**Maintaining the balance of the electric energy ridge through high-power hybrid energy storage ridges.**

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**Abstract.** The article presents an analysis of the combined use of high-power hybrid electric energy storage stationary electric chemical batteries and supercapacitors and the stabilization of the balance of the electric energy range. Also listed are the characteristics of stationary hybrid accumulators. The current state-of-the-art various chemical electric energy storage lead-acid accumulator, supercapacitor and simple capacitor parameters are given comparative characteristics. Characteristics of lead-acid battery batteries and supercapacitors discharge and discharge are presented. With the help of battery batteries and supercapacitors, a model construction of a hybrid energy storage system was built, and through this device the characteristics of which depend on the power of the current forces were obtained and analyzed.

**INTRODUCTION**

Currently, the issue of efficient storage and distribution of electricity is becoming more important in transport, renewable energy systems and telecommunication infrastructures. One of the most widely used energy storage devices is lead — acid batteries, which are significant for their low cost and reliability. However, their main disadvantage is that low energy density and fast operation are degraded in deep cycles. At the same time, supercapacitors are characterized by a very high energy density, resistance to millions of charging-discharge cycles and the possibility of providing fast electricity. But their energy density is lower than that of conventional batteries. Therefore, it can be a reliable, high-quality battery with a longer service life, which is more resistant if a lead-acid battery and supercapacitors are jointly developed as a hybrid electric energy storage system in a state suitable for today [1]. Electricity consumers the character of the energy system is sharply variable, which at such times negatively affects the dynamic stagnation of electricity-generating sources in the energy range. In this case, a sharp change in voltage will be able to disrupt sensitive equipment. In this, especially pulsed and sharply variable loads are caused by the launch of high-power engines, induction, arc furnaces and similar devices. At times of low night load, the value of electricity generated in thermal power plants is not possible to change in large quantities, but it is observed that the voltage in power lines exceeds the established nominal values [2-4].

In today's world, electrical chemical electrical energy storage systems are used to prevent these problems. But a sharp change in the load is reducing the life of battery batteries due to the fact that the discharge current exceeds the maximum. However, the use of electrical chemical preservatives in conjunction with supercapacitors prevents such problems [5].

Electrical chemical energy harvesting constructions are applied to collect and repel energy chemically. They are called galvanic elements or battery batteries. These types of energy harvesting devices are the most common. There is also a lot of work being done in the world to increase the service life of these devices.

Superconductors, or so-called ignitors, are used in large-speed collection and transmission of electricity in construction. It is seen as an alternative to conventional electric chemical accumulators, which, through this feature, began to be widely used in the automotive industry.

Such an advantage of supercapacitors is explained by their structure and the mechanism of energy collection. The supercapacitor consists of two electrodes immersed in an electrolyte, and between them there is a separator separating the liquid. The Separator prevents the direct exchange of charge between the cathode and the anode. Energy accumulation occurs through an electrostatic charge-a double layer of electricity — that forms on two opposite surfaces adjacent to the electrodes an advantage of supercapacitors is explained by their structure and the m.

During the charging process, the electrolyte ions irregularly tend to the opposite charged electrode surface. This process is fully reversible, resulting in superconductors having high power, long service life, energy storage duration, and simplicity of maintenance.

Supercapacitors are characterized by a much larger capacity compared to conventional electric chemical batteries, and a higher energy capacity compared to ordinary capacitors. Currently, lithium-ion accumulators can return between 70% and 95% of the energy they receive, compared to 85% to 99% in supercapacitors.

In addition, while battery batteries tend to reduce capacity after several hundred discharge cycles, ionistors can operate for millions of cycles almost without loss of capacity.

In this case, a comparison of the characteristics of their capacitor, supercapacitor and battery batteries

Shown from Table 1 [6].

**Table 1.** Comparison of capacitor, supercapacitor and battery characteristics

|  |  |  |  |
| --- | --- | --- | --- |
| **Description** | **Capacitor** | **Supercapacitor** | **storage batteries** |
| of the type | al, ta oxide | Acute C, H2SO4, TEABF4/AC, PC, | Pb-Ac To cd-rom, Select-MH, li-ion |
| Charge collection method | Electrostatic | Electrostatic | Electric chemical |
| E (W·hr/kg) | <0.1 | 1-10 | 20-200 |
| P, (w/kg) | >>10000 | 500-10000 | 200-5000 |
| Discharge Full time | 10⁻⁶ – s 10-3 | s 1-60 | 5 min – 5 hours |
| fully charged time: up to | 10⁻⁶ – s 10-3 | s 1-60 | 10 min – 10 hours |
| Discharge effectiveness | 1,0 | 0,85–0,99 | of 0.7–0,95 |
| full of the number of cycles, n | >>10⁶ | >10⁶ | 103 – 5·103 |
| rated voltage U (V) | High | of 2.3 – to 2.7 | to 3.2 – 3.7 |
| Charge to store the index | Low | Low | High |
| charged to line up the shape of the curve | Linear | Linear | Flat |
| temperature range | from -60 to 125°c | -40 to 65°C | from -40 to 60°c (discharge) / from 0 to 45°c (charging test) |
| 1 kw·hour price | >1 000 000 $ | >10 000 $ | 250 $ – 1000 $ |

To charge, you need to have on hand:

- the nominal charge of the battery when charging;

-the degree of pulsation of alternating current and battery charge;

- parallel universe;

- rechargeable battery to control the entire circuit;

- increase the battery capacity;

-in case of emergency shutdown of the battery, up to 90% of the charge level is maintained.;

- battery charging current limit;

-loading is done with a trigger.

Comparison of capacitive rechargeable batteries or capacitors used in the assembly of a supercapacitor charge, determination of the main parameters of the charge and discharge of batteries all cells have the same length and width. The differentiation of supercapacitors from conventional accumulators is also observed in the description of charge–discharge curves. In supercapacitors, this curve will have a constant slope, in accumulators the charge–discharge form will have a nonlinear form with a horizontal area. This can be seen in Figures 1 and 2.



**FIGURE 1.** Hermetic lead is a discharge characteristic of an acid battery.

From the discharge characteristic of hermetic type lead acid battery batteries, it can be seen that rapid discharge at different voltages reduces their active capacity and also reduces the service life shrinks. In this case, with the sequestration of the start time of discharge, there will be a significant storage capacity for their charge capture.

The charge characteristic of supercapacitors will have a linear incidence. Their charge characteristic is shown in Figure 2, with the voltage being a linear smooth riser and the current strength being constant over time.



**FIGURE 2.** Supercapacitor charging characteristics.

The joint use of battery batteries with supercapacitors reduces the damage to accumulators for peak States of the electrical energy system. Their performance cycles are not adversely affected [7].

Currently, in the power supply systems of enterprises, power transformers operate in an unloaded mode, which leads to an increase in idle losses [8]. Even at this time, electricity creates the need to use the nergy storage Ridge.

**EXPERIMENTAL RESEARCH**

A device was developed with the aim of researching hybrid energy storage systems consisting of supercapacitors and electrical chemical energy harvesting devices. This device is based on the study of the modes of operation of the hybrid energy storage system in different load types and their values.

With the joint application of supercapacitor and battery batteries, a hybrid energy storage system is equipped. A system with a sharply variable consumer load through a hybrid electric energy storage system we will build a model

and test as an experiment how the hybrid energy storage system behaves in this system. In doing so, we build the experimental device model shown in Figure 3 below.



**FIGURE 3.** Schematic diagram of the experimental setup.

As can be seen from the picture, the device consists of two parts: a 12-V fixed current and a 220-V variable current part. In the variable current section there is a loading location, that is, an engine and spark plugs. This part loading was done with a pulsed engine and lights were installed as static loading [23-52].

The fixed current section houses BSC-83, a lead-acid battery, inverter and control unit. When collecting electricity, a control device is installed to control the charging system. A solar panel is used to generate electricity, or other 12 V sources can also be used[9-10,11,12]

The device uses current sensors to measure the current forces flowing through the networks.

This device can simulate 4 modes:

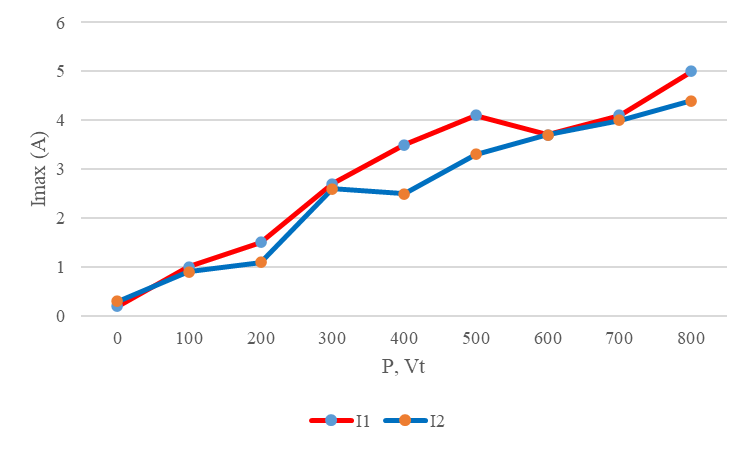
- charging hybrid energy system;

- discharge of the electrical chemical Enegia collection system in a sharp change and in a static state;

- superconducting discharge in a sharp change and in a static state. The device uses current sensors to measure the current forces flowing througte [13-14,15,16]

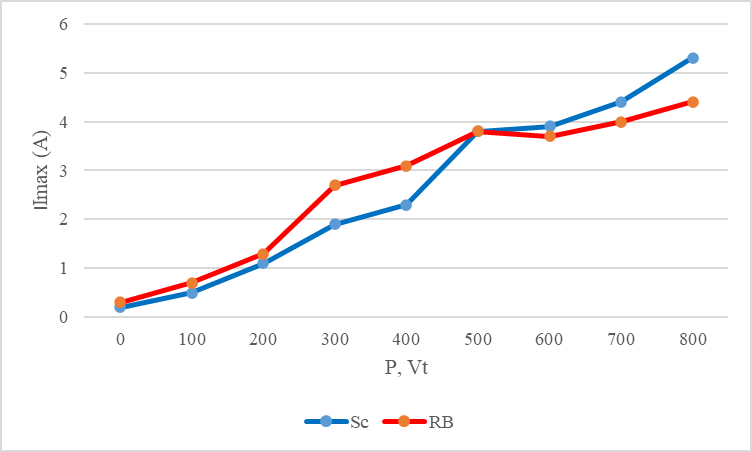
**RESEARCH RESULTS**

In the case of low load in the electrical energy system, the charge of the hybrid system and its load are subject to a sharp change, as well as research on the power and current strength of the hybrid system in the case of discharge at the time of increasing load. In this case, kamani is studied in pulsed and sharply variable cases. In the first case, we observe the variation of the discharge token in accordance with the load capacity the case of low load in the electrical energy system, the charge of the hybrid system and its load are subject to a shar.



**FIGURE 4.** Graph of the dependence of the hybrid system current and load current on the load power.

The i1 value of the hybrid system current changes to the load current i2 with a nonlinear bond i.e. with an increase in power, the load current does not match the value of i2. In the graph obtained according to the results of the analysis, discharge with an increase in the load current to the maximum leads to an increase in the current of the supercapacitor. At a small value, loading receives energy from the electrical chemical energy storage system. However, when the load current reaches its maximum i.e. during a sharp load change and in pulsed cases, battery batteries cannot be maximally discharged, and in this case, the superconductor receives energy from the energy storage system at peak times. We can see this from Figure 5 of the power dependence graph of the supercapacitor and battery batteries below [17-18,19].



**FIGURE 5.** Graph of current strength versus power for supercapacitor and battery cells.

Based on the results of the analysis of the resulting graph, the accumulator current is the main source in the initial case. As the load token increases, the supercompensation current begins to rise. In this case, the load current protects the battery from a large discharge current in cases of increased load [20-22].

**CONCLUSIONS**

The results of the study showed that in the current electrical energy system, there is no possibility to change the power of the existing electric power generating thermal eleter stations in large quantities. The electric energy range requires extensive consideration of the ability to collect electricity at low load times through energy storage systems, as well as the ability to extract energy from the energy storage range at a time when the load has increased dramatically. Also as energy storage systems, electrical chemical methods are currently being used. But this made it possible that the batteries were not resistant to sharp and pulsed changes in the loading value. Therefore, the need for the application of hybrid ridges, which work in accordance with the drastic changes in loading, as well as the development of automatic ridges, which effectively control them, increases.

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