Neural Network Model of Sunflower Seed Drying Process in Combined Drum Dryer

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ABSTRACT

This article is devoted to the neural network modeling of the drying process based on the experimental results obtained on the drying of sunflower seeds in combined drum dryer. Modeling was carried out in the Neural Networks Toolbox package in the Matlab system. The adequacy of the built model was checked and compared with the experimental results.

Keywords: sunflower seeds, neural network modeling, drying process, grain dryer.

Introduction

Drying of grain and seeds grown in agriculture has always been one of the urgent issues. The types and capabilities of grain and seed drying devices are also expanding. Each dryer has its own drying methods, which indicates that the drying process has its own model. The models found based on the experimental results allow to predict the output results with high accuracy. Creating a mathematical model of the drying process in the traditional way requires a lot of calculations. Taking into account many factors affecting the drying process complicates the modeling process. In order to build mathematical model, the experiment must be properly planned, and then mathematical model with certain coefficients is developed based on the variation of the input parameters. However, this process will not happen quickly. Recently, research on neural network-based modeling of drying processes has been carried out effectively [1-8]. Neural network modeling differs from the traditional method in its accuracy, convenience and many possibilities. In this article, we will consider neural network modeling of sunflower seed drying process using Matlab software package. Modeling was carried out based on the results of experiments conducted in combined dryer for drying sunflower seeds.

Materials and methods

The combined drum dryer was designed and built for drying sunflower seeds [9-10]. This dryer has the possibility of additional use of solar thermal energy. The effect of solar thermal energy on the drying process is evaluated by the change in the air temperature value in the solar collector in the dryer. Therefore, solar thermal energy is also taken into account during the drying process. Experiments were carried out on drying sunflower seeds in the dryer [11-12].

The following were taken as input parameters during the drying process:

1) drying agent temperature, °C.
2) initial moisture content of sunflower seeds, %.
3) air temperature in the solar collector, °C.
4) drying period of sunflower seeds, min.

The moisture content of sunflower seeds at the output of the dryer was taken as the output parameter.

The total number of experiments conducted is 31, and the results obtained based on the change of the input parameters values in the combined view are presented in Table 1.

Experimental results obtained based on changes in the values of the input parameters

Table 1

№	Drying agent temperature, °C	Initial moisture content of sunflower seeds, %.	Air temperature in the solar collector, °C.	Drying period of sunflower seeds, min.	Moisture content of sunflower seeds at the exit of the dryer, %
1	78	38	55	36	22,6
2	82	38	55	36	21
3	78	46	55	36	31,4
4	82	46	55	36	30
5	78	38	65	36	22
6	82	38	65	36	20
7	78	46	65	36	30,9
8	82	46	65	36	29
9	78	38	55	72	17
10	82	38	55	72	20,2
11	78	46	55	72	21,3
12	82	46	55	72	14
13	78	38	65	72	15,1
14	82	38	65	72	13,3
15	78	46	65	72	16,2
16	82	46	65	72	13
17	76	42	60	54	21,2
18	84	42	60	54	16,6
19	80	34	60	54	14,6
20	80	50	60	54	24,9
21	80	42	50	54	25,8
22	80	42	70	54	21,1
23	80	42	60	18	32,3
24	80	42	60	90	10,6
25	80	42	60	54	16,7
26	80	42	60	54	20,4
27	80	42	60	54	18,3
28	80	42	60	54	20,2
29	80	42	60	54	17,1
30	80	42	60	54	20,1
31	80	42	60	54	16,1

Based on the experimental results presented in Table 1, we will build neural network model of the drying process in the Matlab (Neural Networks Toolbox) system. The simple one-layer neural network model structure based on the Levenberg-Marquardt algorithm is shown in Fig. 1.

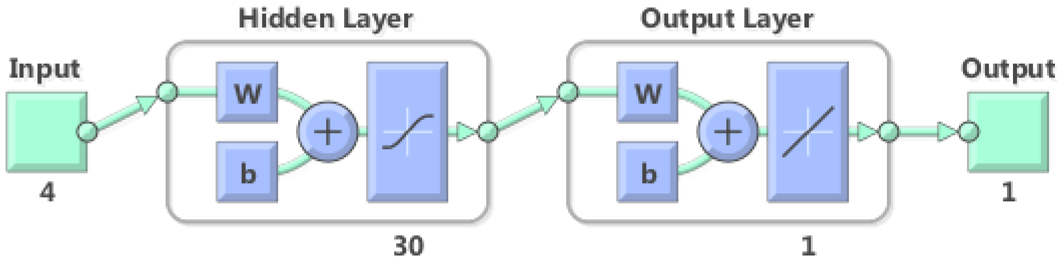

Figure 1. Neural network architecture.

The number of neurons in the hidden layer was taken as 30 to make the calculations quick and easy.

Results and discussion

Based on the created model, we calculate (predict) the moisture content of sunflower seeds at the exit of the dryer (Fig. 2).

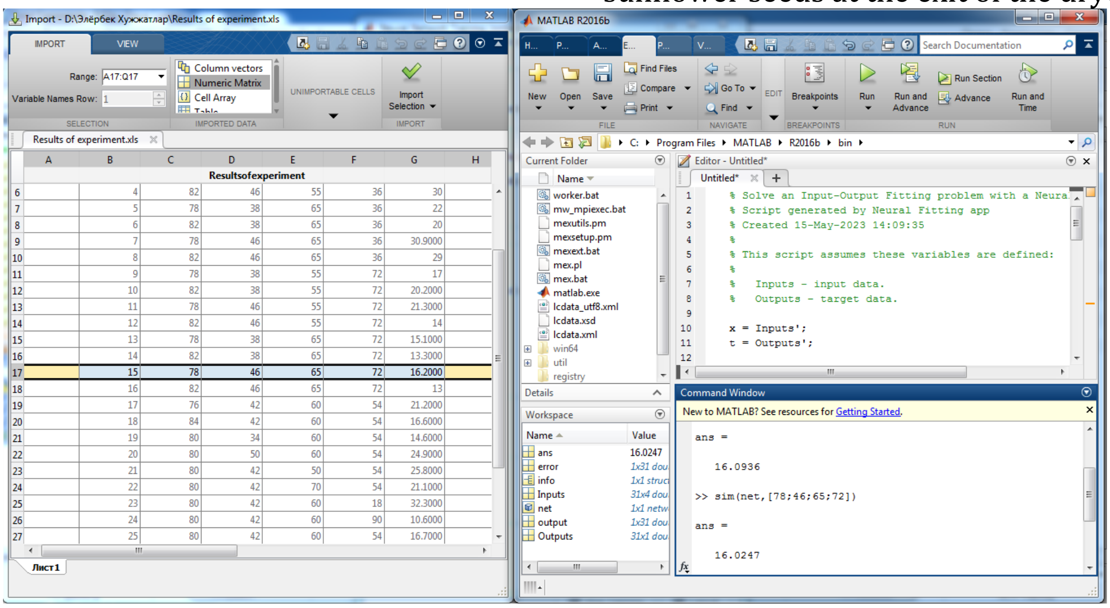

Figure 2. Calculation of the output parameter using the constructed model.

Figure 2 shows that the difference between the experimental value and the model-predicted value is small.

The difference between the values found based on the experiment and the model was calculated, and the adequacy of the found model to the experimental values was determined. The difference between the values obtained from the model and the experimental value of the output value at the average values of the input parameters, which are the temperature of the drying agent, the initial humidity of the sunflower seeds, and the air temperature in the solar collector, according to the change of the drying time, was calculated. The calculation results are shown in Fig. 3.

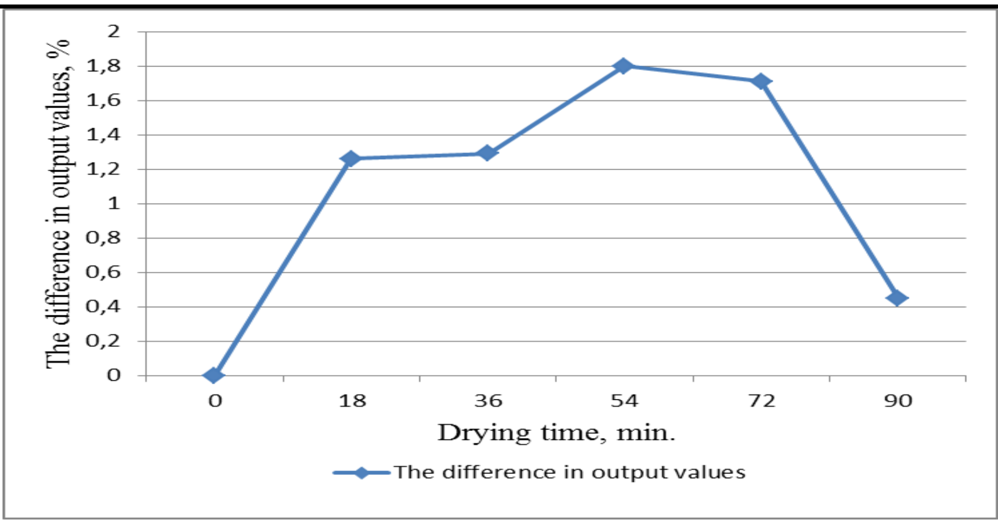

Figure Figure 3. A diagram of the difference between the experimental and model values.

It can be seen from this figure that the difference between the experimentally obtained and model-predicted outputs does not exceed 2%. Based on this, the constructed neural network model can be considered as a monad to the experiment. The adequacy of the built model can also be seen from Figure 4

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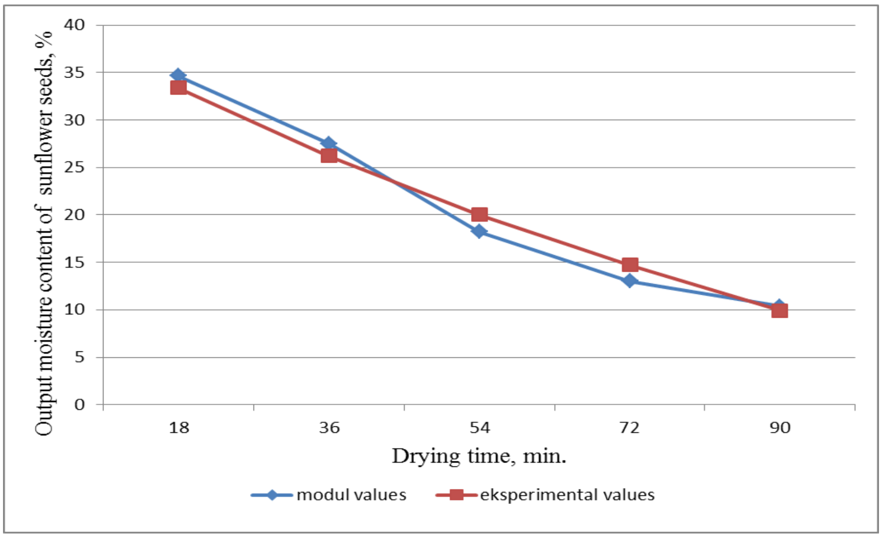

Figure 4. Adequacy graph of experiment and model values.

It can also be seen from Figure 4 that the output values predicted by the model are not significantly different from the output values found in the experiment. So, we can use this constructed neural network model in our research.

The built neural network model is distinguished by its easy construction based on the results of the experiment. The model trained and built based on typical algorithms also provides the required accuracy. Through the built neural network model, we can predict values that are much closer to the experimental values. In addition, the accuracy level of the neural network model can be increased by increasing the number of experiments.

Conclusion

The neural network model was built in the Matlab system based on the experimental results obtained by planning the experiment. This type of modeling is built on the basis of typical algorithms and does not require excessive and lengthy calculations. The built neural network model is adequate to the experimental values, which can also be seen in the graphical form. We believe that it is appropriate to use neural network modeling for quick and easy modeling based on experimental results of drying processes.

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