynamical programming method. In the third block compliance of the given pressures H_{giv} with calculation values is H_{cal} determined. If such compliance does not exist (the fourth block), then aggregate structures and regime for H_{giv} shall be equal to one of the calculation solutions in the pressure calculations. Interpolation according to the pressures are carried out based on the minimum of discharge losses.

Interpolation according to the capacities are carried out the sme way (the fifth and the sixth blocks), if N_{cal} calculation values do not comply with N_{giv} station capacities according to the schedule of their function.

In the seventh block aggregate structures and capacities are determined for theregular loading schedule. This program is preliminary because all kinds of limitations are included in it. The preliminary program is corrected in the eighth block and in the ninth block final results are received.

Apart from the solutions of the difficult task of regime optimization, it is recommended to have analytical solutions of the simplifie dvariants of the tasks, which could give us a possibility to find main regulations of the optimal management of HPP regimes, which in itself ensures the means of controlling tas solution corrections. In the simple case, namely, if we give the limiation in the form of an equation, the process of finding ooptimal solutions is much more simplified, in which case variation estimation methods could be used - first of all the method of Lagranzhe, which gives a posibility to find continuous functioning extremum in the form of equations (equation of relation) during completion of maximum and minimum additional conditions. The mentioned condition is olso considered in our program.

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