

Polish Academy of Sciences
University of Engineering and Economics in Rzeszów
University of Life Sciences in Lublin
Faculty of Production Engineering

TEKA

COMMISSION OF MOTORIZATION AND ENERGETICS IN AGRICULTURE

**AN INTERNATIONAL QUARTERLY JOURNAL
ON MOTORIZATION, VEHICLE OPERATION,
ENERGY EFFICIENCY AND MECHANICAL ENGINEERING**

Vol. 16, No 4

LUBLIN–RZESZÓW 2016

Editor-in-Chief: *Eugeniusz Krasowski*

Assistant Editor: *Andrzej Kusz*

Associate Editors

1. Motorization and vehicle operation: *Kazimierz Lejda*, Rzeszów, *Jaromir Mysłowski*, Szczecin
2. Mechanical engineering: *Janusz Laskowski*, Lublin, *Adam Dużyński*, Częstochowa
3. Energy efficiency: *Witold Niemiec*, Rzeszów, *Stepan Kovalyshyn*, Lviv
4. Mathematical statistics: *Andrzej Kornacki*, Lublin

Editorial Board

Dariusz Andrejko, Lublin, Poland
Andrzej Baliński, Kraków, Poland
Volodymyr Bulgakow, Kiev, Ukraine
Aleksandr Dashchenko, Odessa, Ukraine
Kazimierz Dreszer, Lublin, Poland
Dariusz Dziński, Lublin, Poland
Jan Gliński, Lublin, Poland
Jerzy Grudziński, Lublin, Poland
Janusz Grzelka, Częstochowa, Poland
Bohdan Hevko, Ternopil, Ukraine
Aleksandr Hotubenko, Lugansk, Ukraine
L.P.B.M. Jonssen, Groningen, Holland
Józef Kowalczyk, Lublin, Poland
Volodymyr Kravchuk, Kiev, Ukraine
Elżbieta Kusińska, Lublin, Poland
Andrzej Marezuk, Lublin, Poland
Leszek Mościcki, Lublin, Poland
Janusz Mysłowski, Szczecin, Poland
Stanisław Nikotajenko, Kiev, Ukraine
Paweł Nosko, Lugansk, Ukraine
Gennadij Oborski, Odessa, Ukraine

Yurij Osenin, Lugansk, Ukraine
Marian Panasiewicz, Lublin, Poland
Sergiy Pastushenko, Mykolayiv, Ukraine
Iwan Rohowski, Kiev, Ukraine
Marek Rozmus, Lublin, Poland
Povilas A. Sirvydas, Kaunas, Lithuania
Volodymyr Snitynskiy, Lviv, Ukraine
Stanisław Sosnowski, Rzeszów, Poland
Ludvikas Spokas, Kaunas, Lithuania
Andrzej Stępniewski, Lublin, Poland
Michail Sukach, Kiev, Ukraine
Aleksandr Sydoruk, Kiev, Ukraine
Wojciech Tanaś, Lublin, Poland
Giorgiy F. Tayanowski, Minsk, Bielarus
Andrey Tevyashev, Kharkiv, Ukraine
Denis Viesturs, Ulbrok, Latvia
Dmytro Voytiuk, Kiev, Ukraine
Janusz Wojdalski, Warszawa, Poland
Anatoliy Yakovenko, Odessa, Ukraine
Tadeusz Złoto, Częstochowa, Poland

All the articles are available on the webpage: <http://www.pan-ol.lublin.pl/wydawnictwa/Teka-Motrol.html>

All the scientific articles received positive evaluations by independent reviewers

Linguistic consultant: *Małgorzata Wojcieszuk*

Typeset: *Adam Niezbecki*

Cover design: *Hanna Krasowska-Kotodziej*

© Copyright by Polish Academy of Sciences 2016

© Copyright by University of Engineering and Economics in Rzeszów 2016

© Copyright by University of Life Sciences in Lublin 2016

In co-operation with Volodymyr Dahl East-Ukrainian National University of Severodoneck 2016

Editorial Office address

Polish Academy of Sciences Branch in Lublin
Pałac Czartoryskich, Plac Litewski 2, 20-080 Lublin, Poland
e-mail: eugeniusz.krasowski@up.lublin.pl

Printing

elpil
Artyleryjska Str. 11, 08-110 Siedlce, Poland
e-mail: info@elpil.com.pl

ISSN 1641-7739

Edition 60+16 vol.