**UDC 62-83: 628.12**

# PROCEDURE FOR DEVELOPING A TURBOMECHANISM PRODUCTIVITY ESTIMATOR BASED ON A NEURAL NETWORK DURING THE POWER SUPPLY OF NON-TRADITIONAL ENERGY SOURCES

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*The paper considers the procedure of developing a productivity estimator for a turbomechanism using the apparatus of artificial neural networks. The power supply of the installation comes from an unconventional energy source.*

***Keywords:*** *turbomechanism, productivity, estimator, non-traditional sources, neural networks.*

# ПРОЦЕДУРА РОЗРОБКИ ОЦІНЮВАЧА ПРОДУКТИВНОСТІ ТУРБОМЕХАНІЗМУ НА ОСНОВІ НЕЙРОННОЇ МЕРЕЖІ ПРИ ЖИВЛЕННІ УСТАНОВКИ ВІД НЕТРАДИЦІЙНИХ ДЖЕРЕЛ ЕНЕРГІЇ

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*У роботі розглянута процедура розробки оцінювача продуктивності для турбомеханізму при використанні апарата штучних нейронних мереж. Живлення установки при цьому відбувається від нетрадиційного джерела енергії.*

***Ключові слова:*** *турбомеханізм, продуктивність, оцінювач, нетрадиційні джерела, нейронні мережі.*

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Nowadays centrifugal turbomechanisms found wide applications in different areas. A special place is occupied by turbomechanisms of private houses, which have a non-traditional or alternative power source, such as a wind turbine or solar panels. It is necessary to maintain a constant voltage on the drive motor of the turbomechanism to ensure its continuous operation when measuring the necessary technological coordinates for the control system.

The process of determining and estimation the turbomechanisms' technological coordinates is an integral part of their automatic control systems design, however, the sensors, which provide information to the system, are expensive or the access for their installation is limited by the construction of the hydraulic network.

In [1], the authors propose a system with two temperature and pressure sensors on input and two on pump output to calculate its efficiency. To increase the water supply system energy efficiency, the forecasting method can be used [2]. Measuring the productivity of a turbomechanism is a separate problem, as performance sensors are quite expensive and inaccurate.

To develop a neural network (NN) productivity estimator [3], we use the Matlab2014b package with Neural Network editor (nntool). The block diagram for neural network training is shown in Fig. 1. The turbomechanism (TM) is powered by a non-traditional energy source, provided that the voltage and frequency $f^*$ at the input of the frequency converter (FC) of the induction motor (IM) is stabilized.

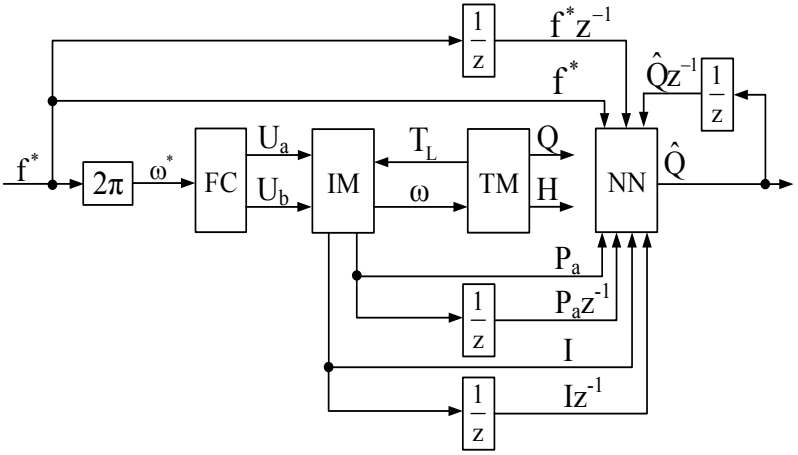


***Fig. 1. Function diagram of system for editor ntstool***

In Fig. 1 the following notations have been used: Pa – active power; $Paz^{-1}$ – active power delayed by one quantization cycle; I – stator current module; $Iz^{-1}$ – stator current module delayed by one quantization cycle; $f^*z^{-1}$ – task for frequency delayed by one quantization cycle; $\hat{Q}$ – observed value of the productivity; $\hat{Q}\,z^{-1}$ – observed value of the productivity delayed by one quantization cycle.

To form further input arrays for training neural networks during the simulation process, the set frequency varies in the range from 50 Hz to 30 Hz with a step of 2 Hz. Also, to increase the accuracy of the neural network, the network resistance varies in the whole possible range at each frequency, namely from 0 s2/m5 to 6.439 s2/m5. The graphs of the task for frequency and network resistance are presented in Fig. 2.

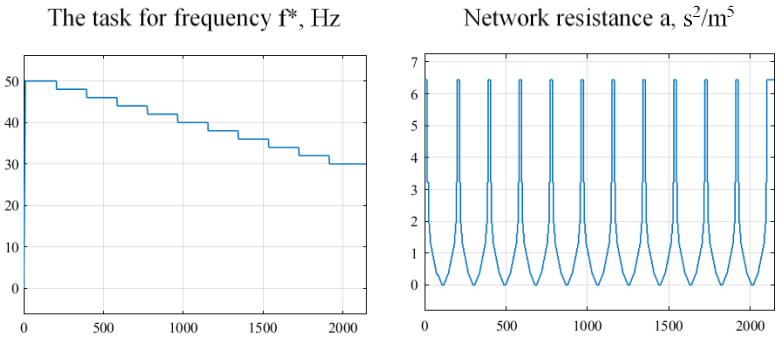


***Fig. 2. Diagram of the task for frequency and network resistance respectively***

After training the neural network on the signals given in Fig. 2., it is possible to check of working capacity of the developed estimator with the schedule of change of hydraulic resistance according to different laws. According to the proposed method, it is possible to develop estimators of any technological coordinates of turbomechanisms.

**Literature:**

1. Wanjiru E.M., Sichilalu S.M., Xia X. Optimal integrated diesel grid-renewable energy system for hot water devices. Energy Procedia. 2016. T. 103. №. April. P. 117–122.

2. Aguilar F.J., Aledo S., Quiles P.V. Experimental analysis of an air conditioner powered by photovoltaic energy and supported by the grid. Applied Thermal Engineering. 2017. T. 123. P. 486–497.

3. Burian, M. Pechinik, M. Pushkar and A. Tytarenko, “Investigation of the Pump Unit Control System With the Neural Network Productivity Estimator,” 2019 IEEE 6th International Conference on Energy Smart Systems (ESS), Kyiv, Ukraine, 2019, p. 298–302.