

# **12th IIR Conference on Phase Change Materials and Slurries for Refrigeration and Air Conditioning (PCM 2018)**

Refrigeration Science and Technology Proceedings 2018-02

Orford, Canada  
21 - 23 May 2018

ISBN: 978-1-5108-6835-9

**Printed from e-media with permission by:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571



**Some format issues inherent in the e-media version may also appear in this print version.**

Copyright© (2018) by International Institute of Refrigeration  
All rights reserved.

Printed by Curran Associates, Inc. (2018)

For permission requests, please contact International Institute of Refrigeration  
at the address below.

International Institute of Refrigeration  
177 Boulevard Maiesherbes  
75017 Paris  
France

Phone: +33 1 42 27 32 35

Fax: +33 1 47 63 17 98

[iifiir@iifiir.org](mailto:iifiir@iifiir.org)

**Additional copies of this publication are available from:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571 USA  
Phone: 845-758-0400  
Fax: 845-758-2633  
Email: [curran@proceedings.com](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

# Final Program

Sunday, the 20th of May 2018		
17-19 pm	Registration Welcome Cocktail	Orchestre Bistro
Monday, the 21st of May 2018		
8-9 am: Registration		
Time	Activity	Room
9 – 9.25	Opening ceremony *Prof. Sébastien Poncet, Conference chair *Dr Ina Colombo, IIR Deputy Director General *Dr Laurence Fournaison, Chairperson on the IIR working group on “Phase-Change Materials and Slurries for Refrigeration and Air Conditioning”	Orchestre
9.25-10.20	Keynote Lecture 1 : <u>Dominic Groulx</u> (Dalhousie University) <i>The Rate Problem: Search for Application Specific Optimization of Energy Storage Density and Exchange Rate .....1</i>	Orchestre
10.20-10.40	Coffee break	Orchestre
10.40-12.00	Session 1 chaired by Dr Hakim Nesreddine (Lab. Technologies Energie, Hydro-Québec)	Orchestre
10.40-11.00	<u>Alexis Sevault</u> (SINTEF), K. Banasiak, J. Bakken, A. Hafner <i>A novel PCM accumulator for refrigerated display cabinet: design and CFD simulations .....10</i>	Orchestre
11.00-11.20	<u>Saad Akhtar</u> (McGill University), A. Madiseh, A. P. Sasmito <i>Numerical investigation of a novel phase-change renewable energy system for underground mine heating and cooling .....17</i>	Orchestre
11.20-11.40	<u>Mahmood Mastani Joybari</u> (Concordia University), F. Haghghat, A. Moreau, Y. Yuan <i>A front tracking method for melting of phase change materials .....25</i>	Orchestre
11.40-12.00	<u>Gonzalo Diarce</u> (University of the Basque Country), A. Campos-Celador, L. Quant, A. Garcia-Romero <i>A simple and fast methodology for the design of plate-based LHTES systems .....34</i>	Orchestre
12.00-13.30	Lunch	Salle à manger
13.30-15.30	Session 2 chaired by Dr Laurence Fournaison (IRSTEA)	Orchestre
13.30-13.50	<u>Eneja Osterman</u> (University of Ljubljana), U. Stritih <i>Parametrical analysis of PCM thermal storage system for heating and cooling of buildings – Paper 010 .....40</i>	Orchestre
13.50-14.10	<u>Yuka Kusama</u> (University of Tokyo), Y. Ishidoya <i>Measurement results of indoor environment and energy saving in experimental residences constructed with PCM plaster in Hokkaido (Japan) .....48</i>	Orchestre
14.10-14.30	J. Vennapusa, K. Singh, <u>Sujay Chattopadhyay</u> (IIT Roorkee) <i>Development of PCM based packaging material for thermal buffering .....54</i>	Orchestre
14.30-14.50	S. Asfour, P. Tittelein, <u>Laurent Zalewski</u> (Université d’Artois) <i>Dynamic study efficiency of the use of phase change materials integrated on the ceiling of a community hall .....62</i>	Orchestre
14.50-15.10	<u>Andreas Hantsch</u> (Institute of Air Handling and Refrigeration, Dresden) <i>Energetic effects of flow through wall elements with phase change materials for building component activation .70</i>	Orchestre
15.10-15.30	<u>Navid Morovat</u> (Concordia University), A. Athienitis .....76 <i>Impact of building-integrated PCM on the indoor thermal environment and energy performance of an office zone</i>	Orchestre
15.30-15.50	Coffee break	Orchestre
15.50-17.50	Session 3 chaired by Prof. Michael Kauffeld (Karlsruhe University of Applied Sciences)	Orchestre
15.50-16.10	<u>Aurélien Bordet</u> (Université de Sherbrooke), S. Poncet, M. Poirier, N. Galanis <i>New flow regimes for propylene-glycol based ice slurry in pipes .....84</i>	Orchestre
16.10-16.30	<u>Charles Onokoko</u> (Université de Sherbrooke), N. Galanis, S. Poncet, M. Poirier <i>A pseudo-single-phase continuum model for melting ice slurries in pipe flows .....90</i>	Orchestre
16.30-16.50	<u>Sam Brooks</u> (University of Bristol), G. Quarini, M. Tierney <i>Ice slurry production control system for supercooled brine in a nylon helical coiled heat exchanger .....98</i>	Orchestre
16.50-17.10	<u>Michel Poirier</u> (CanmetEnergy), J. Tamasauskas, D. Giguère <i>Concept and performance of a solar assisted heat pump using ice slurry as a phase change storage medium .....106</i>	Orchestre
17.10-17.30	<u>Christoph Steffan</u> (Institute of Air Handling and Refrigeration, Dresden), J. Schwarz, M. Safarik, M. Honke, U. Hesse <i>Compact plate heat exchanger design and optimization for ice slurry applications: a review of experiences and development steps .....114</i>	Orchestre
17.30-17.50	<u>Seyed Soheil Mousavi Ajarostaghi</u> (Babol Noshirvani University of Technology), S. Poncet, M. A. Delavar, K. Sedighi <i>Numerical simulation of the melting process in a shell and coil tube ice storage system for air-conditioning application .....124</i>	Orchestre

Tuesday, the 22th of May 2018		
Time	Activity	Room
8.30 – 9.25	Keynote Lecture 2 : <u>Andreas Athienitis</u> (Concordia University) <i>Modeling and optimal operation of high performance buildings with integrated phase change materials .....133</i>	Orchestre
9.25-10.20	Keynote Lecture 3 : <u>Michael Kauffeld</u> (Karlsruhe University of Applied Sciences) <i>25 years working with ice slurry: history, current technologies and future developments .....142</i>	Orchestre
10.20-10.40	Coffee break	Orchestre
10.40-12.20	Session 4 chaired by Prof. Nicolas Galanis (Université de Sherbrooke)	Orchestre
10.40-11.00	<u>Noé Beaupère</u> (CEA Grenoble), U. Soupremanien, L. Zalewski <i>Solidification monitoring of supercooled phase change materials .....150</i>	Orchestre
11.00-11.20	<u>Hiroshi Suzuki</u> (Kobe University), I. Watanabe, R. Hidema, Y. Komoda, T. Horie, N. Ohmura, H. Asano <i>Dispersion and flow characteristics of hard-shell microcapsules with phase change materials .....158</i>	Orchestre
11.20-11.40	<u>Henri Schmit</u> (ZAE Bayern), C. Rathgeber, L. Sun, S. Hiebler <i>Model-based prediction and experimental verification of eutectic PCM .....166</i>	Orchestre
11.40-12.00	<u>Virginia Vasile</u> (University POLITEHNICA of Bucharest), A. Badea, H. Necula, R. Revellin, J. Bonjour, P. Haberschill <i>Investigation of heat transfer and rheology of a phase change material emulsion with a high concentration in surfactant .....174</i>	Orchestre
12.00-12.20	<u>Jessica Pipes</u> (SASOL), T. Gross, M. Maywald, D. Schaer <i>High purity single cut paraffins as feedstock for PCM materials .....182</i>	Orchestre
12.20-13.30	Lunch	Salle à manger
13.30-15.30	Session 5 chaired by Prof. Dominic Groulx (Dalhousie University)	Orchestre
13.30-13.50	<u>Anastasia Stamatiou</u> (Lucerne University of Applied Sciences and Arts), R. Waser, L.J. Fischer, J. Wörlitschek <i>High power thermal energy storage using phase change material slurries .....183</i>	Orchestre
13.50-14.10	<u>Michel Pons</u> (CNRS, LIMSI), L. Fournaison, A. Delahaye, D. Dalmazzone <i>Effect of phase change kinetics on energy efficiency of secondary refrigeration with hydrate slurries .....191</i>	Orchestre
14.10-14.30	<u>Kohei Nakamura</u> (Toho Gas Co.), T. Ina, H. Suzuki, R. Hidema, Y. Komoda .....198 <i>Ammonia alum hydrate-based phase change materials for effective use of excess exhaust heat from gas engines</i>	Orchestre
14.30-14.50	<u>Sung Choi</u> (Korea University), Y.T. Kang <i>An experimental investigation on performance evaluation of CO2 hydrate formation for district cooling application.....206</i>	Orchestre
14.50-15.10	<u>Mark Dannemand</u> (Technical University of Denmark), S. Furbo <i>Supercooling stability of sodium acetate trihydrate composites in multiple heat storage units .....211</i>	Orchestre
15.10-15.30	S. Frehner, <u>Anastasia Stamatiou</u> (Lucerne University of Applied Sciences and Arts), L. Fischer, J. Worlitschek <i>Techno-economic analysis of a phase change material slurry for industrial applications .....216</i>	Orchestre
15.30-15.50	Coffee break	Orchestre
15.50-17.50	Session 6 chaired by Prof. Masahiro Kawaji (City College of New-York)	Orchestre
15.50-16.10	N. Dhaidan, <u>Manar Al-Jethelah</u> (University of Guelph) <i>Study on the effect of nanoparticle dispersion on the melting of PCM in hemicylindrical cell .....224</i>	Orchestre
16.10-16.30	<u>Seyed Soheil Mousavi Ajarostaghi</u> (Babol Noshirvani University of Technology), S. Poncet, A. Dolati, M. A. Delavar <i>Numerical simulation of the charging process in a horizontal shell-and-tube phase change material storage .....232</i>	Orchestre
16.30-16.50	R. Lazzarin, <u>Simone Mancin</u> (University of Padova), M. Noro, G. Righetti, L. Zamboni <i>Simulation of the phase change process of paraffin waxes with and without AI foams for advanced hybrid thermal energy storages .....240</i>	Orchestre
16.50-17.10	<u>Vikram Soni</u> (IIT Kanpur), A. Kumar, A. Kumar, V.K. Jain <i>Behaviour of phase change material during discharge stage in a thermal energy storage system: an experimental and numerical study .....249</i>	Orchestre
17.10-17.30	J. Hlinik, <u>Lubomir Klimes</u> (Brno University of Technology), P. Charvat, M. Ostry <i>A study into optimal design of an air-PCM thermal energy storage unit with CSM panels .....257</i>	Orchestre
17.30-17.50	<u>Damien Mathis</u> (Université Laval), P. Blanchet, V. Landry, P. Lagiere <i>Decorative wood-based panels loaded with biosourced PCMs .....263</i>	Orchestre
18.30	Cocktail and Gala dinner	Bistro

Wednesday, the 23rd of May 2018		
Time	Activity	Room
8.30 – 9.25	Keynote Lecture 4 : <u>Jörg Worlitschek</u> , A. Stamatiou, L. Fischer (Lucerne University of Applied Sciences and Arts) <i>High power thermal energy storage research at Lucerne University of Applied Sciences and Arts .....269</i>	Orchestre
9.25-10.20	Keynote Lecture 5 : <u>Anis Somani</u> (Sunwell Technologies Inc.) <i>Overview of Industry Applications of DeepChill™ Slurry .....277</i>	Orchestre
10.20-10.40	Coffee break	Orchestre
10.40-12.20	Session 7 chaired by Prof. Jocelyn Bonjour (Université de Lyon, CETHIL)	Orchestre
10.40-11.00	<u>Evan Owens</u> (Arkansas Tech University), S.E. Hosseini, G. Phillips <i>Energy consumption reduction in a refrigeration system using phase change materials .....285</i>	Orchestre
11.00-11.20	T. Dufour, H.M. Hoang, V. Osswald, P. Clain, <u>Laurence Fournaison</u> (IRSTEA), A. Delahaye <i>Impact of thermal energy storage on the sizing and energy consumption of a district cooling system .....293</i>	Orchestre
11.20-11.40	<u>Peter Hoock</u> (ZAE Bayern), S. Pöllinger, A. Krönauer, S. Hiebler, F. Bailly, K. Baysal, A. Kleiner, M. Laudahn, C. Weiß <i>PCM in a fridge / freezer combination – a challenging PCM application.....301</i>	Orchestre
11.40-12.00	C. Monsalve, C.A. Isaza, J. Cofré, <u>Diego A. Vasco</u> (Universidad de Santiago de Chile) <i>Assessment of an integrated household refrigerator with an eutectic phase change material and a solar photovoltaic system .....309</i>	Orchestre
12.00-12.20	<u>Stefan Gschwander</u> (Fraunhofer Institute for Solar Energy Systems), M. Delgado Gracia, M. Brütting, H. Neumann, P. Schossig <i>Characterization of PCM, standardization in the frame of the IEA ECES Annex 33 and SHC task 58 .....318</i>	Orchestre
12.20-13.30	Lunch	Salle à manger
13.30-15.30	Session 8 chaired by Prof. Simone Mancin (University of Padova)	Orchestre
13.30-13.50	<u>Masahiro Kawaji</u> (City College of New-York) <i>Phase-change-material nanoemulsions for energy transport and storage .....326</i>	Orchestre
13.50-14.10	<u>Laura Quant</u> (University of the Basque Country), G. Diarce, A. Campos-Celador, A. Garcia Romero, D. Haillet <i>A thermal stability study of the urea sodium nitrate eutectic mixture as a PCM .....334</i>	Orchestre
14.10-14.30	L.J. Fischer, <u>Simon Maranda</u> (Lucerne University of Applied Sciences and Arts), A. Stamatiou, S. Von Arx, J. Wörlitschek <i>Experimental investigation on heat transfer characteristics in a phase change dispersion .....340</i>	Orchestre
14.30-14.50	<u>Henri Schmit</u> (ZAE Bayern), J. Linn, D. Pauckner, K. Müller, S. Hiebler <i>Generation, crystal fraction and viscosity of K<sub>2</sub>HPO<sub>4</sub>·6H<sub>2</sub>O-PCS .....349</i>	Orchestre
14.50-15.10	<u>Michael Biedenbach</u> (Fraunhofer Institute for Solar Energy Systems), L. Poetzsch, S. Gschwander <i>Characterization of an n-Octadecane PCS in a 0.5 m<sup>3</sup> storage tank test facility .....357</i>	Orchestre
15.10-15.30	B. Nienborg, <u>Stefan Gschwander</u> (Fraunhofer Institute for Solar Energy Systems), R. Horn, H. Weinläder, F. Klinker, P. Schossig <i>Life cycle assessment of phase change materials, components and system concepts .....365</i>	Orchestre
15.30-15.50	Coffee break	Orchestre
15.50-17.30	Session 9 chaired by Dr Michel Poirier (Natural Resources Canada, CanmetEnergy)	Orchestre
15.50-16.10	<u>Milan Ostry</u> (Brno University of Technology), S. Bantova, P. Charvat, L. Klimes <i>Investigation of compatibility of organic and inorganic PCMs with the materials of containers .....373</i>	Orchestre
16.10-16.30	R. Lazzarin, <u>Simone Mancin</u> (University of Padova), M. Noro, G. Righetti <i>Porous media for advanced hybrid thermal energy storages .....379</i>	Orchestre
16.30-16.50	<u>Runfeng Li</u> (Beijing Jiaotong University), Y. Zhou, X. Duan <i>Preparation and properties of paraffin / tailing ceramic composite phase change energy storage materials .....387</i>	Orchestre
16.50-17.10	<u>Michael Biedenbach</u> (Fraunhofer Institute for Solar Energy Systems), F. Klunder, S. Gschwander <i>Investigations on the stability of metallic cans for PCM macro-encapsulation .....395</i>	Orchestre
17.10-17.30	M.A. Bashir, K.P. Amber, <u>Muhammad Waqar Aslam</u> (Mirpur University of Science and Technology), A. Kousar, R. Ahmed, M. Abid <i>Performance analysis of a double pass solar air heater with and without thermal storage medium .....403</i>	Orchestre