ТЕХНИЧЕСКИЕ НАУКИ

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Shodibekova F.T.
Assistant of the department «Hydraulics and hydropower»

Saidov F.S.
Assistant of the department «Hydraulics and hydropower»

Tashkent state technical university
Uzbekistan, Tashkent

TENDENCIES OF DEVELOPMENT AND VARIANTS OF BUILDING MODERN HAES

In article theoretical bases of hydro accumulation electro stations are considered. Reveals positive sides of building HAES. Also the author considers technical characteristics stations influencing power indicators. Variants of building HAES are offered by authors in detail described.

Keywords: *HAES, energy, power, capacity, pressure, turbine, pump, efficiency, reservoir, project.*

HAES are unique high maneuver installations by means of which it is possible to accumulate to (reserve) electric energy, returning it in a power supply system as required. They intend for removal first of all daily peaks of loading in power supply systems. Modern HAES are equipped with reversible units which can work both in a mode «turbine-generator», and in a mode «engine-pump». In time intervals when electric loading in GEN (general electric network) is minimum (night), units HAES pump over water from the bottom water basin in top on height some tens or hundreds meters and consume thus energy from a power supply system (fig. 1 see). During short peaks of loading, when in a power supply system deficiency of generating capacity is formed (mainly during morning and evening time), hydro units HAES work in a generating mode, spending the water reserved in the top water basin [1].

Modern HAES possess a number of positive sides in difference from modern power stations:

- Building HAES demands considerably smaller expenses, than hydroelectric power station (HPS) or heat electro station (HES).

● Unlike enough inertial thermal and nuclear stations HAES can operatively react to changes of loading in a power supply system and within several minutes to type from zero considerable capacity. It is especially actual at power interruptions.

● To advantages HAES, except rather high value of efficiency, concerns as well low cost of civil work. Unlike usual (HPS), here there is no necessity to block small river, to build high dams with long tunnels, etc.

● The fast recoupment at the expense of change of modes.

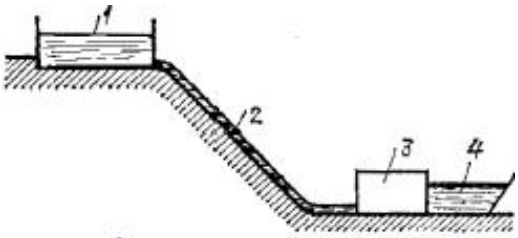

Fig. 1. The scheme of HAES
1 – high pool; *2* – water line;
3 – The building of HAES;
4- bottom pool

Prospects of application HAES in many respects depend on technical parameters of station which concerning these stations are understood as the developed energy, rated power, the average expense, a pressure and efficiency [2].

Pressures of HAES. Static pressure H_{ST}, as well as on hydroelectric power station (HES), is equal to a difference of levels of the top and bottom reservoirs and in the course of work HAES varies at them operate and filling. Changes of levels in reservoirs at work HAES can reach 30 m.

In a turbine mode a pressure (net) less static on size of hydraulic losses at water movement in water waters:

$$H_T = H_{ST} - h_{T.Lost} \quad (1)$$

In a pump mode a developed pressure more static on size of hydraulic losses at return movement of water in water waters:

$$H_H = H_{ST} + h_{T.Lost.} \quad (2)$$

Efficiency HAES for HAES simple accumulation it is characterized by the relation of energy E_T, developed in a turbine mode, to energy E_H, spent in a pump mode:

$$\eta_{HAES} = \frac{E_T}{E_P} \quad (3)$$

In the course of water swapping from below upwards losses also are back inevitable, for this reason in efficiency on modern HAES varies within 65-75 %.

Capacity N_T and electric power development in turbine mode E_T HAES depend on a pressure and volume of used water in a cycle of accumulation and are defined as for HPS, electric power development usually pays off as product of the established capacity on an estimated time of its use in a turbine mode.

Capacity and energy consumption in a turbine mode:

$$N_T = 9{,}81\ Q \cdot H_T \cdot \eta_T \quad (4)$$

$$E_T = N_T \cdot T_T, \quad (5)$$

where Q – the expense of water which is flowed through from high pool (HP) to bottom pool (BP);

η_T – efficiency of the turbine unit or the reversible unit in a turbine mode;

T_T – an operating time in a turbine mode [3].

In 2015 in the world worked HAES as the general established capacity more than 190 GW (on other sources – to 500 GW) and stations total capacity 30 GW were under construction. For example, in France at the expense of HES-HAES system daily change of loading to 35 % becomes covered. Under the European standards, for reliable, qualitative and favorable work of a power supply system maneuverable capacities should make at least 25 % from rated power of power stations of system. In Republic of Uzbekistan (RUz), as well as in many other things the countries, shortage of maneuverable power stations is observed; because of it quality of the electric power and reliability of a power system worsens. So, in RUz maneuverable power plants are only two HES – «Charvak» and «Hodzhikent». Capacities make them 650 and 165 МВт accordingly. Total capacity of all power plants in RUz is equal 12 300 МВт. From the aforesaid follows, that maneuverable capacity makes approximately 6 % from the established.

The lack of considering above told, authors some variants of building HAES taking into consideration a geographical place Republic Uzbekistan position were offered:

The most favorable is building HAES near to «Novo-Angrenskaya» heat electro station (HES). Near HES there are water resources which can be used for HAES, in particular, the Akhangaran water basin.

Creation new HAES or HPS demands erection of new water basins that demands the big capital investments. Water basin building at a design stage is an uneasy problem. For capital investment reduction at building HAES it is possible to save on erection of water basins. One of variants is a building only one water basin, and instead of the second to use the large river or the channel.

Except above considered variants the Republic Uzbekistan government already considered projects with use of available water basins. Such, as: the Talimarjon water basin on the Karshi main channel, Tuyamuyin hydro knot on the river Amudarya, the Arnasay water basin on the river Sirdarya and other water basins. According to these researches it is revealed, that in the water basins resulted above – ecologically pure electric power, in the absence of scientific and technical bases of creation hydro energy complex unreasonably lost.

Thus, the above-stated arguments, confirm that that the given branch completely is not opened also many questions have found the answer. It is necessary to carry out fuller research of variants of building HAES the future. Geographic location of Uzbekistan optimum for building HAES, experts of different branches who from the different parties can consider possible variants of building of station are for this purpose necessary and choose the optimum project.

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Шодибекова Ф.Т.
ассистент кафедры «Гидравлика и гидроэнергетика»

Саидов Ф.С.
ассистент кафедры «Гидравлика и гидроэнергетика»

Ташкентский государственный технический университет
Узбекистан, г. Ташкент

ТЕНДЕНЦИИ РАЗВИТИЯ И ВАРИАНТЫ СТРОИТЕЛЬСТВА СОВРЕМЕННЫХ ГАЭС

В статье рассматриваются теоретические основы гидроаккумулирующих электростанций. Раскрываются положительные стороны строительства ГАЭС. Также автором рассмотрены технические характеристики, влияющие на энергетические показатели станции. Подробно описаны варианты строительства ГАЭС, предложенные авторами.

Ключевые слова: *ГАЭС, энергия, мощность, объем, давление, турбина, насос, эффективность, резервуар, проект.*