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ГАЛАХИМ



Experimental studies of the thermal characteristics of an electric thermal storage

Authors: A.V. Khimenko, D.A. Tikhomirov, S.S. Trunov, A.V. Kuzmichev

**Affiliations: Federal State Budgetary Scientific Institution "Federal
Scientific Agroengineering Center VIM"**

Experimental studies of the thermal characteristics of an electric thermal storage

A.V. Khimenko, D.A. Tikhomirov, S.S. Trunov, A.V. Kuzmichev

Federal State Budgetary Scientific Institution "Federal Scientific Agroengineering Center VIM", Moscow

Keywords: electric thermal storage, heat storage element, the charging and the heat output modes, rate of heating and cooling, chamotte, magnesite

Research Objective:

Carrying out experimental studies of the thermal and dynamic characteristics of electric thermal storage (ETS) to verify the data obtained as a result of numerical simulation of heat exchange processes in the modes of charging and heat output of ETS.

Analysis and evaluation of the efficiency of the charging and heat output modes of ETS with heat storage elements made of chamotte with round-shaped channels and of magnesite with slit-shaped channels.

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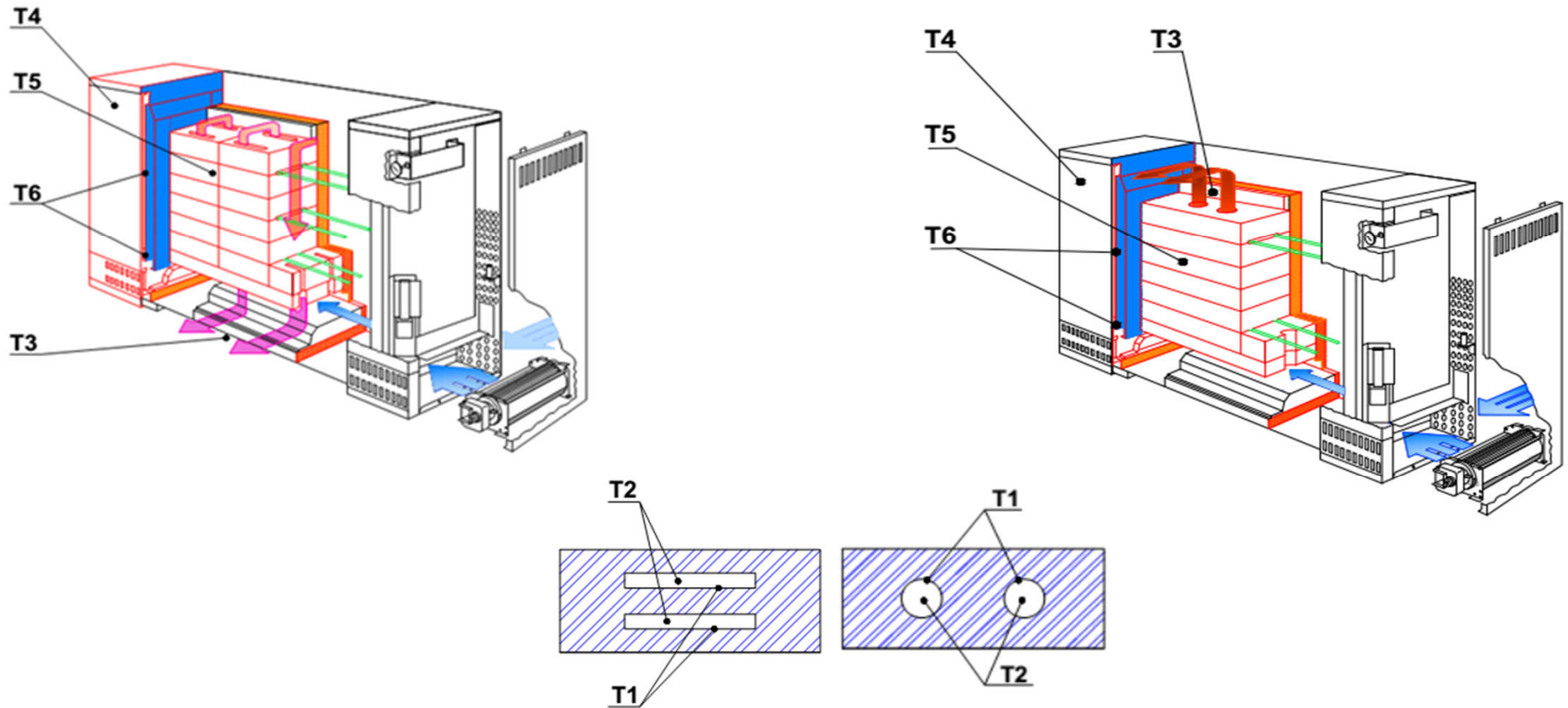
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Results

Functional-technological scheme of ETS with heat storage elements made of magnesite (standard design) and chamotte (proposed design) with indication of the installation locations of thermocouples



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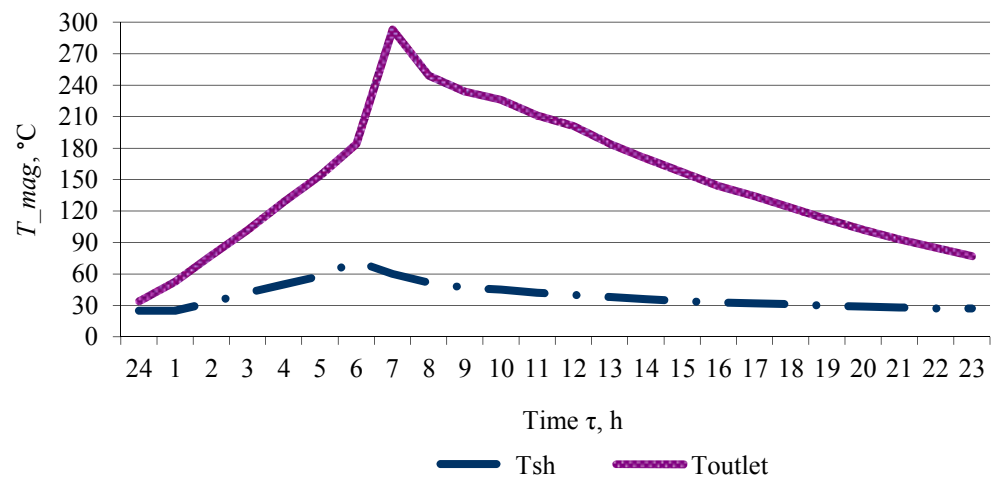
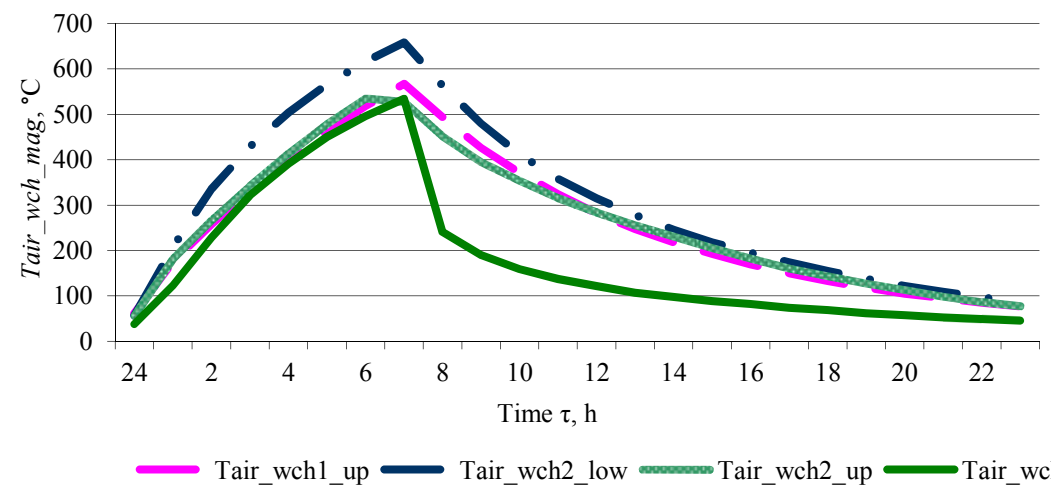
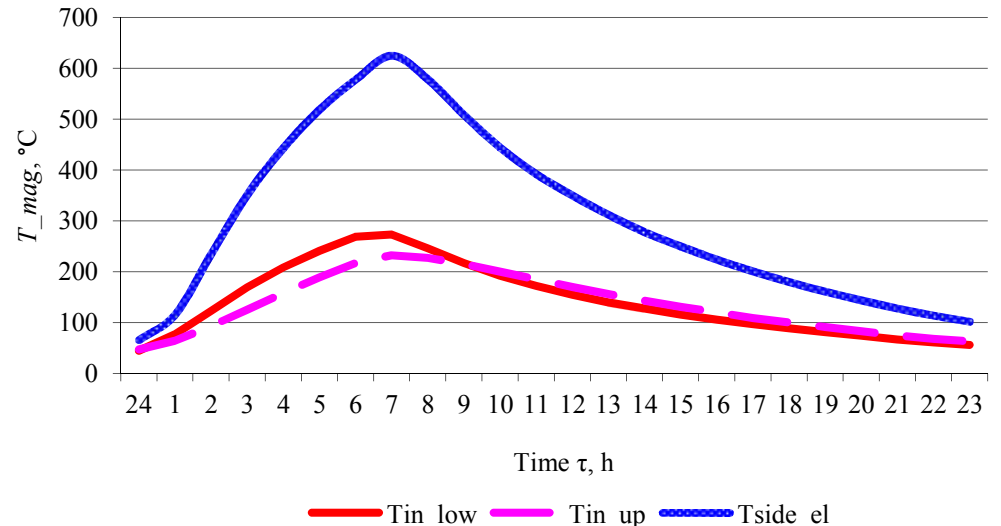
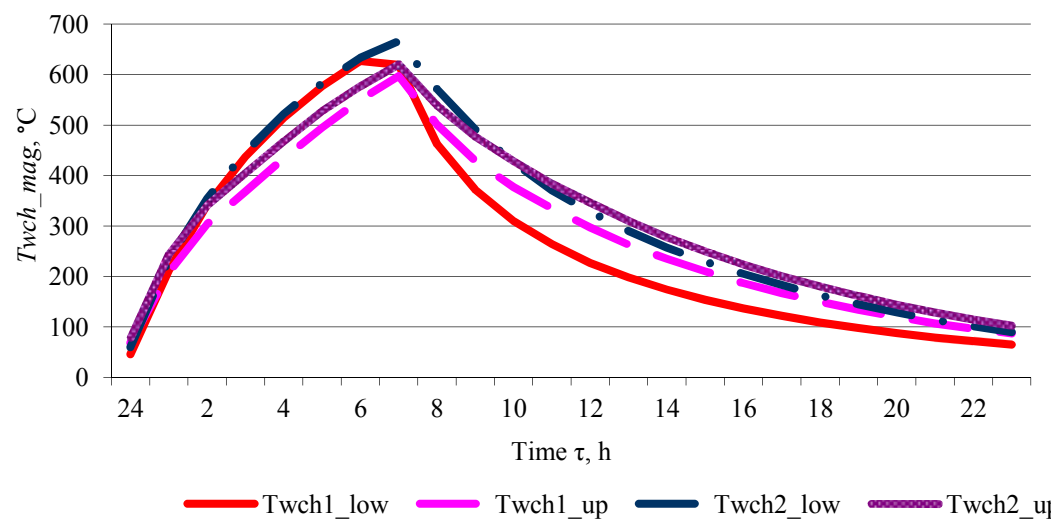
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Results

Results of experimental studies of thermal and dynamic characteristics of ETS (magnesite)



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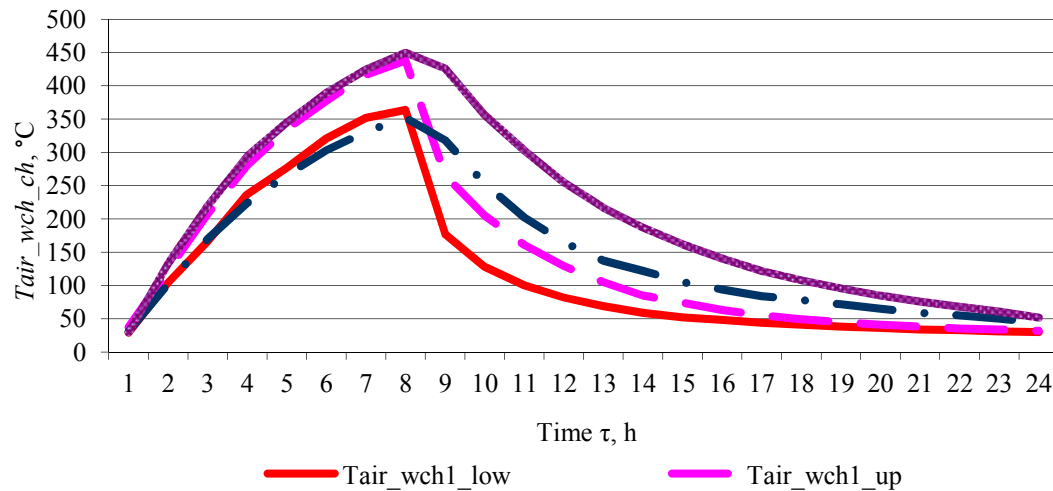
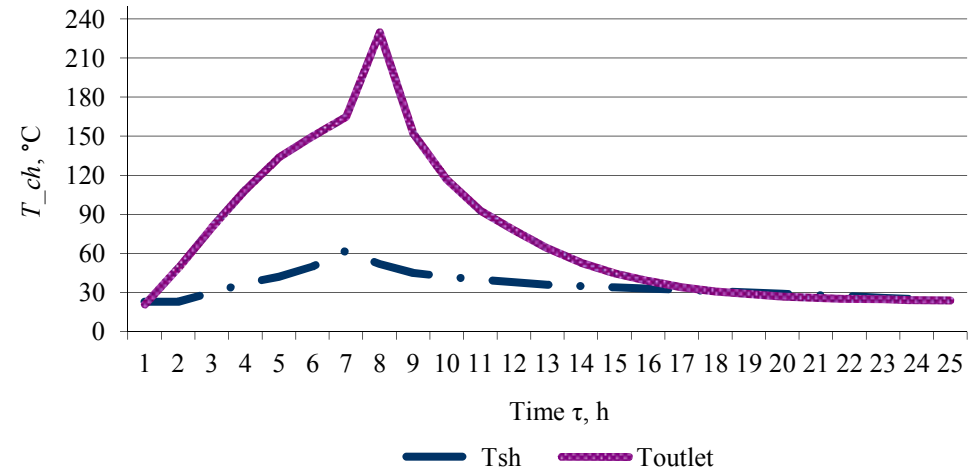
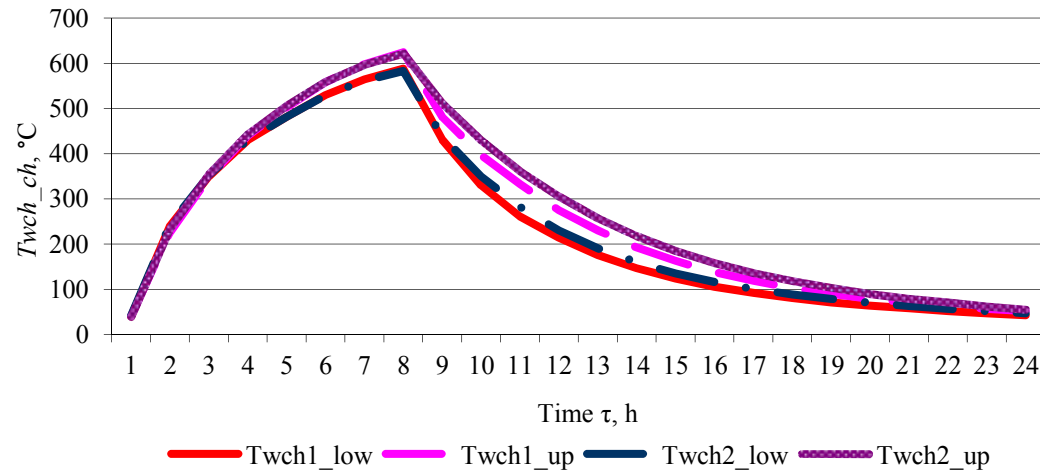
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Keywords: electric thermal storage, heat storage element, the charging and the heat output modes, rate of heating and cooling, chamotte, magnesite

Results

Results of experimental studies of thermal and dynamic characteristics of ETS (chamotte)



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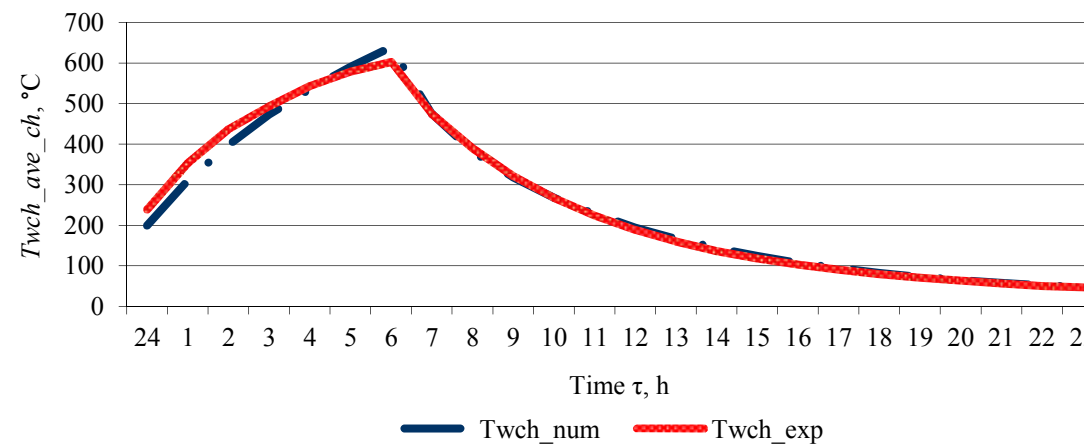
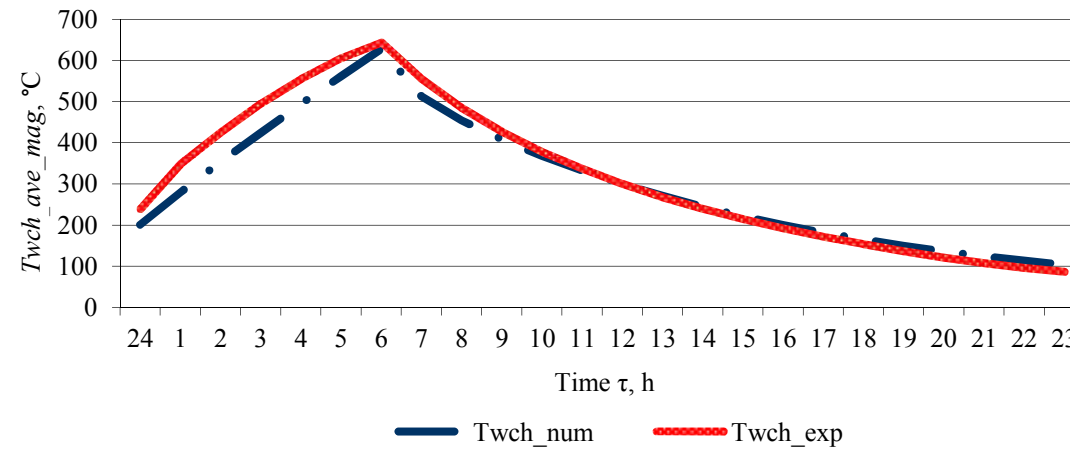
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Results

Verification of the results of numerical simulation of heat exchange processes in heat storage elements made of chamotte and magnesite with the results of experimental studies



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Results

As a result of experimental studies were obtained: 1. The temperature change T_{wch} walls of the air channels of the heat storage elements with slit-shaped and round-shaped channels made of magnesite and chamotte in lower and upper zones in the modes of charging and heat output of ETS; 2. The temperature change of the heated air T_{air_wch} in the channels of heat storage elements with channels of slit-shaped and round-shaped channels made of magnesite and chamotte in lower and upper zones in the modes of charging and heat output of ETS; 3. The temperature change of the thermal insulation T_{in} in lower and upper zones of ETS; 4. The temperature change on the surface of the housing T_{sh} and the temperature change of the heated air at the outlet of ETS T_{outlet} .

The calculated average cooling rate of heat storage elements based on the obtained experimental data $m_{mag} = 9,28 \cdot 10^{-5} \text{ s}^{-1}$ и $m_{ch} = 1,54 \cdot 10^{-4} \text{ s}^{-1}$ confirms the dynamics of temperature changes of heat storage elements made of magnesite and chamotte in the ETS heat output mode. The rate of heating of heat storage elements made of magnesite varies during the ETS charging mode from $3,39 \cdot 10^{-4}$ to $1,94 \cdot 10^{-5} \text{ s}^{-1}$, for heat storage elements made of chamotte – from $7,22 \cdot 10^{-4}$ to $1,39 \cdot 10^{-5} \text{ s}^{-1}$.

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Conclusions

As a result of the experimental studies of the thermal characteristics of ETA, data on the temperature change in the heat storage elements made of magnesite and chamotte during the period of charging and heat output of ETS, as well as the values of the temperature of the heated air in the channels of the heat storage elements, at the outlet from ETS, the temperature change in the thickness of the thermal insulation, as well as on the surface of the ETS housing, were obtained.

The limiting basic and root-mean-square errors of temperature measurements by thermocouples ChA (K) and ChC (L) in the range from 50 to 650 °C were calculated.

The dynamics of heating and cooling of heat storage elements made of magnesite and chamotte in the modes of charging and heat transfer of ETS is analyzed.

The average rate of heating and cooling of heat storage elements made of magnesite and chamotte in the modes of charging and heat output of ETS is calculated.

The noted features of the temperature distribution, as well as the dynamics of heating and cooling of heat storage elements, are also traced in the results of theoretical studies, which are in qualitative agreement with the obtained experimental data (the discrepancy is no more than 15%).

The proposed ETS design with heat storage elements made of chamotte with round-shaped channels provides a more efficient heat output when using a cheaper heat storage material compared to the standard ETS design with heat storage elements made of magnesite with slit-shaped channels.

References

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Thank you for your attention!

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Affiliations: Federal State Budgetary Scientific Institution "Federal Scientific Agroengineering Center VIM"

Contact details: Moscow, 1st Institutskiy proezd, 5, tel. 8 (499) 171-43-49
