OPERATION OF HYDROPOWER PLANTS IN SLOVAKIA

Ján Zbojovský, Pavol Hocko, Marek Pavlík, Jozef Király

ABSTRACT

This paper deals about hydropower plants in Slovakia. Hydropower is the most used renewable energy source for electricity in the Slovak Republic. Hydro potential of rivers is used to generate electrical energy, which is permanently renewing and inexhaustible primary energy source.

1. INTRODUCTION

Utilisation of hydro energy potentials is the main concern of hydro power plants, which belong to Slovenské elektrárne. Hydro power plants with its operational flexibility and the possibility of rapid changes of powers are able to cover the rapidly changing requirements of power in daily load and thus are suitable to cover emergency situations in the power system. Hydro power plants with large storage tank (e.g. Orava, Liptovská Mara, Nosice, Kráľová, Gabčíkovo) and pumped storage hydro power (e.g. Čierny Váh Liptovská Mara, Ružín, Dobšiná) are creating supplies of water to solve unsteadiness consumption of electric energy during a day.

Hydro power plants are useful as regulators or power supplies in the power system and are suitable in terms of utilization of primary energy sources which are on our territory. Hydro power plant is usually built as hydro energetic project, that fulfills certain criteria, and energetic signification may not be a priority.

Summary installed capacity of hydropower plants in the portfolio of Slovenské elektrárne, is 1652, 7 MW, which is approximately 30% of the total installed capacity of Slovak power plants. Installed power in "flow" hydropower is 736, 6 MW, and in pumped storage power plants 916, 4 MW. (Čierny Váh 734, 4 MW, 98 MW Liptovská Mara, Dobšiná 24 MW and 60 MW Ružín).

2. SCHEDULING OF THE OPERATION HYDRO POWER PLANTS

In the process of planning the operation, there is a distinction between two time levels: long-term planning (annual, quarterly, monthly), which are intended to secure the volume of electricity production, and a short-term planning (weekly, daily), in which the process of scheduling is extended time dimension, e. i. time of the production. Quality of planning service of water plants has a significant impact on the stability and security of the entire power system. Model for the preparation of operation and the management of hydro power (PPVE) is used.

2.1. Basic functions of the model PPVE

Model PPVE is internally divided into an optimizing and simulation model. The optimizing model is mainly used in the process of preparing operation, to create plans of operations in required time resolutions. (day, month, year). Its main function is processing of hydrological inputs and modeling of hydraulic conditions and hydraulic linkages hydropower plants on the rivers Váh and Orava (Váh cascade), Danube (Gabčíkovo), Hnilec (HPP Dobšiná) and Hornád (HPP Ružín).

The output of the optimizing model is a plan of production hydropower plants with severance of power reserve to ensure support services within a defined time grid, designed based on the criteria of the planning.

The simulation model is mainly applied in the process for controlling operation of HPP, where ensure the solution of immediate operating conditions in whole electricity supply system and its parts. The objective is to realize purposes determines preparing of operation during a solution of actual influence of unexpected events (change in hydrological conditions, changing electricity supply system requirements). The output of the simulation model are the values of flow balance during individual HPP and level schedule tanks (or refrain) and the channels of HPP corresponding in fixed set point required (base) powers and required levels of support services.

2.2. The division of model PPVE to the basic scheme object

Hydropower plants can be divided according to three schemes: dam, channel and accumulate.

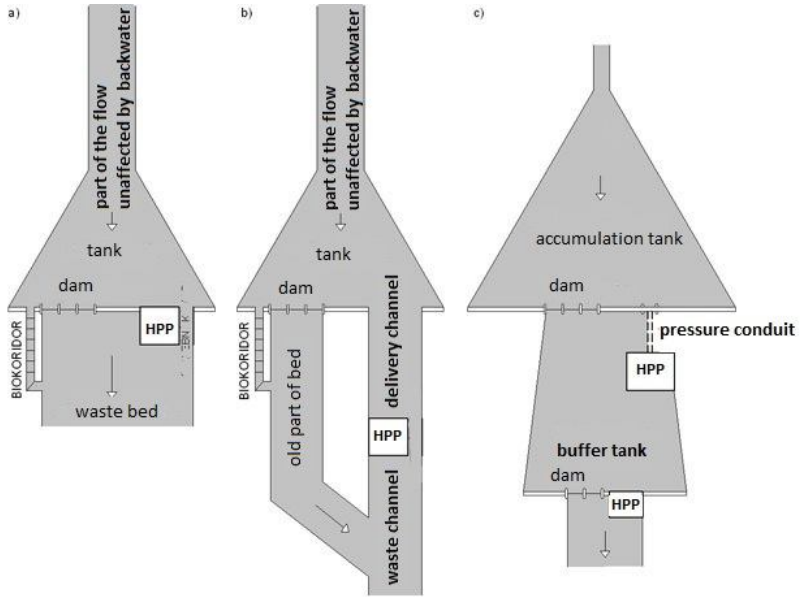

Figure 1 – Object scheme, a) dam, b) channel, c) accumulate

In case of dam scheme we say about the hydropower plants which are built near the impound. In case of channel scheme we consider about the hydropower plants which are built on a derivation channel led by impound with daily regulations of flows. We can attach HPP to an accumulation scheme, which are built near the large accumulation tank with long-time regulations of flows (year or multiyear). Accumulation tank are connected with buffer tank, near those are also built HPP but with small power. Control plant is those, which is built on direct hydraulic coupling on an accumulation tank.

2.3. Basic functions of the model PPVE

The basic computational scheme of model PPVE scheme is shown in Fig. 2.

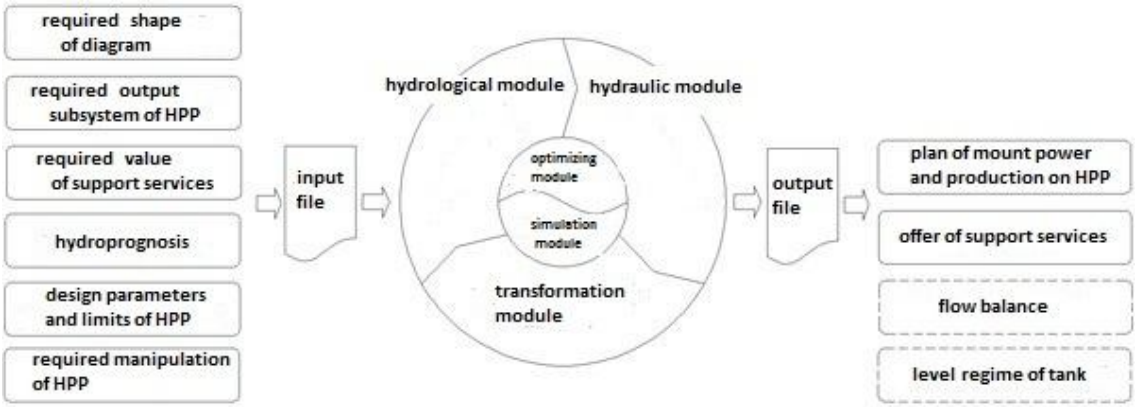

Figure 2 – Basic computational scheme

The role of the transformation module is following on the results of the hydrological and hydraulic module to convert the transformation of flows (hydrological module) and gradient (hydraulic module) to electric power. Another task of the transformation module is to determine the impact of the provision of support services for the balance of storage capacity of tanks (i.e. the calculation of flow and volume equivalent to the required levels of support services). An important factor by assessing the quality of planning service HPP is due to the random nature of the activation of support services the most accurate calculation of the amounts required to provide support services. The task of optimization and simulation module is itself a solution of objective function using a modified simplex method for solving nonlinear optimization problems by a correction algorithm that gives a quick convergence to the optimal solution. The decisive criterion for selection of this method was the requirement for the shortest time of computing.

3. SMALL AND LARGE HYDROPOWER PLANTS IN SLOVAKIA

Large hydropower plants (HPP)

Slovakia built 25 large hydropower stations whose installed capacity is 2446 MW. The largest hydroelectric power plant is Gabčíkovo with installed capacity of 720 MW, which produces half the electricity produced by hydro power plants in Slovakia. Then there are four water pumping stations with total installed capacity of 917 MW, in addition to covering of peak load, they perform the function of regulatory source and emergency reserves.

The technical potential of hydropower is possible in large hydro power plants use 5,600 GWh, which at present is the potential use of 75%.

Small hydropower plants (HPP)

From the total technical potential of hydro energy 7,600 GWh is possible in small hydro power plants use about 2,000 GWh /year, representing 15% of exploitable hydropower potential. The remaining technical potential is 1,750 GWh. For this potential, especially after taking into account environmental considerations can still be used from 1200 to 1350 GWh per year, equivalent installed capacity at 300 MW.

4. CONCLUSIONS

Slovak Republic is the country that is rich in rivers. Currently, the renewable sources are on the rise and ambitious of the EU is that 20% of energy comes from renewable sources in 2020. Building of new HPP in Slovakia is one of ways how to get this goal.

The model mentioned in my paper is applied in practice nowadays. It offers many new functions mainly on the field of planning and it also provides supporting services.

REFERENCES

[1] *Kolcun, M.; Mešter, M.; Chladný, V.; Cimbala, R.; Rusnák, J.; Tkáč, J.; Hvizdoš, M.:.Elektrárne, TUKE 2006, ISBN 80-8073-704-5*

[2] SE a.s.*:* Vodné elektrárne Trenčín.Trenčín 2003

[3] *Avalaible on the internet: http://www.asb.sk/inzinierske-stavby/vodohospodarske-stavby/ako-sa-planuje-prevadzka-vodnych-elektrarni-na-slovensku-5824.html*

[4] *Avalaible on the internet: http://www.seas.sk/sk/elektrarne/typy-elektrarni/vodne*

[5] *Avalaible on the internet: http://www.platforma.ekofond.sk/moderne-vyucovanie/teoria/55-vodna-energia*

ACKNOWLEDGEMENT

This publication is the result of the Project implementation: Protection of the population of the Slovak Republic from the effects of electromagnetic fields, ITMS: 26220220145, Activity 2.1 supported by the Research & Development Operational Programme funded by the ERDF.

Authors:

Ing. Ján Zbojovský
Technical University in Košice
Department of Electric Power Engineering
Mäsiarska 74, 041 20 Košice, Slovak Republic
E-mail: jan.zbojovsky@tuke.sk
Tel: + 421 55 602 3562

Ing. Pavol Hocko
Technical University in Košice
Department of Electric Power Engineering
Mäsiarska 74, 041 20 Košice, Slovak Republic
E-mail: pavol.hocko@tuke.sk
Tel: + 421 55 602 3560

Ing. Marek Pavlík
Technical University in Košice
Department of Electric Power Engineering
Mäsiarska 74, 041 20 Košice, Slovak Republic
E-mail: marek.pavlik@tuke.sk
Tel: + 421 55 602 3562

Ing. Jozef Király
Technical University in Košice
Department of Electric Power Engineering
Mäsiarska 74, 041 20 Košice, Slovak Republic
E-mail: jozef.kiraly@tuke.sk
Tel: + 421 55 602 3560