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Book review

Heat Pipes and Solid Sorption Transformations: Fundamentals and Practical Applications, Edited L.L. Vasiliev, Sadik Kakac (Eds.). CRC Press, Taylor & Francis Group, Florida, USA (May, 2013). p. 518 (Hardback), Publisher's price: £89.00, ISBN: 978-1-4665-6414-5

In the words of the publisher: "Developing clean energy and utilizing waste energy has become increasingly vital. Research targeting the advancement of thermally powered adsorption cooling technologies has progressed in the past few decades, and the awareness of fuel cells and thermally activated (heat pipe heat exchangers) adsorption systems using natural refrigerants and/or alternatives to hydrofluorocarbon-based refrigerants is becoming ever more important. **Heat Pipes and Solid Sorption Transformations: Fundamentals and Practical Applications** concentrates on state-of-the-art adsorption research and technologies for relevant applications based on the use of efficient heat transfer devices—heat pipe and two-phase thermosyphons—with the objectives of energy efficiency and sustainability. This book also discusses heat pipe thermal control as it relates to spacecraft applications".

The book is a collection of Chapters written by experts in their fields, and the contents are listed at the end of this Review. Readers of this journal will be familiar with the contributions of Leonard Vasiliev, who has been associated with Applied Thermal Engineering since its conception. He is an expert in porous media, heat pipes, adsorption and heads the Porous Media Laboratory at the A.V. Luikov Heat and Mass Transfer Institute in Minsk. Sadik Kakac is in the Department of Mechanical Engineering, TOBB University of Economics and Technology in Ankara, and hold positions at several other Universities, including the University of Miami.

The first Chapter, 'A Review of Modeling Approaches to Heat and Mass Transfers in Porous Wicks' has the laudable aim of presenting tools that may assist the designer of a variety of heat pipe types (including loop heat pipes) to model their performance, thus reducing the number of experiments needed. The solution is not complete, however, as 3D modelling of pore networks is, say the authors, still needed, particularly where two-phase phenomena are taking place.

Adsorption cycles – both in the context of cooling and the heat transformer (a device that appears less popular now than twenty years ago – possibly due to poor economics) – are dealt with in Chapters 2 and 3. In the cooling case, much is made of a cooler/desalination unit employing three adsorption beds and two evaporators, while in the case of heat transformers, the dynamics of three machines is given emphasis. Examples of work in Italy, Russia and the United Kingdom (the latter being centred on the University of Warwick) are discussed.

A Chapter on boiling mechanisms is followed by a review of heat pipe applications with a bias towards uses where greenhouse gas emissions can be minimised. These include heat pipe cold storage systems for data centres, loop heat pipes for large scale geothermal heat extraction, and their use in conjunction with phase change materials (PCMs) for heat collection. It includes a sketch of what may be the largest heat pipe ever proposed – a 10 km long, 1 km in diameter unit for taking heat from the ground area in cities. Professor Vasiliev and L.L. Vasiliev, Jr. are authors of the next Chapter (6) on the thermal management of solid sorption machines and fuel cells using heat pipes and thermosyphons. The former, in particular, has been a major area of activity at the Luikov Institute in Minsk for many years and this is illustrated by the wide variety of concepts presented here. More recent work on micro-heat pipes and the application of nano-coatings and nano-fluids into the heat pipe area are reviewed, and of particular interest to this reviewer is the introduction of the micro heat pipe effect in porous media, that to some extent mirrors work on heat transfer by evaporation/condensation within human sweat ducts. Several members of the group at the Luikov Institute follow this with two Chapters on modelling of adsorption systems followed by the application of such systems (in conjunction with heat pipes) for hydrogen gas storage and transportation.

Mikhail Bezrodny of Kiev examines in Chapter 9 a variety of aspects of two-phase thermosyphons, with an emphasis on materials compatibility and the properties of the working fluids. While interesting, the data rely a little too much on examples of fluids that are largely shown to be unsuccessful (sulphur) or are CFCs (R12, R113, for example). This is followed by a chapter on space applications of variable conductance heat pipes (VCHPs) that are excellent for precise thermal control. They are additionally becoming increasingly of interest for terrestrial applications, in conjunction, for example, with thermal storage.

Thermosyphons are again featured in a Chapter by Marcia Mantelli from Brazil. Entitled 'Thermosyphon Technology for Industrial Applications' the text concentrates upon the heat transfer limits, design and construction of units, with only 8 pages being assigned to applications. Again, some toxic or banned fluids are included in the lists of working fluids presented, but the procedures for assembly are very useful for PhD students etc. starting to work in this field.

No heat transfer book is complete without a section devoted to flow and heat transfer in micro-channels, and the final Chapter in this book, by Kuznetsov and Safonov from Novosibirsk in Siberia, deals with two-phase flow in micro- and mini-channels. There is a natural emphasis on the application of the data and correlations to channels that are appropriate to those that include capillary-driven flows, as one would see in heat pipes, with flow boiling being examined, allowing an appropriate extension of the Liu-Winterton model to micro-scale behaviour.

In summary, there are very useful data in this collection, particularly on the solid sorption aspects and the use of heat pipes therein. Much of the general data on heat pipes and boiling heat

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transfer can be found in other literature, but it is very useful to have a different perspective, as presented here, especially relating to the applications implicit in the title of the text.

A list of Chapters and their authors is given below.

Professor David Reay
David Reay & Associates

List of Chapters and Authors

A Review of Modelling Approaches to Heat and Mass Transfers in Porous Wicks
Sassi Ben Nasrallah and Marc Prat
Thermally Powered Adsorption Cooling: Recent Trends and Applications
B.B. Saha and I.I. El-Shakawy
Optimisation of Adsorption Dynamics in Adsorptive Heat Transformers: Experiment and Modelling
Yuri I. Aristov
Mechanisms of Intensive Heat Transfer for Different Modes of Boiling
Victor V. Yagov
A Review of Practical Applications of Heat Pipes and Innovative Application of Opportunities for Global Warming
M. Mochizuki, A. Akbarzadeh and T. Nguyen
Heat Pipes and Thermosyphons for Thermal Management of Solid Sorption Machines and Fuel Cells
L.L. Vasiliev and L.L. Vasiliev Jr.
Modeling of Heat and Mass Transfer in Sorption and Chemisorption Heat Converters and Their Optimisation
L.L. Vasiliev, O.S. Rabinovich, N.V. Pavlyukevich and M.Yu. Liakh
Sorption Systems with Heat Pipe Thermal Management for Hydrogenous Gas Storage and Transportation
L.L. Vasiliev and L.E. Kanonchik
Fundamental Questions of Closed Two-Phase Thermosyphons
M.K. Bezrodny
Thermal Control Systems with Variable Conductance Heat Pipes for Space Application: Theory and Practice
V.M. Baturkin
Thermosyphon Technology for Industrial Applications
Marcia B.H. Mantelli
Fluid Flow and Heat Transfer with Phase Change in Minichannels and Microchannels
V.V. Kuznetsov and S.A. Safonov

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