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THE CONCEPT OF HYDROACCUMULATIVE POWER PLANTS

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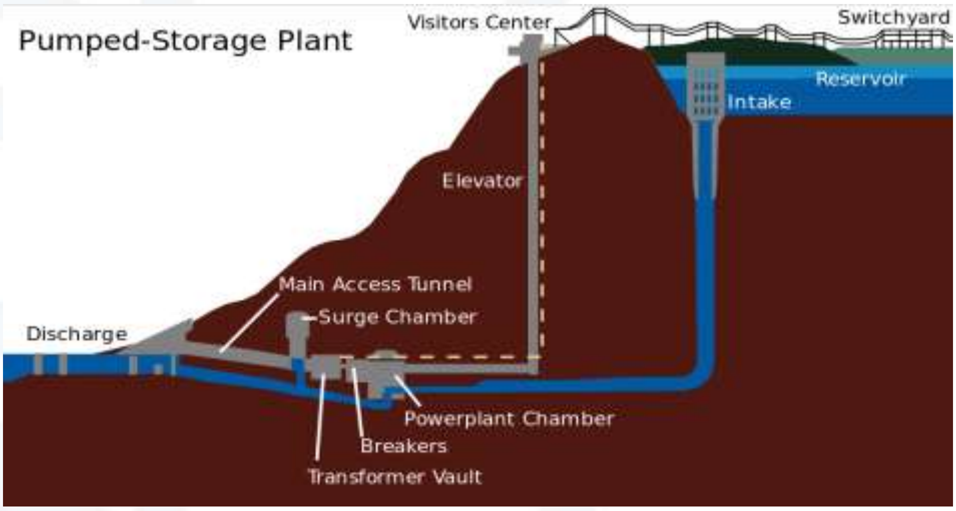
Annotation
This article discusses the principle of operation and convenience of a Pumped storage power plant (HPP), as well as its technical design.

Keywords: PSPP, pump, pump-turbines, generator mode, thermal power plants and nuclear power plants, transformer booth, water intake, swimming pool.

Introduction

The PSPP uses either a complex of generators and pumps, or reversible hydroelectric units that are capable of operating both in the generator and pump mode.
During the nighttime power failure, the PSPP receives cheap electricity from the grid and spends it on pumping water to the upstream (pumping mode).
During the morning and evening peaks of energy consumption, the PSPP discharges water from the upstream to the lower one, while generating expensive peak electricity, which it gives to the power grid (generator mode).
In large power systems, a large share can be made up of thermal and nuclear power plants, which can not quickly reduce electricity generation with a night-time reduction in energy consumption or do so with large losses.
This fact leads to the establishment of a significantly higher commercial cost of peak electricity in the power system, compared to the cost of electricity generated during the night period.



Under such conditions, the use of PSPPs is cost-effective and increases both the efficiency of using other capacities (including transport ones) and the reliability of power supply.

The first PSPPs in the early 20th century. they had an efficiency of no more than 40%, the efficiency of modern PSPPs is 70-75%.

The efficiency of a PSPP depends on a set of main factors, including natural conditions (primarily topogeological conditions of the site that determine the head, capacity, length of water pipes, seismicity, etc.); the possibility of using existing reservoirs; placement of loads in the center of the power system; types and parameters of power plants in the power system; availability of power lines for power delivery; equipment parameters; CP.D. the accumulation cycle. The increase in pressure is generally a positive factor, allowing you to reduce the volume of reservoirs, the dimensions of the PSPP building, but it can lead to lengthening of water pipelines. PSPPs are built at both high and medium pressures. For example, the Grand Maison PSPP (France) with a capacity of 1.8 million kW has a head of 905 m, and the PSPP Ludington (USA) with a capacity of 2.06 million kW – 107.7 m (Figure 4.53).

As a rule, modern PSPPs tend to be placed closer to the load center of the power system, in many cases next to powerful thermal power plants and nuclear power plants, so that PSPPs become their satellites. For example, Tashlyk PSPP is located next to the South Ukrainian NPP.

At PSPP, the upper and lower reservoirs are designed to accommodate a pumped storage tank. In addition, in one of the reservoirs (usually located on a river), a tank is provided to compensate for water losses due to evaporation and filtration from reservoirs.

In the PSPP building, with the help of hydraulic power, electrical, mechanical and auxiliary equipment, control systems, the electric energy taken from the grid is converted into mechanical water energy accumulated in the upper reservoir, and then the mechanical water energy is converted back into electrical energy supplied to the power system to consumers.

PSPP buildings are constructed in the same way as hydroelectric power stations in the riverbed, near-dam, onshore, open, underground and semi-underground, but they have distinctive features related to the composition and type of the main hydraulic power equipment, which can be performed according to two-car, three-car and four-car schemes.

PSPP buildings with reversible hydraulic units consisting of a pump-turbine and a motor-generator (two-machine scheme) are most widely used. In such buildings, to ensure operation in pumping mode, an increase in the negative suction height H S of the pump turbine is required, i.e. a greater depth of the impeller under the level of the lower stream, which, when the building is open, leads to the need for its additional deepening into the base and an increase in height, but practically does not affect the design of the underground building.

Operation of PSPPs in power systems. The commissioning of powerful thermal power plants and nuclear power plants to cover the basic part of the load schedule of power systems, the tendency to decompression of load schedules and the growth of the peak part led to the widespread construction of PSPPs in the second half of the twentieth century. Only PSPPs, due to their inherent versatility, participating in capacity regulation, are able to increase the loads of thermal power plants and nuclear power plants in the failed part of the daily load schedule, i.e. artificially increase the basic part of the load schedule and reduce its unevenness, performing the function of a consumer-regulator; cover the peak or half-peak part of the load schedule, serve as a high-speed emergency and load reserve of the system. The phenomenon of a PSPP is that its regulating capacity in the power system corresponds to the sum of installed capacities in the turbine and pump modes, which makes up the power range of the station, i.e. the PSPP can carry out double regulation.

The PSPP operation mode in the presence of a closed water circulation system between the upper and lower reservoirs practically does not depend on the river flow. PSPs perform regulatory functions in the power system in the broadest sense, with maximum use of their advantages of speed and high readiness for start-up. Therefore, they are operated in various modes with multiple starts and stops during the day, performing the role of maneuvering power at the entrance and exit of peaks, reactive power compensator, means of filling night dips, emergency and frequency reserve. So, taking into account modern requirements to ensure stable operation of the power system, the estimated number of starts at the Blenheim Cilboa PSPP with a capacity of 1.04 million kW (USA) is 6000 per year. In real-world operating conditions during the most stressful periods, for example, at the Zagorskaya PSPP (Russia) with a capacity of 1.2 million kW, the number of starts per day reached 30 without taking into account starts in the synchronous compensator mode.

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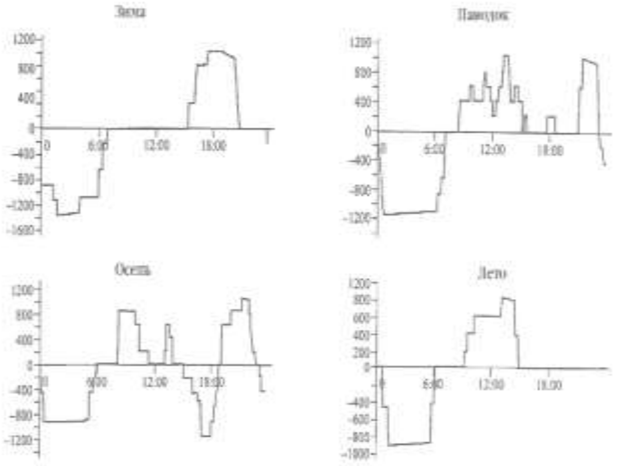

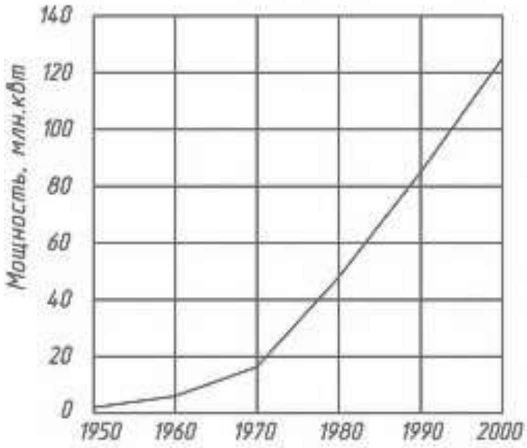

The use of the PSPP as an emergency and frequency reserve of the power system is becoming one of its most important functions. In the event of an accident in a power system with large generating sources or power lines, fast switching of the PSPP to turbine mode or switching of the PSPP from pump mode to turbine mode will compensate for the power lost by the power system and allow to exclude an emergency shutdown of consumers. It is the PSPP, together with the HPP, that largely prevents the "collapse" of the power system in severe emergency situations.

At a number of PSPPs in the upper reservoirs, an emergency water supply is additionally reserved, designed to operate for 1.5–3 hours.

When the PSPP operates in the weekly regulation mode on weekends, when the load decreases, and the TPP and NPP are forced to reduce capacity, due to the PSPP operation in the pump mode, the unloading of the TPP and NPP can be reduced. The additional volume of water pumped by the PSPP into the upper reservoir on weekends is used on working days to cover the peak part of the load schedule.

The use of Zagorsk PSPP on weekends allows to increase the level of weekly regulation at the HPP Volzhskokamsky cascade, providing an increase in their output on working days.

The nature of PSPP operation modes changes throughout the year, based on changes in the daily load schedules of the power system in different seasons of the year. As an example, Figure 2.15 shows the operating schedules of the Zagorsk PSPP.

High economic efficiency, increased reliability of power systems when using PSPPs, including ensuring regulatory requirements for the quality of electricity (frequency, voltage), and preventing emergency disconnection of consumers, served as the basis for their widespread construction.

In the last decade, many countries (USA, Canada, Western Europe, etc.) have liberalized the electricity market. At the same time, the role of PSPPs in ensuring the stability of power systems is increasing due to power redundancy, frequency and voltage regulation.

Long-term operation of PSPPs has shown their high reliability and efficiency in combined power systems, which are based on the basic capacity of large thermal power plants and NPPs. PSPPs become constant satellites of such power plants, and when placed in close proximity, they increase the reliability and efficiency of NPP and TPP operations, as well as reduce power transmission line costs and electricity losses. Placing the PSPP near the NPP allows it to be used as an additional reserve of power supply for the NPP's own needs in emergency situations to improve the safety of the NPP.

In a number of countries (Japan, Italy), the capacity of PSPPs in the power systems is more than 10% of the installed capacity of all power plants.

References

1. Suyarov A. Power Loss Minimization in Distribution System with Integrating Renewable Energy Resources //International Journal of Engineering and Information Systems (IJEAIS). – 2021. – Т. 5. – №. 2. – С. 37-40.
2. Hasanov M. et al. Optimal Integration of Photovoltaic Based DG Units in Distribution Network Considering Uncertainties //International Journal of Academic and Applied Research (IJAAR), ISSN. – 2021. – С. 2643-9603.
3. Suyarov A. O. et al. USE OF SOLAR AND WIND ENERGY SOURCES IN AUTONOMOUS NETWORKS //Web of Scientist: International Scientific Research Journal. – 2022. – Т. 3. – №. 5. – С. 219-225.
4. Sorimsokov U. S. et al. THE SCIENTIFIC BASIS OF ENERGY CONSERVATION USING THE CARNOT CYCLE //Web of Scientist: International Scientific Research Journal. – 2022. – Т. 3. – №. 5. – С. 209-214.
5. Sorimsokov U. USE OF ALTERNATIVE ENERGY TO REDUCE POWER LOSSES AND IMPROVE VOLTAGE //Gospodarka i Innowacje. – 2022. – Т. 23. – С. 20-25.
6. Suyarov A. et al. Whale Optimization Algorithm For Intogreting Distributed Generators In Radial Distribution Network //Available at SSRN 3938852. – 2021.
7. Boliev A. M. INCREASING THE ECONOMIC EFFICIENCY OF THE RENEWABLE ENERGY SYSTEM IN UZBEKISTAN //Journal of Academic Research and Trends in Educational Sciences. – 2022. – Т. 1. – №. 4. – С. 130-135.
8. Джуманов А. Н. и др. ИЗМЕРИТЕЛЬНЫЕ ТРАНСФОРМАТОРЫ ТОКА //World science: problems and innovations. – 2021. – С. 76-78.

9. Mamasaliev O. Theoretical Foundations of Energy Saving //International Journal of Engineering and Information Systems (IJEAIS) ISSN. – 2021. – С. 293-296.
10. Tanirbergenov R., Suyarov A., Urinboy J. Application of Solar and Wind Units as Primary Energy Sources in Autonomous Networks //International Journal of Advanced Research in Science, Engineering and Technology. – 2020. – Т. 7. – №. 9.
11. Hasanov M. et al. Optimal Integration of Wind Turbine Based Dg Units in Distribution System Considering Uncertainties //Khasanov, Mansur, et al." Rider Optimization Algorithm for Optimal DG Allocation in Radial Distribution Network." 2020 2nd International Conference on Smart Power & Internet Energy Systems (SPIES). IEEE. – 2020. – С. 157-159.
12. Khonturaev I. et al. Atom Search Optimization Algorithm for Allocating Distributed Generators in Radial Distribution Systems //E3S Web of Conferences. – EDP Sciences, 2021. – Т. 264. – С. 04084.
13. Kurbanov A. et al. An Appropriate Wind Model for The Reliability Assessment of Incorporated Wind Power in Power Generation System //E3S Web of Conferences. – EDP Sciences, 2021. – Т. 264.
14. Absalamovich N. B. Research on the use of alternative energy sources in Uzbekistan: Problems and prospects //ACADEMICIA: An International Multidisciplinary Research Journal. – 2020. – Т. 10. – №. 11. – С. 763-768.
15. Нариманов Б. А., Шодийева Н. Ш. К. ОБ ПОЯТИЕ ГИДРОАККУМУЛИРУЮЩЕЙ ЭЛЕКТРОСТАНЦИИ (ГАЭС) //Academic research in educational sciences. – 2021. – Т. 2. – №. 5. – С. 286-293.
16. Нариманов Б. А. ОПРЕДЕЛЕНИЕ ОРБИТАЛЬНОГО ДВИЖЕНИЯ СПУТНИКОВ //Современная наука: проблемы, идеи, инновации. – 2019. – С. 76-81.
17. Narimanov B. A. FORECASTING OF PROCESSES THE TURNOVER AND STRUCTURE OF THE FINANCIAL RESOURCES OF THE BANKING SECTOR //Academic research in educational sciences. – 2021. – Т. 2. – №. 4. – С. 1980-1991.
18. Olimov O. Basic Ways to Improve Efficiency Operations of Asynchronous Electric Drives //International Journal of Engineering and Information Systems (IJEAIS) ISSN. – 2020. – С. 107-108.
19. Olimov O., Khazratkulova X. USE WIND ENERGY IN THE CONDITIONS OF JIZZAKH REGION (UZBEKISTAN) //InterConf. – 2020.

20. Nosirovich O. O. Energy saving and application of frequency converters and soft start devices //ACADEMICIA: AN INTERNATIONAL MULTIDISCIPLINARY RESEARCH JOURNAL. – 2021. – Т. 11. – №. 2. – С. 1232-1235.
21. Fazliddin A., Tuymurod S., Nosirovich O. O. Use Of Recovery Boilers At Gas-Turbine Installations Of Compressor Stations And Thyristor Controls //The American Journal of Applied sciences. – 2021. – Т. 3. – №. 09. – С. 46-50.
22. Alisher B. Frequency-Controlled Electric Drive of Pumping Units (October 30, 2020) //International Journal of Engineering and Information Systems (IJEAIS) ISSN. – С. 109-111.
23. Болиев А. М. Влияние пандемии COVID-19 на энергетический сектор. Основные проблемы в секторах возобновляемых источников энергии //ИННОВАЦИОННОЕ РАЗВИТИЕ НАУКИ И ОБРАЗОВАНИЯ. – 2021. – С. 169-179.
24. Alisher B. Frequency-Controlled Electric Drive of Pumping Units //International Journal of Engineering and Information Systems (IJEAIS) ISSN. – 2020. – С. 109-111.
25. Alisher B., Mirzaev U. Technical and Economic Indicators of a Microhydroelectric Power Station in Agriculture //International Journal of Engineering and Information Systems (IJEAIS) ISSN. – 2020. – С. 51-56.
26. Orzikul N. Analysis of Energy Saving In Enterprises (September 30, 2020) //International Journal of Engineering and Information Systems (IJEAIS) ISSN. – С. 130-134.
27. Orzikul N. Potential and Opportunities of the Use of Renewable Energy Sources in Uzbekistan //Potential and Opportunities of the Use of Renewable Energy Sources in Uzbekistan. International Journal of Engineering and Information Systems (IJEAIS) Vol. – 2020. – Т. 4. – С. 186-191.
28. Саъдуллаев Т. М., Курбанов А. А., Сайлиев Ф. О. Перспективное развитие ветроэнергетики в узбекистане //экспериментальная наука: механизмы, трансформации, регулирование. – 2020. – С. 48-50.
29. Orzikul N. Analysis of Energy Saving In Enterprises //International Journal of Engineering and Information Systems (IJEAIS) ISSN. – 2020. – С. 130-134.