led to a system of equations of 8 unknownsIn this case, at each step, the coefficients were calculated depending on the temperature, namely: the heat capacity of the components, their thermal conductivity and the entropy of the reacting substances (PbO_2, Pb, $PbSO_4$ and solutions of H_2SO_4). Thus, the task is to find an algorithm for calculating the optimal time step for the chosen difference scheme. Also, during the simulation, an assumption was made that the mixing of acid solutions occurs instantly and its concentration due to a chemical reaction changes throughout the entire volume of the battery also instantly, depending on the degree of its charge.

Fig. 4 shows a comparison of the temperatures of the elements depending on the daily load.

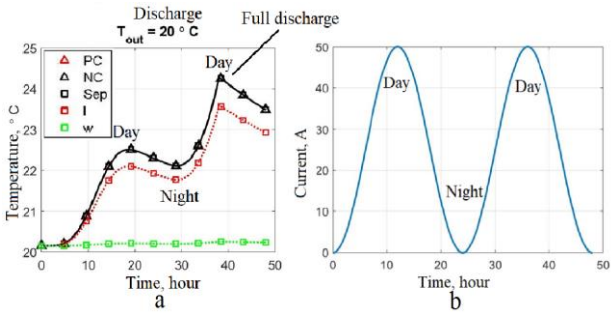

Fig. 4. Battery temperature (b) versus daily load over time (b).

The daily load in fig. 4 was modeled on the basis of a sinusoid to reflect the frequency of energy consumption: during the day the load is maximum (50 A), at night it is minimum (0 A). As shown in fig. 4, the battery is discharged within 38 hours. The battery temperature rises over time and may rise above its optimum operating temperature. In order to prevent this, it is necessary to regulate the ambient temperature in the storage room, which will be the boundary condition for the system under study.

4 Conclusion

This work is a continuation of the study of the use of flow graphs in modeling dynamic systems using the example of a lead-acid battery. This object was chosen for modeling due to the significant functional heterogeneity of its structure, which leads to problems in the construction of a differential model and its numerical solution. This is due to the need to reconcile dissimilar physical aspects when describing battery performance and to deal with discontinuous functions. In contrast to previous studies, calculations of the temperature of the components under dynamic conditions are carried out here. The calculations were carried out in the Matlab environment.

During the study, it was found that the choice of the difference scheme affects the calculation time: to calculate according to the Euler scheme (right-hand difference scheme) it is necessary to spend 100 times more time than when calculating according to the left-hand difference scheme.

There is one more aspect of the numerical search for the equation of evolution of a dynamical system, and this aspect is the choice of the optimal time step. The authors assume that its choice is influenced by the internal structure of the object under study, which is reflected by its connectivity matrix of the flow graph of the object. This structure, in fact, we set ourselves, building a graph for the dynamical system under study.

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