

# UK HEAT TRANSFER 2007



10<sup>th</sup> UK heat Transfer Conference  
International Symposium on Phase Change  
September 10- 11, 2007  
John McIntyre Centre, Pollock Halls  
Edinburgh, Scotland, United Kingdom

## Programme



Website: <http://ukheattrans.see.ed.ac.uk/>



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Edinburgh, Scotland, United Kingdom

**Co-Chairs**

Khellil Sefiane, University of Edinburgh  
Peter Kew, Heriot-Watt University

**Conference Secretariat**

Avril Davies, University of Edinburgh

**Local Organising Committee**

John Christy, (Edinburgh university)  
Don Glass, (Edinburgh university)  
Dave McNeil, (Heriot-Watt university)  
David Reay, (D. Reay and Associates/HWU)

**Scientific Committee**

Geoffrey Hewitt, (Imperial College, London)  
Keith Cornwell, (Heriot-Watt university)  
David Kenning, (Brunel and Oxford universities)  
Brian Axcell, (Manchester university)  
Alan Deakin, (Consultant)



BRITISH AIRWAYS



**MONDAY, SEPTEMBER 10, 2007**

**Prestonfield Room**

08:00 - 09:00	Registration
09:00 - 09:15	Welcome and Organizational Remarks (Prestonfield Room- John McIntyre Centre)
09:20 - 10:00	<b>Invited Keynote Address (Prestonfield Room)</b> <b>G.F. Hewitt, Chemical Engineering, Imperial College, UK</b> <i>Keeping the nuclear option open (KNOO), thermal hydraulics studies</i>

**Session 1: Heat Exchangers, Prestonfield Room-John McIntyre Centre**

**Poster Session 1**

**CHAIR: David Reay, David Reay & Associates, UK**

10.00 - 10.05	H1	NOVEL DIODIC HEAT TRANSFER SURFACES: THEORETICAL AND EXPERIMENTAL EXAMINATION	G. L. Quarini
10.05 - 10.10	H2	VARIABLE VOLUME HEAT EXCHANGERS	G. L. Quarini and R.E. Watkins
10.10 - 10.15	H3	DESIGN FOR MINIMUM BLOCK VOLUME IN COMPACT CONTRAFLOW PLATE-FIN EXCHANGERS	Eric M. Smith
10.15 - 10.20	H4	EXPERIMENTAL AND CFD STUDIES OF HEAT TRANSFER IN AN AIR-FILLED FOUR-PIPE TUBE BUNDLE	L. Liu, G. F. Hewitt, S. M. Richardson
10.20 - 10.25	H5	INVESTIGATION OF FLOW DISTRIBUTION IN MICROCHANNELS HEAT SINKS FOR TWO PHASE FLOWS	D. Bogojevic, K. Sefiane, A. J. Walton, J. R. E. Christy, et al.
10.25 - 10.30	H6	NUMERICAL MODELING OF HEAT AND MASS TRANSFER IN FINNED DEHUMIDIFIER	Giulio Croce, Erika De Candido, Paola D'Agaro
10.30 - 10.35	H7	PRESSURE DROP IN MULTI-PARALLEL CHANNELS OF CORRUGATED PLATE STEAM CONDENSERS	Prabhakara Rao Bobbili and Bengt Sunden
10.35 - 10.40	H8	PERFORMANCE CHARACTERISTICS OF A SYNTHETIC JET MODULE FOR ELECTRONIC COOLING	Deepak Jagannatha , Ramesh Narayanaswamy, et al.
10.40 - 10.45	H9	COMPOSITE FOULING ON HEAT EXCHANGE SURFACE IN AUSTRALIAN SUGAR MILL EVAPORATOR	H. Yu and R. Sheikholeslami
10.45 - 10.50	H10	THE ROLE OF FLOODING IN THE DESIGN OF VENT AND REFLUX CONDENSERS	J. C. Sacramento and P. J. Heggs
10.50 - 10.55	H11	HEAT EXCHANGERS USED IN REFRIGERATION CIRCUITS - CONTROL FOR ENERGY EFFICIENCY -	Fatma Marhoon, Peter Senior and Peter Heggs
11:00 - 11:20		<b>BREAK 1</b>	

**Session 2: Boiling and Evaporation, Prestonfield Room-John McIntyre Centre**

**Poster Session 2**

**CHAIR: David B.R. Kenning, Brunel University, UK**

11:20 - 12:00		<b>Keynote: Critical Heat Flux in Nano-Fluids</b>	
		<i>W. Worek, Mechanical Engineering, University of Illinois at Chicago, USA</i>	
12:00 - 12:05	B1	NEW EXPERIMENTAL RESULTS ON FLOW BOILING OF R-134a IN A VERTICAL MICROCHANNEL	Claudi Martin-Callizo, Rashid Ali, Björn Palm
12.05 - 12.10	B2	EXPERIMENTAL STUDY OF COMPLEX TWO-PHASE INSTABILITIES FOR THE OPTIMISATION OF START-UP OF A VERTICAL THERMOSYPHON REBOILER OPERATING UNDER VACUUM	Abdelmadjid Alane and Peter J. Heggs
12.10 - 12.15	B3	POOL BOILING INVESTIGATIONS ON SILICON WITH ARTIFICIAL CAVITIES, IMMERSED IN FC-72	C. Hutter, K. Sefiane, A.J. Walton, T.G. Karayiannis, D.B.R. Kenning
12.15 - 12.20	B4	TWO-PHASE FRICTIONAL PRESSURE GRADIENT CORRELATIONS IN SMALL RECTANGULAR CHANNELS	I. Y. Chen, Yi-Min Chen
12.20 - 12.25	B5	AN EXPERIMENTAL STUDY OF WICKLESS MINIATURE HEAT PIPES OPERATING IN THE TEMPERATURE RANGE 200°C TO 450°C	H. Jouhara, C. Kelly, A.J. Robinson
12.25 - 12.30	B6	HYDRODYNAMICS, HEAT TRANSFER AND INFRARED MEASUREMENTS DURING FLOW BOILING INSTABILITIES IN A SINGLE MICROCHANNEL	Jacqueline Barber, K.Sefiane, D.Brutin and L.Tadrst
12.30 - 12.35	B7	COMPARISON OF THE THREE-ZONE EVAPORATION MODEL WITH BOILINGHEAT TRANSFER IN A COMPACT TUBE BUNDLE	Ebenezer Adom, Peter Kew, Keith Cornwell
12.35 - 12.40	B8	A GAS-LIQUID FLOW PATTERN PREDICTIVE METHOD FOR MACRO- AND MINI-SCALE ROUND CHANNELS	H. O. M. Felcar, G. Ribatski, J. M. Saiz Jabardo
12.40 - 12.45	B9	FLOW BOILING IN HORIZONTAL SMOOTH TUBES: NEW HEAT TRANSFER RESULTS FOR R-134a AT THREE SATURATION TEMPERATURES	Ricardo J. DA SILVA LIMA, Jesús MORENO QUIBÉN and John R. THOME
12:50 - 14:00		<b>LUNCH (provided) + Posters for Session 1 and Session 2</b>	

<b>Session 3: Computational Heat Transfer, Prestonfield Room-John McIntyre Centre</b>		<b>Poster Session 3</b>
<b>CHAIR: Dave McNeil, Heriot-Watt University, UK</b>		
<b>14:00 - 14:40</b>		<b>Keynote: Direct Numerical Simulations of multiphase Flows</b>
		<i>G. Tryggvason, Mechanical Engineering, Worcester University, USA</i>
<b>14:40 - 14:45</b>	C1	MODELLING AND NUMERICAL STUDY OF TWO-PHASE FLOW AND BOILING HEAT TRANSFER IN A MICROCHANNEL C.Y. Ji, Y.Y. Yan
<b>14:45 - 14:50</b>	C2	USING ADVANCED WALL FUNCTIONS IN THE COMPUTATION OF BUOYANT FLOWS Seyed Ali Omranian, Hector Iacovides, Brian P. Axcell
<b>14:50 - 14:55</b>	C3	MOLECULAR DYNAMICS SIMULATION OF THE EVAPORATION OF NONPOLAR L-J FLUIDS IN THE VICINITY OF DRY-OUT REGION IN A MICROCHANNEL HEAT SINK C.Y. Ji, Y.Y. Yan
<b>14:55 - 15:00</b>	C4	LAMINAR FORCED CONVECTION IN THE ENTRANCE REGION OF STRAIGHT MICROCHANNELS WITH UNIFORM WALL HEAT FLUX: EFFECTS OF VISCOUS DISSIPATION S. Del Giudice, C. Nonino, S. Savino
<b>15:00 - 15:05</b>	C5	LBM SIMULATION OF BUBBLES FLOW AND COALESCENCE IN MICROCHANNELS Y.Y. Yan, Y.Q. Zu, Y.H. Sun
<b>15:05 - 15:10</b>	C6	EXPERIMENTAL AND NUMERICAL INVESTIGATION OF 2-PHASE PRESSURE DROP IN VERTICAL CROSS FLOW OVER A HORIZONTAL TUBE BUNDLE Khalid Bamardouf and David McNeil
<b>15:10 - 15:15</b>	C7	NON-ISOTHERMAL THIN-FILM FLOW ON A STATIONARY OR ROTATING CYLINDER B. R. Duffy, S. K. Wilson
<b>15:15 - 15:20</b>	C8	CONVECTIVE HEAT TRANSFER IN PULSED SEPARATED FLOWS T.J. Craft, H. Iacovides, P. Momeni
<b>15:20 - 15:25</b>	C9	SIMULATION-BASED OPTIMIZATION OF THERMAL SYSTEMS Yogesh Jaluria
<b>15:25 - 15:30</b>	C10	PRESSURE LOSS AND HEAT TRANSFER THROUGH HEAT SINKS PRODUCED BY SELECTIVE LASER MELTING M. Wong, I. Owen, C.J. Sutcliffe
<b>15:30 - 15:35</b>	C11	CRITICAL ANALYSIS AND IMPROVEMENT OF A MECHANISTIC MULTI-SITE MODEL FOR POOL NUCLEATE BOILING A. Sanna, D.B.R. Kenning, E. Pavlovic, I. Golobic, K. Sefiane, T.G. Karayiannis and R.A. Nelson
<b>15:35 - 15:40</b>	C12	MULTI-JET IMPINGMENT COOLING ON A CONCAVE SURFACE, UNDER STATIONARY AND ROTATING CONDITIONS. Alex Skillen, Hector Iacovides
<b>15:40 - 15:45</b>	C13	INFLUENCE OF THE IMBIBITION PROCESS ON THE TEMPERATURE DISTRIBUTION IN A POROUS MEDIUM J. P. Escandón, O. Bautista, F. Mendez and E. Bautista
<b>15:45 - 15:50</b>	C14	ESTIMATION OF TRANSIENT HEAT FLUX ON A MOVING BOUNDARY, APPLICATION: CHARRING ABLATORS Ali Hakkaki-Fard, and Farshad Kowsary
<b>15:50 - 15:55</b>	C15	INFLUENCE OF HUMIDITY AND HEATING SUBSTRATE GEOMETRY ON THE DYNAMICS OF EVAPORATING SESSILE DROPLETS Fabien GIRARD, Mickaël ANTONI and Annie Steinchen
<b>15:55 - 16:00</b>	C16	CFD PREDICTION FOR CONFINED IMPINGEMENT JET HEAT TRANSFER USING DIFFERENT TURBULENT MODELS Y.Q. Zu, Y.Y. Yan, J.D. Maltson
<b>16:00 - 16:05</b>	C17	NUMERICAL INVESTIGATION OF MARANGONI CONVECTION CAUSED BY THE PRESENCE OF A BUBBLE SITUATED UNDER A UNIFORMLY HEATED SURFACE: INFLUENCE OF GRAVITY LEVEL Séamus M. O'Shaughnessy, Anthony J. Robinson
<b>16:05 - 16:10</b>	C18	A THEORETICAL STUDY OF ACTIVE MAGNETIC REGENERATIVE REFRIGERATORS FOR ROOM TEMPERATURE APPLICATIONS Jianghong Wu, Dengfang Mou, Fei Han, Xihui Wang, Yungui Chen
<b>16:10 - 16:15</b>	C19	COMPUTATION OF CONVECTIVE HEAT TRANSFER IN RIBBED COOLING PASSAGES Hector Iacovides, Joaquim Pujol
<b>16:20 - 16:40</b>		<b>BREAK 2 + Posters for Session 3</b>
<b>17:00 - 19:00</b>		<b>Visit to Old College</b>
<b>19:30 - 23:00</b>		<b>Conference Dinner</b>

**TUESDAY, SEPTEMBER 11, 2007**

<b>Session 4: Enhanced Heat Transfer, Prestonfield Room-John McIntyre Centre</b>		<b>Poster Session 4</b>
<b>CHAIR: Tassos G. Karayiannis, Brunel University, UK</b>		
09:00 - 09:40		<b>Keynote: Current status and fundamental research needs in thermal management within a PEMFC stack</b> <i>S. Kandlikar, Mechanical Engineering, Rochester Institute of Technology, USA</i>
09:40 - 09:45	E1	STRUCTURE DISJOINING PRESSURE AND NUCLEATE BOILING HEAT TRANSFER OF THERMAL NANOFLUIDS Dongsheng Wen
09:45 - 09:50	E2	THE R134A VAPOUR FLOW HEAT TRANSFER IN HORIZONTAL METAL-FOAM TUBES W. Lu, C.Y. Zhao, Z.Y. XU, S.A. Tassou
09:50 - 09:55	E3	EXPERIMENTAL INVESTIGATIONS ON BOILING HEAT TRANSFER IN HORIZONTAL METAL-FOAM TUBES C.Y. Zhao, W. Lu, S.A. Tassou
09:55 - 10:00	E4	CONDENSATION OF STEAM ON ENHANCED TUBES M Baisar and A Briggs
10:00 -10:05	E5	EXPERIMENTAL STUDIES OF NANOFLUID DROPLETS IN SPRAY COOLING Gail Duursma, Khellil Sefiane, Aiden Kennedy
10:05 - 10:10	E6	SURFACE HEAT TRANSFER FROM AN IMPINGING SYNTHETIC AIR JET Alan McGuinn, Tim Persoons, Tadhg S. O'Donovan, Darina B. Murray
10:10 - 10:15	E7	HEAT TRANSFER AT THE MELTING INTERFACE FOR CYLINDRICAL METAL RODS BURNING IN OXYGEN UNDER REDUCED-GRAVITY CONDITIONS Theodore A. Steinberg, Nicholas R. Ward
10:15 - 10:20	E8	THE APPLICATION OF SHAPE MEMORY ALLOY AS LONGITUDINAL VORTEX GENERATORS FOR ENHANCED CONVECTIVE HEAT TRANSFER Mohd S Aris, Ieuan Owen, Chris Sutcliffe
10:20 - 10:25	E9	SURFACE HEAT TRANSFER DUE TO SLIDING BUBBLE MOTION Brian Donnelly, Tadhg S. O'Donovan & Darina B. Murray
10:25 - 10:30	E10	THERMAL BEHAVIOR OF MAGNETIC FLUID FLOW UNDER THE INFLUENCE OF AN EXTERNAL MAGNETIC FIELD Yimin Xuan, Qiang Li
10:30 - 10:35	E11	IR THERMOGRAPHY MEASUREMENT OF IMPINGING JET HEAT TRANSFER FROM A HEATED THIN FOIL Thomas L. Lupton, Darina B. Murray, Anthony J. Robinson
10:35 - 10:40	E12	THE EFFECT OF NOZZLE SHAPE ON PRESSURE DROP AND HEAT TRANSFER TO FREE-SURFACE LIQUID JET ARRAYS Brian P. Whelan, Anthony J. Robinson
10:50 - 11.10	<b>BREAK 3</b>	
<b>Session 5: Droplets Behaviour, Prestonfield Room-John McIntyre Centre</b>		<b>Poster Session 5</b>
<b>CHAIR: Adrian Briggs, Queen Mary, University of London, UK</b>		
11:10 - 11:50		<b>Keynote: Heat and Mass Transfer in Fires: Scaling Laws and their application</b> <i>J. Torero, Civil Engineering, University of Edinburgh, UK</i>
11:50 - 11:55	D1	MODELLING DROPLET-HOT WALL INTERACTIONS IN THE PRESENCE OF VAPOUR GENERATION USING THE LEVEL SET METHOD D. Chatzikiriakou, S.P. Walker, G.F. Hewitt, C. Narayanan C. Narayananc and D. Lakehal
11:55 - 12:00	D2	DROPLET DEPOSITION AND EVAPORATION ON A HEATED SURFACE COOLED BY A TURBULENT FLOW OF GAS AND VAPOUR K.H. Ardron, J.D. Jackson
12:00 - 12:05	D3	CONTACT LINE MOTION AND FORCED WETTING OF NANOFLUIDS J.M. Skilling, K. Sefiane, J. MacGillivray
12:05 -12:10	D4	DROPLET EVAPORATION: MATHEMATICAL MODELLING AND EXPERIMENT G. J. Dunn, S. K.Wilson , B. R. Duffy, S. David, K. Sefane
12:10 - 12:15	D5	MODELLING LIFTED HYDROGEN JET FIRES USING THE BOUNDARY LAYER EQUATIONS O. Onokpe, P.S. Cumber
12:15 - 12:20	D6	DROPWISE COOLING: EXPERIMENTAL TESTS BY INFRARED THERMOGRAPHY AND NUMERICAL SIMULATIONS. P. Tartarini, M.A. Corticelli and L. Tarozzi
12:20 - 12:25	D7	ANALYSIS OF THE SPRAY FIELD DEVELOPMENT ON A VERTICAL SURFACE DURING WATER SPRAY-QUENCHING USING A FLAT SPRAY NOZZLE W J J Vorster, S A Schwindt, J Schupp, A M Korsunsky
12:25 - 12:30	D8	ON THE ROLE OF THERMAL INSTABILITIES IN THE EVAPORATION OF VOLATILE SESSILE DROPS R. Moffat, K. Sefiane
12:30 - 13:40	<b>LUNCH (provided) + posters for session 4 and Session 5</b>	
<b>Session 6: General Heat Transfer, Prestonfield Room-John McIntyre Centre</b>		<b>Poster Session 6</b>

<b>CHAIR: Donald H. Glass, University of Edinburgh, UK</b>		
<b>13:40 - 14:20</b>		<b>Keynote: Energy production from green house effect to mitigate climate change</b>
		<i>Francis Meunier, CNAM-IFFI (EA-21), Paris, France</i>
<b>14:20 - 14:25</b>	G1	MODELLING OF HEAT AND MASS TRANSFER IN STRUCTURED CEREAL MATERIAL S.W Porter, Brian Bartlett, Tony Whitney and G.L Quarini
<b>14:25 - 14:30</b>	G2	INCREASING EFFICIENCY OF POWER PLANTS BY HEAT RECOVERY OF FLUE GASES Lars Wollenweber, Andrea Luke
<b>14:30 - 14:35</b>	G3	REQUIREMENTS FOR SIMILARITY IN THE CASE OF HEAT TRANSFER TO FLUIDS AT PRESSURES ABOVE THE CRITICAL VALUE AND AN APPROACH TO THE CORRELATION OF EXPERIMENTAL DATA J.D. Jackson
<b>14:35 - 14:40</b>	G4	INFLUENCES OF BUOYANCY ON FRICTION IN THE CASE OF AIR FLOWING IN A HEATED VERTICAL TUBE Jiankang Li, J.D. Jackson
<b>14:40 - 14:45</b>	G5	THERMAL AND HYDRAULIC PERFORMANCE OF SETTING CEMENTS USED TO FIX PROSTHETIC DEVICES G. L. Quarini, I. Learmonth, S. Gheduzzi
<b>14:45 - 14:50</b>	G6	A SIMPLE METHOD OF ESTIMATING ICE FRACTION AND AVERAGE ICE PARTICLE SIZE OF ICE SLURRIES BY TRANSIENT MELTING THERMAL MEASUREMENTS T. S. Evans, G. S. F. Shire, E. A. Ainslie and G. L. Quarini
<b>14:50 - 14:55</b>	G7	COATINGS J P Feist, A L Heyes
<b>14:55 - 15:00</b>	G8	JET IMPINGEMENT HEAT TRANSFER FOR LOW NOZZLE-TO-PLATE DISTANCES H. Burnham-Slipper, M.J. Clifford, S.J. Pickering
<b>15:00 - 15:05</b>	G9	ANALYSIS OF THE TRANSIENT THERMAL PERFORMANCE OF MICRO-CHANNEL HEAT SINKS G. Joyce, H.M. Soliman
<b>15:05 - 15:10</b>	G10	PREDICTION OF REFRIGERANT ABSORPTION AND ONSET OF NATURAL CONVECTION IN LUBRICANT OIL Jader Barbosa, Jr., Stefan Thoma, Moisés Marcelino Neto
<b>15:10 - 15:15</b>	G11	HEAT AND MASS TRANSFER IN AIR-FED PRESSURISED SUITS K. Tesch, T.G. Karayiannis, M.W. Collins, M.A. Atherton
<b>15:15 - 15:20</b>	G12	EXPERIMENTAL STUDY OF HEAT TRANSFER IN GAS TURBINE BLADES USING A NON-INVASIVE, NON-DESTRUCTIVE, TRANSIENT INVERSE METHOD P. Heidrich, J. v. Wolfersdorf, M. Schnieder
<b>15:20 - 15:25</b>	G13	THE EFFECT OF VENTILATOR CONFIGURATIONS IN NATURALLY VENTILATED GREENHOUSE APPLICATIONS Sunita Kruger, Leon Pretorius
<b>15:25 - 15:30</b>	G14	EFFUSION FILM COOLING: ADIABATIC COOLING EFFECTIVENESS OF TWO MULTIHOLE PATTERNS N. M. Yusop, G. E. Andrews, D. B. Ingham and M. Pourkashanian
<b>15:30 - 15:35</b>	G15	EXPERIMENTAL AND NUMERICAL STUDY OF A DOUBLE-DIFFUSIVE TWOLAYER SYSTEM IN A LATERALLY HEATED ENCLOSURE Morrison, D., Okorafor, A., Stables, A. and He, S.
<b>15:40 - 16:00</b>		<b>BREAK 4 + posters for Session 6</b>
<b>International Symposium on Phase Change, Duddingston Room- John McIntyre Centre</b>		
<b>CHAIR: Charles Ward, University of Toronto, canada</b>		
<b>Co-chair: John Thome</b>		
<b>13:00 - 13:30</b>	S1	<b>Invited opening lecture: ENERGY TRANSPORT DURING WATER EVAPORATION,</b> <i>Charles A. Ward, University of Toronto, canada</i>
<b>13:40 - 14:00</b>	S2	<b>Keynote: NUSSELT CONDENSATION WITH SURFACE TENSION PRESSURE GRADIENTS,</b> <i>John Rose, Queen Mary University London, Uk</i>
<b>14:10 - 14:30</b>	S3	<b>Keynote: COOLING OF MICROPROCESSORS USING FLOW BOILING OF REFRIGERANTS IN MICRO-EVAPORATORS,</b> <i>John Thome, Ecole Polytechnique Fédérale de Lausanne, Switzerland</i>
<b>14:40 - 15:00</b>	S4	WHAT CAN WE LEARN FROM A CONTINUOUS DESCRIPTION OF HEAT AND MASS TRANSPORT FOR EVAPORATION AND CONDENSATION, <i>D. Bedeaux, Norwegian University of Science and Technology, Norway</i>
<b>15:10 - 15:25</b>	S5	MASS FLUX AND HEAT TRANSFER IN EVAPORATING SESSILE DROPLETS ON A HEATING SUBSTRATE, <i>M. Antoni, University Aix-marseille III, France</i>
<b>15:30 - 15:45</b>	S6	SURFACE TRANSFER COEFFICIENTS IN NON-EQUILIBRIUM THERMODYNAMICS STUDIED BY NON-EQUILIBRIUM MOLECULAR DYNAMICS SIMULATIONS, <i>Signe Kjelstrup, Norwegian University of Science and Technology, Norway</i>
<b>16:00 - 16:20</b>		<b>Concluding Discussion</b>