Identification of qualitative regularities in the functioning of neural network models of a critical resource of lubricating oils

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This paper proposes a comparison of two approaches to building a model of a critical resource of lubricating oils, describing the rate of change in the optical density of oils with time, depending on the duration and temperature of temperature control. The requirements for the model can be characterized by three qualitative properties:

- adequacy (or accuracy) of the description of the speed parameter;
- smoothness of the model;
- the ability to identify qualitative regularities of the process of thermo-oxidative destruction.

The purpose of the model is to predict the rate of change in optical density for temperatures and durations of thermostating, other than those studied in the process of experimental research.
Baseline data for building a neural network model of the rate of change in optical density - the difference between adjacent measurements of optical density, provided that $\Delta t = \text{const}$. The results are presented for the case $\Delta t = 8$ hours. Complicating the structure of the model, namely increasing the number of layers in the network and the neurons in them, does not lead to a compromise, that is, to preserve the smoothness of the model and the accuracy of the prediction of the partial derivative.

Let us turn to the second approach, where the source data is the calculated values of the differential estimate of the partial derivative $\frac{\partial D}{\partial t}$ obtained from the primary optical density model. The basic functions for differentiation are smooth models describing the dependence of density $D$ on $t$ and $T$. Thus, the “two-step” process of building a model was used $\frac{\partial D}{\partial t}$:

Stage I: smoothing, using the neural network approach, the initial data obtained in a series of experiments to determine the optical density.

Stage II: the use of the obtained model dependence for the construction of an estimate of the partial derivative with respect to time: .
In conclusion, we note that the adequacy of building models from experimental data is determined by many factors. The model can have various purposes. Predictive models should have a high accuracy, determined by the selected quality criteria. Research (cognitive) models have a different purpose and are used for a deeper study of the processes taking place. Here, a more important role is played by the ability of the model to describe the qualitative characteristics of the process.

In this work, emphasis was placed on the ability of the model to contribute to the mapping of the regularities of the course of the process of thermo-oxidative destruction for its deeper study. The second approach for our needs turned out to be more informative.