Chapter 5
Materials and Methods of Thermal Energy Storage in Power Supply Systems

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ABSTRACT

The chapter considers the factors that affect the incomplete use of power. The analysis and systematization of accumulating systems on the types of accumulated energy, on the processes occurring during storage, types of devices and types of generated energy is performed. Each of the possible ways of accumulating energy is analyzed in detail. Various variants of conformity of schedules of change of a consumed load within a year and a total resource of solar radiation are considered. The analysis of the parameters of heat-accumulating materials and their classification depending on the material class, the way of heat accumulation and return, on the cyclicity of work, etc. are provided. It is shown that the level of temperature, the scale of the storage unit, and the necessary duration of heat storage determine the requirements for the construction of batteries and the choice of heat-storage substances. The prospects of research on the search for new ways of accumulating energy and technical means for their implementation are considered.

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INTRODUCTION

Under normal conditions energy production must correspond to the regime of its total consumption. The power of the power plants should be expected to satisfy the maximum possible load regardless of its duration. At the same time, the power system needs a sufficient reserve of power to ensure the continuity of energy supply to consumers in the event of a reduction in the capacity of individual power generating units of the system during a normal production process or due to sudden emergency or breakdowns.

Uneven energy consumption leads to the fact that the power of power plants is most fully used only at the time of maximum load. Incomplete use of the power system capacity can also be caused by:

- The presence in its composition of power plants with variable available capacity, for example, thermal power plants;
- Insufficient regulation of hydroelectric power stations;
- Lack of maneuverability of power regulation of nuclear power plants;
- Uneven output of solar and wind power plants due to diurnal and seasonal fluctuations in solar radiation intensity and wind speed;
- Other factors.

Increasing the use of the system’s capacity and the creation of energy reserves are major problems in the design and operation of power systems (Popel & Fortov, 2015, Sorensen, 2011, Vasilev, Elistratov, Mukhammadiev & Pretro, 1995).

Needs in accumulation increases at the operation of power plants based on renewable energy sources (RES) – the energy of the sun, wind, etc.

In this case the inclusion of accumulating units in the power system improves the reliability and stability of the power supply to consumers, makes it possible to regulate the operation mode of power plants without strict dependence on the energy consumption mode by cutting the peak of the graph by means of discharging the battery and filling the graphs with charge of the battery.

BACKGROUND

There are different kinds of energy accumulators. They can be classified according to the types of accumulating energy, the processes occurring during its storage, the types of devices and the types of energy given out (figure 1).

The following species are among the most interesting and applicable accumulation means (Babaev & Danilin, 2002):

- Heat (cold) accumulators are installations in which the energy is stored as heat (cold) due to heat capacity, heats of phase transitions or endothermic (exothermic) reactions;
- Accumulators of electrochemical energy are installations in which the electric power is saved and given out as a result of chemical reactions;
- Mechanical accumulators are installations in which the energy is stored in the form of the potential and kinetic energy of physical bodies;