

WATER POWER PLANTS IN SLOVAKIA

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ABSTRACT

This paper deals about hydro power plants in Slovak Republic. Hydro power plants are significant part of Slovakian power system. They are used to generation peak load, frequency regulation etc. Hydropotential in Slovakia is used at 51%. Hydro power plants produce 21% of electricity every year.

1. INTRODUCTION

It has always been strong man's desire to “chain” water energy from rivers and change it into mechanical energy either in mills or later by using turbines and aggregates to produce electricity. Utilisation of hydro energy potentials is the main concern of Hydro Power Plants, which belong to Slovenské elektrárne. The history of hydro power plants dates into 1912 when small HPP Rakovec on the river Hnilec was commissioned, later in 1931 another SHPP Krompachy on the river Hornád followed. We use both small as well as big rivers, from the east to the west of Slovakia: Hornád, Hnilec, Orava, Hron, Váh and Danube.

The Váh river is after Danube the second largest river in Slovakia and is the most important one from point of view of hydro energy potential. Its length is over 375 km and difference in altitudes more than 900m.

Big reservoirs on the upper flow of the river play an important role in floods prevention and discharge regulation.

Close to these reservoir there are peak hydro power plants providing electricity, preventing from floods and releasing water for downstream hydro power plants as well as providing water for industry and irrigation.

2. TYPES OF HYDRO POWER PLANTS

Hydro power plants are divided from the following points of view:

- 1) the idea of the project energy use of the watercourse:
 - river
 - derivation
- 2) depending on the size fall:
 - low pressure power plants
 - middle pressure power plants
 - high pressure power plants
- 3) according to the operation and type of energy accumulation:
 - repumping power plants
 - accumulation power plants
 - flow hydro power plants

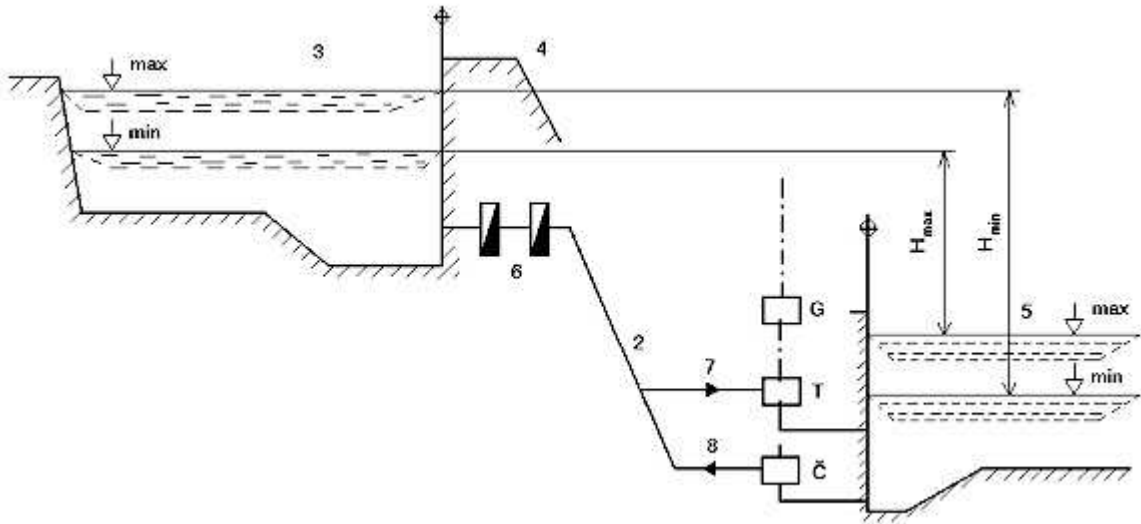


Figure 1 – Principle scheme of pumped storage water powerplant: G – Generator, T – Turbine, Č – pump, 1 – powerplant, 2 – pressure pipe, 3 – upper reservoir, 4 – emergency dike, 6 – cap of pressure pipe, 7 – cap of turbine, 8 – cap of pump

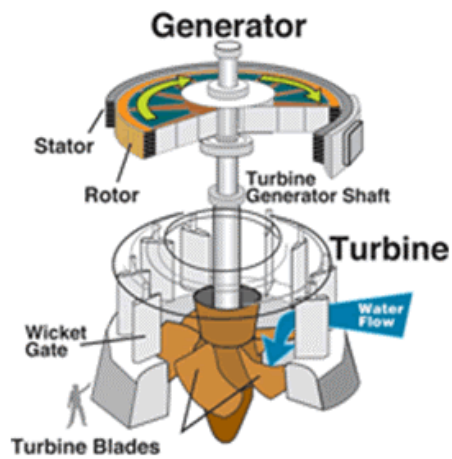


Figure 2 – Principle scheme of hydrogenerator

3. INSTALLED CAPACITY

Table 1 – Installed capacity of hydro power plants in Slovak republic

Hydro power plant	Installed capacity (MW)
Gabčíkovo	720
Čunovo	24,28
Kráľová	44,8
Madunice	43,2
Horná Streda	25,5
Nové Mesto	25,5
Kostolná	25,5
Trenčín	16,1
Dubnica	16,5
Ilava	15
Ladce	13,6
Nosice	67,5
Pov. Bystrica	58,2
Mikšová	93,6
Hričov	31,5
Žilina	85
Lipovec	38,4
Sučany	38,4
Krpeľany	24,75
Bešeňová	4,8
Liptovská Mara	198
Čierny Váh	735,2
Orava	21,75
Tvrdošín	6,2
Dobšiná	24
MVE Rakovec	0,5
MVE Krompachy	0,33
PVE Ružín	60
Ružín II.	1,8
Ondava, Domaša	12,4

4. MOST IMPORTANT HYDRO POWER PLANTS

The two most important hydro power plants which are in slovakian power system are Gabčíkovo HPP and Čierny Váh HPP.

Pumped storage hydro power plant Čierny Váh is situated in the wally of the river Čierny Váh. It was built in years 1976 – 1983. Aggregate TG6 was put into trial operation as the first one in March 1981, last one was aggregate TG7 in October 1982. In the time of construction the main purposes of the PSHPP Čierny Váh were peak operation with daily water accumulation, participation in frequency regulation and transmission of power to the grid.

This HPP consists of four parts: upper and lower reservoirs, penstocks, power station.

The lower reservoir was established by blocking of the Čierny Váh river valley by 375 m long dam. Its capacity is 5,1 mil. m³. and the available capacity for pumping operation is 3,7 mil. m³. The level fluctuates by 7,45 m between elevations 726,00m – 737,45 m.

The upper reservoir of irregular shape is situated between Biely and ČiernyVáh valleys. Available capacity of the reservoir is 3,7 mil. m³ of water. The level fluctuates by 25m between elevation points.

The lower reservoir dam comprises also the power station including the control room. There are installed 6 pumping turbo aggregates comprising – motor generator, Francis turbine, accumulation pump. The accumulation pump and the turbine are connected via a gear clutch. The turbo aggregates are arranged in three double units. Total installed capacity of pumping turbo aggregates is 734,6 MW. The third double unit is connected to a machinery set consisting of run-of-river Kaplan turbine and generator with capacity 0,8 MW. The turbine uses head range between 12-21 m and maximum discharge is 8 m³.s⁻¹. Output of the power plant is taken out to one-phase block transformers 15,75/420 kV and to 400 kV substation Liptovská Mara. Units can operate in following modes: turbine, pumping and compensating operation. All units are automatically controlled. Reaction time is of units: 70 s for full power in turbine operation, 120 s for pumping operation.



Figure 3 – HPP Čierny Váh

In line with the original project prepared in cooperation with the Hungarian Republic the purpose of the waterworks Gabčíkovo – Nagymaros was complex multipurpose solution of water management situation in economies of former Slovakia and Hungary. The Hungarian Republic stopped works in Nagymaros locality, which was unilateral decision of the country and in contradiction to intergovernmental agreement from 1977.

The HPP Gabčíkovo comprises two main constructions: a flood gate and a power plant.

The aim of the project is to enable shipping through two lock chambers using the difference in elevation points of 23,6 m, electricity generation and partial flood prevention.

The waterworks was successfully put into operation and since October 1992 it has been fulfilling its functions. Since the Danube river blocking on October 1992 individual turbo aggregates were put into operation.

TG 1-8 at the HPP Gabčíkovo were designed in order to fulfill water transport requirements as well as those of power engineering. Parameters of turbo aggregates enable quick start of TG, full power is available within 20 s.

Each Kaplan turbine with four runners blades has weight 1 225 t. There are 8 TGs in the power plant. Turbine absorption capacity ranges from 413 to 636 m³.s⁻¹.

Generation and power regulation is controlled by the Hydro Dispatching Centre. Automated system of dispatcher control was created for operative HPP control and optimal hydro potential utilisation with respect to Temporary Manipulation Order of HPP Gabčíkovo.

During HPP operation there were two emergency situations:

- failure of TG6 guide bearing – when main and exciting generator get into contact. The failure on guide bearing was classified as construction type
- second emergency situation was in 400 kV substation.



Figure 4 – HPP Gabčíkovo

Table 2 – Technical data of HPP Čierny Váh and HPP Gabčíkovo

Plant title	Čierny Váh	Gabčíkovo
Output	735,2 MW	720 MW
Designed annual production for middle year	1 285 000 MWh	2 980 000 MWh
Head	428-391 m	16-24 m
Discharge	turbine 30m, pumping turbine 20-22 m	8x413-636 m ³ s ⁻¹
Type of turbine	Francis	Kaplan
Generator - output - voltage	124 MW - 15,75 MW	100 MVA - 15,75 kV
Transformer - output voltage	250MVA - 15,75/420 kV	T1,T2: 100 MVA - 15,75/121 kV, T3-T8: 2x100 MVA - 15,75/400 kV
Substations	6 - 22 - 400 kV	15,75 - 22 - 110 - 400 kV
Operation regimes	aut. turbine, pumping turbine, compensation	turbine
Year of operation starting	1982	1992 - 1995

5. CONCLUSIONS

Hydro power plants have rich history in Slovak republic. They have important role in power system from point of view peak load, frequency regulation and reliable supply electricity to consumers.

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