

# **IV International Scientific-Technical Conference**

**6–8 February 2020, Kielce**  
(Poland, Ukraine, Croatia, Slovakia, Sweden, USA)

## **ACTUAL PROBLEMS OF RENEWABLE POWER ENGINEERING, CONSTRUCTION AND ENVIRONMENTAL ENGINEERING**

**Book of abstracts**

Part II

KIELCE 2020

6-8 February 2020, Kielce (Poland, Ukraine, Croatia, Slovakia, Sweden, USA)

Under the general editorship Prof. doctor of science Anatolij Pavlenko

**The organizers:**

- Kielce University of Technology, Faculty of Environmental, Geomatic and Energy Engineering (Poland)
- Koszalin University of Technology, Faculty of Civil Engineering, Environment and Geodetic Sciences (Poland)
- Ivano-Frankivsk National Technical University of Oil and Gas (Ukraine)
- The European Academy of Education and Science (Ukraine - Poland)
- KTH Royal Institute of Technology, Department of Chemical Engineering (Sweden)
- University of Zagreb Faculty of Metallurgy (Croatia)
- National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" (Ukraine)
- Smart Heat Corporation, Skokie, Illinois (USA)
- University of Žilina Department of Power Engineering (Slovakia)

**Scientific and organizing committee of the conference:**

**Co-organizers:**

- Prof. PŚk doctor of science LIDIA DĄBEK – Faculty of Geomatic and Energy Engineering, Kielce University of Technology (Poland)
- Prof. doctor of science ANATOLIY PAVLENKO – Department of Building Physics and Renewable Energy, Kielce University of Technology (Poland)
- Prof. PK doctor of science WIESŁAWA GŁODKOWSKA – Department of Concrete Structures and Concrete Technology, Koszalin University of Technology (Poland)
- Prof. doctor of science ALEKSANDER SZKAROWSKI – Department of Construction Networks and Systems, Koszalin University of Technology (Poland)
- Prof. doctor of science HANNA KOSHLAK – Department of Building Physics and Renewable Energy, Kielce University of Technology (Poland)
- Prof. doctor of science ENGVALL KLAS – Department of Chemical Engineering (Sweden)
- Prof. doctor of science LADISLAV LAZIĆ – Faculty of Metallurgy University of Zagreb (Croatia)
- Prof. doctor of science MILAN MALCHO – Department of Power Engineering (Slovakia)
- Doctor of science ANDREJ KAPJOR – Department of Power Engineering (Slovakia)
- Prof. doctor of science OLEG MANDRYK – Ivano-Frankivsk National Technical University of Oil and Gas (Ukraine)
- Doctor of science HELEN SKOP – Smart Heat Corporation (USA)
- Prof. doctor of science VALERII DESHKO – National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" (Ukraine)

© Copyright by Politechnika Świętokrzyska, Kielce 2020

ISBN 978-83-65719-84-3

Wydawnictwo Politechniki Świętokrzyskiej  
25-314 Kielce, al. Tysiąclecia Państwa Polskiego 7  
tel./fax 41 34 24 581  
e-mail: wydawca@tu.kielce.pl  
www.wydawnictwo.tu.kielce.pl

## Participation without presentation

<b>CFD-SIMULATION OF HEAT TRANSFER AND HYDRODYNAMICS PROCESSES IN THE HEAT ACCUMULATOR TANK</b> <i>VG. Demchenko, AV. Baraniuk</i> .....	120
<b>ANALYSIS OF ACCURACY DESCRIPTION PROPERTIES OF SUBSTANCES</b> <i>V. Volchok, H. Volchok</i> .....	121
<b>EXPERIMENTAL RESEARCH OF THE DRYING GRAIN MATERIALS AT VARIOUS HEAT SUPPLY</b> <i>I. Mukminov, O. Bondarenko</i> .....	123
<b>INVESTIGATION OF GAS FLOW IN THE ENERGY EFFICIENT CENTRIFUGAL COMPRESSOR CHANNEL DIFFUSERS</b> <i>M. Kalinkevych, M. Radchenko</i> .....	123
<b>TECHNICAL COMPONENTS OF ECOLOGICALLY SAFE INSTALLATION OF SMALL HYDRO POWER PLANTS IN THE UKRAINIAN CARPATHIANS</b> <i>L. Arkhytova, O. Mandryk</i> .....	125
<b>SOLAR PHOTOELECTRIC STANCE IN THE ELECTRICAL SYSTEM OF THE SCHOOL</b> <i>Dubrovska V., Shklyar V., Hlovatskiy D., Biriukov D</i> .....	128
<b>NUMERICAL STUDY OF AIR-FILLED ANTENNA ARRAY GRID PARAMETERS</b> <i>Alexander M. Syanov, Elena S. Kosukhina, Valery V. Maluk, Alexey V. Kosukhin</i> .....	130
<b>USE OF n-CdTe SINGLE-CRYSTAL SUBSTRATES IN SOLAR POWER ENGINEERING</b> <i>Mazur T.M., Mazur M.P</i> .....	131
<b>INCREASING THE EFFICENCY OF AIR CONDITIONING SYSTEMS THROUGH RATIONAL DISTRIBUTION OF THERMAL LOAD</b> <i>M. Radchenko, E. Trushliakov, O. Shchesiuk, S. Forduy, V. Tkachenko</i> .....	132
<b>DEVELOPMENT OF SUN AIR HEATERS FOR MODERNIZATION OF GRAIN DRYERS</b> <i>I. Boshkova, N. Volgusheva</i> .....	133
<b>THERMAL CONDUCTIVITY OF THE WET POLLUTION LAYER ON CONDENSING HEATING SURFACES OF EXHAUST GAS BOILERS</b> <i>V. Kornienko, R. Radchenko, A. Stachel, M. Pyrysyunko, I. Kalinichenko</i> .....	134
<b>STUDYING THE OPERATION OF TWO-STAGE SODIUM-CATION INSTALLATION SF-10A</b> <i>Tetiana Kovalenko, Stepan Lys, Vitalii Serdiuk</i> .....	137
<b>THE INFLUENCE OF THE POWER TRANSFORMER RADIAL CHANNEL WINDING PROFILE ON THE KIND OF THE COOLANT CIRCULATION</b> <i>S. Ilin</i> .....	138
<b>EFFECTIVITY OF USING SOLAR COLLECTORS IN SCHOOL HEATING SUPPLY SYSTEMS</b> <i>Dubrovska V., Shklyar V., Hanzha D</i> .....	139
<b>ELECTRICAL PROPERTIES OF THIN LAYERS OF CdTe OBTAINED BY CHEMICAL OBTAINED ALLOYING WITH CALCIUM IONS</b> <i>Prokopiv V.V., Mazur T.M., Dzundza B.S., Matkivskiy O.M</i> .....	141
<b>EXPERIMENTAL DETERMINATION OF PRESSURE LOSS IN A LOW-FLOW AEROTHERMOPRESSOR WITH INCOMPLETE EVAPORATION</b>	

## ANALYSIS OF ACCURACY DESCRIPTION PROPERTIES OF SUBSTANCES

**V. Volchok, H. Volchok**

Odessa National Academy of Food Technologies,  
112 Kanatnaya Str., Odessa, 65039, Ukraine  
E-mail: recvicv@gmail.com

There has been accumulated a sufficient quantity of the material on the topic of the thermophysical properties of pure refrigerants. The analysis of the existing methods to determine the thermodynamic properties (TP) of mixtures of substances shows that they have no predictive capabilities. Therefore, in practice, either one or another model approach of describing the thermodynamic behavior of mixtures is used, refined on the basis of experimental data.

These include the unified equations of state, which are single-structural forms that allow reproducing TP with a given small error, both liquid and gaseous mixtures. For a multicomponent system, the equations of state (ES) is a thermodynamic model of the equilibrium vapor and liquid phases separately.

It is known that using ES, one can reveal the dependence of thermodynamic functions on  $v$  and  $P$ , integrate differential thermodynamic relations, calculate the volatility (fugacity) of system components, through which phase equilibrium conditions are usually written. In addition, it is possible to establish a connection between the equations of state and any of the thermodynamic potentials of the system, expressed as a function of its natural variables.

The use of these equations for describing the state of matter at high densities is associated with the complexity of determining higher-order virial coefficients. In this regard, there have recently been created the empirical equations of state in which pressure is presented as a polynomial in density with coefficients depending on temperature. These equations also contain an exponential term introduced to compensate for higher-order terms of the virial equation.

To conduct a comparative analysis of various forms of ES, in order to identify their capabilities in describing the thermodynamic surface of binary zeotropic mixtures of refrigerants, three widely used ES were selected and the results of TP calculation were compared according to the original version of the Peng-Robinson (PR) [1], modified by Lee-Kesler (LK) [2] and the Helmholtz free energy equation (HFE) [3] with optimal cross parameters.

The fundamental impossibility of a simultaneous accurate description of the critical point parameters of individual substances and mixtures based on them did not allow accurate reproduction of the experimental data by cubic ES PR. On the whole, the ES PR compared with multiconstant ES showed a fairly acceptable accuracy for engineering calculations.

A comparative analysis of various forms of ES was carried out using experimental data on the boiling pressure and density of binary zeotropic mixtures of refrigerants. At the same time, to find the cross-section coefficients of the ES LK and HFE, we took into account the entire array of experimental data obtained both in this work and the data of other authors, taking into account the errors of the measured values.

The comparison showed that the experimental values of the boiling pressure of binary zeotropic mixtures of refrigerants are quite adequately consistent with the data published by a number of authors. This allowed us to rely on these results with confidence.

A detailed comparison of the three ES forms in describing the boiling pressure of the ternary mixture, R401A refrigerant, showed that the cubic ES PR using limited information and without taking into account the interaction of the mixture components ( $\theta_{ij} = 1$ ) is in satisfactory agreement with experimental data.

In some cases, the multiconstant state of the ES LK is superior in accuracy to the state of HFE for binary mixtures of refrigerants, but in general it is inferior to it when describing the thermodynamic surface of a multicomponent mixture.

The model for the description of TP of substances of multicomponent mixtures of refrigerants, based on the corrected parameters of the ES HFE, gives an opportunity for more realistic description of the available experimental data, compared with other methods based on the rules for combining ES constants.

#### References

1. Peng, D. Y. A New Two-Constant Equation of State / D. Y. Peng, D. B. Robinson // Ind. Eng. Fundam. - 1976. – Vol. 15. – pp. 59–64.

2. Kesler, M.G., B.I. Lee. Improve prediction of enthalpy of functions. Hydrocarbon Processing. 1976, vol. 55, no, 3, pp. 153-158. ISSN 0018-8190.

3. Lemmon, E.W., M.L. Huber, M.O. McLinden. NIST Standard Reference Database 23: Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 9.0. Standard Reference Data Program. USA, Gaithersburg: National Institute of Standards and Technology, 2010.

## EXPERIMENTAL RESEARCH OF THE DRYING GRAIN MATERIALS AT VARIOUS HEAT SUPPLY

I. Mukminov, O. Bondarenko

*Odessa National Academy of Food Technologies*

*1/3 Dvoryanska Str. Odesa, 65082, Ukraine*

E-mail: [fatalrew@gmail.com](mailto:fatalrew@gmail.com)

The work was carried out with the aim of establishing a rational method of supplying heat including a combination of microwave heating.

The experiments were conducted with a dense layer of oats at a fixed initial moisture content on the experimental setup, which provides research with microwave, microwave-convective and convective drying.

Research of the drying kinetics were conducted on the following modes: pulsed and continuous microwave energy supply, microwave-convective supply, cyclic and continuous, and convection.

In pulsed mode the microwave supply periods alternating with pauses.

We research the effect of the power-on time of the magnetron  $\tau_{MW}$  and pauses  $\tau_p$  on the regularities of changes in temperature and moisture content of the material, drying speed and specific energy consumption.

In the experiments to measure the power of the magnetron, the initial and final masses ( $m_0$ ,  $m_f$ ) and temperature ( $t_0$ ,  $t_f$ ), the duration and number of inclusions magnetron ( $\tau_{MW}$ ,  $n_{MW}$ ) and pauses ( $\tau_p$ ,  $n_p$ ).