

HEAT PIPES, HEAT PUMPS, REFRIGERATORS, POWER SOURCES

Proceedings of the VII Minsk International Seminar
Held in Minsk, Belarus, 8–11 September 2008

NIS Scientific Association “Heat Pipes”
National Academy of Sciences of Belarus
Luikov Heat & Mass Transfer Institute
Belarussian National Technical University

Minsk 2008

УДК 536.248.2:621.57

Публикуются доклады, представленные на VII Минский международный семинар «Тепловые трубы, тепловые насосы, холодильники, источники энергии» (8–11 сентября 2008 г.) и посвященные актуальным проблемам развития и совершенствования холодильной техники, теплообменного оборудования, энергосберегающих систем нагрева, охлаждения, кондиционирования.

Редакционная коллегия:

доктор техн. наук

канд. техн. наук

Л. Л. Васильев

А. С. Журавлев

Л. В. Драгун

ISBN 978-985-6456-62-9

© Институт тепло- и массообмена
им. А. В. Лыкова НАН Беларуси,
2008

THE SEMINAR IS SUPPORTED AND SPONSORED BY

- National Academy Of Sciences Of Belarus
- Luikov Heat & Mass Transfer Institute, Minsk, Belarus
- NIS Scientific Association “Heat Pipes”
- Iberica del Espacio SA, Madrid, Spain
- TAIS Company, Moscow, Russia
- Academician M. F. Reshetnev “Information Satellite Systems”, Zheleznogorsk, Krasnoyarsk Territory, Russia
- PETROBRAS SA, Rio de Janeiro, Brazil

The Jubilee Conference “VII Minsk International Seminar “Heat Pipes, Heat Pumps, Refrigerators, Power Sources” is guided by

NATIONAL HONORARY ORGANIZING COMMITTEE

P. A. Vitiaz	<i>Chairman</i> , 1st Vice-Chairman of the Presidium National Academy of Sciences of Belarus
S. A. Zhdanok	<i>Vice-Chairman</i> , Academician-Secretary of the Branch of Physical and Technical Problems, Director of Heat & Mass Transfer Institute of National Academy of Sciences of Belarus
A. M. Rusetskiy	Minister of Industry of Republic of Belarus
L. V. Shenets	Director of the Department of Energy Efficiency, the State Committee of Standardization of Republic of Belarus
V. V. Mayorov	Chief Director of the Open Joint-Stock Company “Beltransgaz”
V. E. Matyushkov	Chairman of the Science and Technologies State Committee
B. M. Khrustalev	Rector of Belorussian National Technical University
V. A. Orlovich	Chairman of Council of Directors of Belorussian Republican Foundation for Fundamental Research
A. F. Iliuschenko	Chief Director of the Belorussian State Scientific and Production Concern of Powder Metallurgy
M. L. German	Director of the Republican Unitary Enterprise “Belarusian Fuel and Energy Institute”

INTERNATIONAL SCIENTIFIC COMMITTEE

Prof. L. Vasiliev (Chairman)	Belarus	Prof. Y. Kato	Japan
Prof. S. Kakaç (Co-Chairman)	Turkey	Prof. S. Khandekar	India
Prof. A. Alexandre	France	Prof. Y. Lee	Canada
Prof. Yu. Aristov	Russia	Prof. J.-C. Legros	Belgium
Dr. V. Buz	Ukraine	Prof. Yu. Maydanik	Russia
Prof. P. Cerisier	France	Prof. J. Mikielewicz	Poland
Prof. G. Chen	China	Dr. R. Mongia	USA
Prof. S. Colle	Brazil	Prof. S. Murthy	India
Prof. R. Cotta	Brazil	Dr. D. Nikanpour	Canada
Prof. R. Critoph	UK	Prof. J. Ochterbeck	USA
Prof. A. Delil	The Netherlands	Prof. H. Ogawa	Japan
Prof. V. Dhir	USA	Prof. M. Ohadi	USA/UAE
Prof. A. Faghri	USA	Prof. M. Poniewski	Poland
Dr. K. Fujioka	Japan	Prof. D. Reay	UK
Dr. K. Goncharov	Russia	Prof. S. Riffat	UK
Prof. M. Groll	Germany	Prof. H. Smirnov	Ukraine
Prof. I. Imris	Slovakia	Dr. A. Torres	Spain
		Prof. R. Wang	China

FOREWORD

This volume contains an archival record of the Seventh Minsk International Conference “HEAT PIPES, HEAT PUMPS, REFRIGERATORS, POWER SOURCES” lectures and presentations.

This Conference is Jubilee because fifteen years ago in 1993 the first Minsk Seminar was organized on this topic.

The Conference took place on September 7- 11, 2008 in Minsk, Belarus with more than 80 participants from 17 countries and is aimed at enhancing the dialogue between the multiple groups and actors involved in the development, transfer and application of renewable energy technologies, heat pipes, heat pumps, refrigerators and new power sources of energy. The central part of the Program is devoted to heat pipe thermal control of space vehicles. Renewable energies are the key players regarding world energy supply security and the reduction of fossil fuel dependency and harmful emissions to the environment. In recent years, fuel cells development, modeling and performance analysis has received much attention due to their potential for distributed power which is a critical issue for energy security and the environmental protection. The golden combination of the modern heat transfer components (heat pipes), efficient energy recovery systems (sorption heat machines) and the new power sources of energy (fuel cells) is an efficient tool to solve the above mentioned problems. The market for portable electronics now is much more accessible to fuel cells than automotive applications. For example, the development of cellular phones with digital broadcast reception may spur the integration of fuel cells into these devices. The automotive fuel cells application with hybrid power systems functioning in cars, planes and tracks is also very promising; the fuel cells converting the fuel directly into electricity are to be functioning without combustion or mechanical energy. In residential sector with the internal combustion engines, polymer electrolyte fuel cells (PEFCs), and solid oxide fuel cells (SOFCs) are welcomed as micro-CHP.

The Conference provides a forum for persons involved in research, development, design and operation of heat pipes, heat pumps, refrigerators, cooling and heating systems, power sources, energy storage and transportation systems and will also be of interest for scientists and engineers working in areas such as heat and mass transfer science, energy management and pollution control. Fundamental and experimental research of the basic processes connected with physical phenomena in heat pipes, thermosyphons, heat pumps, refrigerators, solid and liquid sorption heat machines (heat and mass transfer in capillary systems and porous media with or without chemical transformations, two-phase flows, interface phenomena, processes of sorption, boiling, evaporation and condensation), modelling of heat pipes (variable conductance, cryogenic, miniature/micro, CPL, LHP, pulsating, revolving and rotating) and solid sorption devices start-up, steady-state and transient performances. Permafrost phenomena and heat pipe thermal control of the ground is the subject of the Conference presentations.

During the four working days of the Conference the invited lecturers and participants covered fundamentals and applications of different kinds of the heat and mass transfer in different devices.

The 7th Minsk Jubilee Conference Proceedings incorporate 66 papers, including 17 invited lectures.

I wish to express my sincere thanks to the International Scientific Committee, Belarusian Honorary Scientific Committee and the Conference organizers: National Academy of Sciences of Belarus, Luikov Heat & Mass Transfer Institute, Belarusian Republican Foundation for Fundamental Research, Belorussian National Technical University, Minsk, Belarus, and NIS Scientific Association “Heat Pipes”. The sponsorship of the Conference is gratefully acknowledged, particularly National Academy of Sciences of Belarus, Belarusian Republican Foundation for Fundamental Research, Luikov Heat & Mass Transfer Institute, Iberica del Espacio SA, Madrid, Spain, PETROBRAS SA, Rio de Janeiro, Brazil, TAIS Company, Moscow, Russia, “Academician M.F. Reshetnev “Information Satellite Systems” Joint Stock Company (ISS JSC), Zheleznogorsk, Krasnoyarsk Territory, Russia.

We are also very grateful to all participants, who helped us in organizing this Conference and whose efforts made the Conference a success.

September 2008, Minsk, Belarus

Leonard L. Vasiliev
Conference Chairman