THE COMBUSTION INSTITUTE

(British Section)

NEWSLETTER

VOLUME 2010-1 **Summer 2010**

EDITOR: Professor J.F. Griffiths **E-mail: J.F.Griffiths@leeds.ac.uk**

Internet versions of this *Newsletter* at:- http://www.combustion.org.uk

CONTENTS

THE BRITISH SECTION OF THE COMBUSTION INSTITUTE

For a modest fee there are many benefits:-

- **substantial travel grants to Combustion Symposia and other meetings**
- **reduced fees at Section-sponsored meetings**
- **reduced subscriptions to several combustion journals**
- **the Section's Newsletter**
- **and a chance to meet like-minded people**

Please encourage associates to join the Section, especially research students recruited at the start of this academic year

Details from the Hon. Secretary, Professor Simone Hochgreb.
E-mail: sh372@cam.ac.uk

or download application forms from
http://www.combustion.org.uk/membership.html

COMMITTEE OF THE BRITISH SECTION: 2009-10

Chairman: Professor A N Hayhurst
Chemical Engineering Department
Cambridge University
Pembroke Street
Cambridge CB2 3RA

<anh1000@hermes.cam.ac.uk>

Secretary: Professor S Hochgreb
Department of Engineering
University of Cambridge
Trumpington St
Cambridge CB2 1PZ
Tel: 01223 764098
<sh372@cam.ac.uk>

Membership Secretary Dr K.J. Hughes
SPEME
Houldsworth Building
University of Leeds
Leeds, LS2 9JT
Tel: 0113 343 2503
Fax: 0113 246 7310
<kevinh@chem.leeds.ac.uk>

Treasurer: Dr R. Cracknell
Shell Global Solutions
Shell Research and Technology Centre
Thornton, P O Box 1
Chester CH1 3SH
Tel: 0151 373 5725
Fax: 0151 373 5052
<roger.cracknell@shell.com>

Committee

Professor P Gray, FRS
Gonville and Caius College
Cambridge
CB2 1TA

<pg263@cam.ac.uk>

Professor A. J. Griffiths
Cardiff School of Engineering
Queen's buildings
Newport Road, PO Box 925
Cardiff CF24 OYF
<griffithsaj2@cf.ac.uk>

Professor J.F. Griffiths
School of Chemistry
The University
Leeds LS2 9JT

<J.F.Griffiths@leeds.ac.uk>

Dr Y Hardalupas
Department of Mechanical Engineering
Imperial College of Science, Technology and Medicine
Prince Consort Road
London SW2
<y.hardalupas@imperial.ac.uk

Mr. B. Jones
Kausis Consultancy
7 Lodge Drive
Belper
Derbyshire
DE56 2TP
<bj224@cam.ac.uk>

Professor W.P. Jones
Department of Mechanical Engineering
Imperial College of Science, Technology and Medicine
Prince Consort Road
London SW2
<w.jones@ic.ac.uk>

Professor R.P. Lindstedt
Department of Mechanical Engineering
Imperial College of Science, Technology and Medicine
Prince Consort Road
London SW2
<p.lindstedt@imperial.ac.uk>

Professor G. Makhviladze
Forensic and Investigative Science
University of Central Lancs.
Preston,
PR1 2HE

<gmakhviladze@uclan.ac.uk>

Professor E. Mastorakos
Department of Engineering
University of Cambridge
Trumpington Street
Cambridge
CB2 1PZ
< em257@eng.cam.ac.uk>

Dr G. Rein
Institute of Infrastructure and Environment, Crew Building,
The King's Buildings
School of Engineering & Electronics
The University of Edinburgh
Edinburgh, EH9 3JN
<G. Rein@ed.ac.uk>

Professor R. Stone
Department of Engineering Science,
University of Oxford
Parks Road,
Oxford OX1 3PJ

<richard.stone@eng.ox.ac.uk>

EDITORIAL

Excuses excuses…. I am mindful that this Newsletter is a month or so later than really is appropriate, and I apologise for that. So, to salve my conscience, I had set 31 July as my posting deadline. In the event, at the last minute, Clifford Jones alerted me to an obituary in "The Times", 22 July, following the death of Dr David Warren, which certainly merited inclusion in the Newsletter under "Combustion People". So I may even miss the late, self-imposed deadline.

On another front, although it is too late to give a helpful reminder of the arrangements for the 33rd International Combustion Symposium, it would be remiss of me not to acknowledge that it is yet another "big year" for "The Institute". Having been involved with two, UK-hosted Symposia, my thoughts are with the ever-helpful and (seemingly) ever-cheerful staff in Pittsburgh, the Institute members who have taken responsibility for the programme organisation and the Chinese Section members who have generously taken responsibility to host this prestigious event, to be held in Beijing. I wish them all well for an exceptionally successful Symposium.

Earlier this year your Committee kindly asked me what help could be offered to ease the "burden" of producing the Newsletter. My main response was, of course, that it would be very helpful if other people could offer material for publication. Although not directly in response to that, I am grateful to Stewart Cant, Clifford Jones, Guillermo Rein and Stephen Welch, who have helped me along on this occasion. However, at the last Committee meeting we did also reflect on the possibility of an article comprising amusing or absurd, interesting or inspired quotes or anecdotes pertaining to the feedback from reviewers of the 33rd Combustion Symposium submissions (or even recollections from previous Symposia). I'd be happy to give that a try, with the conditions that it is not a forum to blatantly air grievances or to go "reviewer bashing", and that no-one can be identified or that comments can be traced to a particular source. If there are appropriate offerings out there, please send them to me.

The question was also raised as to whether, in the electronic age, the Newsletter should have an exclusively electronic format. We have always resisted that temptation, in the belief that members are entitled to have, and perhaps actually enjoy receiving, something that they can identify as a physical connection to the Section. However, it may be that there is a generation or two of our members who do not see things that way. Perhaps in this electronic-media orientated world, there are many who find scrolling across a screen the natural way to absorb information. I would be very interested to hear views. Meanwhile, please rest assured that the circulation list is not so huge that the act of putting copies in and labels on envelopes is an especially arduous task, at least as far as I am concerned, and that it is not necessary to think of abandoning printed copies on that account.

I should add that the address labels are generated by Kevin Hughes, and many of my queries are answered by him during the production stage of the Newsletter. I appreciate his help, which is invariably as an instant response.

John Griffiths

COMBUSTION PEOPLE

Dr David Warren, 1925 - 2010

David Warren, who died on 19 July, was known to very many combustion scientists throughout the world. Born and brought up in Australia, in the late '40s, following his graduation in chemistry from the University of Sydney, David Warren came to the UK to take his PhD at Imperial College, under the supervision of Sir Alfred Egerton. His thesis, published in 1951, related to studies of the explosion limits of hydrogen oxidation. This work yielded a number of prestigious publications, in "Proceedings of the Royal Society" and "Nature", both as co-author with Egerton and also as sole author.

On his return to Australia David Warren was appointed as principal research scientist at the Defence Science and Technology Organisation's Aeronautical Research Laboratories (ARL) in Melbourne, a post that he held from 1952 to 1983. His interest in hydrogen combustion had not fizzled out entirely, insofar that further papers were published by him (Faraday Transactions, 1956). Naturally, his combustion activity diversified, one major undertaking being the development of a gas turbine for use with locally-mined, low-rank coal. His background as a chemist would have suited him to such a project. Very much later, he became Scientific Energy Adviser to the Parliament in the State of Victoria.

Inevitably, much wider demands were also placed on his scientific talent, and very early in his career at that. (Several obituaries say that, at ARL, he "pursued a career in electronics".) In 1953, David Warren was appointed as a member of a committee set up to investigate the causes of two, closely spaced, crashes of

the world's first jet airliner, the de Havilland Comet. This sparked the idea of a flight data recorder to help interpret the origins of aircraft accidents – initially through the continuous monitoring of pilots' voices and instrument readings. The idea was encapsulated in his 1954 report, "A device for Assisting Investigations into Aircraft Accidents". By 1956, David Warren and his team at ARL had built a sufficiently compact, and robust, prototype recording unit, capable of storing 4 hours worth of information. (To put this in chronological and technical perspective, "Philips" did not develop the audiocassette recorder until 1962.) It took nearly a decade for the installation of the "black box" to become mandatory in commercial aircraft.

When asked, subsequently, in an interview with the Australian ABC network, David Warren said, "It was called a black box because in the records of my meetings in London, when it was first demonstrated and they were so keen, one of the people in the discussion said, "This is a wonderful black box." And a black box was a gadget box. You didn't have to understand it but it did wonderful things." A Qantas, A380 Airbus was named after him in 2008, in recognition of his contribution to aviation.

Electronics engineer or not, David Warren remained close to his combustion roots. It is formally recorded in the Commemoration of the 50th Anniversary of The Combustion Institute that the Australian / New Zealand Section was formed with David Warren as its founding Chairman, possibly around 1956. Perhaps this resulted from his close connection to Sir Alfred Egerton, who was Chairman of the British Section at that time, and one of the associates of Bernard Lewis and founders of the Institute in 1954. David Warren remained as Chair of the Australian / New Zealand Section for 25 years until his succession by Bob Bilger, in 1981.

David Warren is survived by his wife Ruth, four children and seven grandchildren.

Clifford Jones and John Griffiths

TRAVEL GRANTS AWARDED TO MEMBERS PRESENTING A PAPER OR POSTER AT THE 33rd INTERNATIONAL COMBUSTION SYMPOSIUM

The travel grant is award on the understanding that a brief report (less than 100 words) is submitted on the meeting/session you attend. *Please email your report to the Newsletter editor Prof. John Griffiths (J.F.Griffiths@leeds.ac.uk) when you return!*

Simone Hochgreb

The following members have received £475 each towards Symposium expenses.

John Blamey, Imperial College
Reactivation of a CaO-based sorbent for CO_2 capture from stationary sources.
John Blamey, Nigel Paterson, Paul Stevenson, Denis Dugwell, and Paul Fennell
Iain Burns, Strathclyde University
A method for performing high accuracy temperature measurements in low-pressure sooting flames using two-line atomic fluorescence.
Iain S. Burns, Maxime Wartel, Xavier Mercier, Johan Hult and Clemens F. Kaminski
Cheng Tung Chong, Cambridge University
Measurements of laminar flame speeds of liquid fuels: Jet-A1, diesel, palm methyl esters and blends using Particle Imaging Velocimetry (PIV).
C. T. Chong and S. Hochgreb
Maryam Gharebaghi, Leeds University
Mercury speciation in air-coal and oxy-coal combustion: A modelling approach,
M. Gharebaghi, K.J.Hughes, R.J.Porter, M.Pourkashanian and A.Williams
Sreenivasa Gubba, Leeds University
LES modelling of air and oxy-fuel pulverised coal combustion: Impact on flame properties,
P. Edge, S. Gubba, L. Ma, R. J. Porter, M. Pourkashanian and A. Williams
Andreas M Kempf, Imperial College
Computed Tomography of Chemiluminescence (CTC): High Resolution and Instantaneous 3D Measurements of a Matrix Burner,
J. Floyd and A. Kempf
Malcolm Lawes, Leeds University
Burning rates of turbulent iso-octane aerosol mixtures in spherical flame explosions,
Malcolm Lawes and Aminuddin Saat
Sgouria Lyra, Imperial College
Large Eddy Simulation of a swirl stabilized spray flame,
W.P Jones, S. Lyra and S. Navarro - Martinez

Sean Malkeson, Liverpool University
Modelling of the tangential strain rate term of the Flame Surface Density Transport Equation in the context of Reynolds Averaged Navier Stokes Simulation,
Mohit Katragadda, Sean P. Malkeson and Nilanjan Chakraborty
Morkous S. Mansour, Leeds University
Measurement of Turbulent Burning Velocities in Implosions at High Pressures,
D. Bradley, M. Lawes and M. S. Mansour
Sebastian Mosbach, Cambridge University
Modelling soot formation in a DISI engine,
Jonathan Etheridge, Sebastian Mosbach, Markus Kraft, Hao Wu and Nick Collings
Alexandre Neophytou, Cambridge University
Complex chemistry simulations of spark ignition in turbulent sprays,
Alexandre Neophytou, Epaminondas Mastorakos and Stewart Cant
Michael Pettit, Imperial College
Large-eddy simulation and experiments on non-premixed highly turbulent opposed jet flows,
M W A Pettit, B Coriton, A Gomez and A M Kempf
Vinayaka Prasad, Imperial College
LES-PDF simulation of a spark ignited turbulent methane jet,
W P Jones and V N Prasad
Markus Sander, Cambridge University
Developing the PAH-PP soot particle model using process informatics and uncertainty propagation,
Markus Sander, Robert I. A. Patterson, Andreas Braumann, Abhijeet Raj and Markus Kraft
Raphael Shirley, Cambridge University
First-principles thermochemistry for the combustion of $TiCl_4$ in a methane flame,
Tim S. Totton, Raphael Shirley and Markus Kraft
Oliver Stein, Imperial College
Comparison of flame surface density models for LES,
T. Ma, O. Stein, N. Chakraborty and A. Kempf
Mark Sweeney, Cambridge University
A comparative analysis of flame surface density metrics in premixed and stratified flames,
M. S. Sweeney, S. Hochgreb, M. J. Dunn and R. S. Barlow
Konstantina Vogiatzaki, Imperial College
Stochastic multiple mapping conditioning,
K. Vogiatzaki, A. Kronenburg, S. Navarro-Martinez and W. P. Jones
Chris Wilson, Sheffield University
Aviation gas turbine alternative fuels; security of supply or sustainability?
C W Wilson, L Rye, and S Blakey
Jun Xia, Southampton University
Direct numerical simulation study of evaporation effects in combustion suppression by inert droplets,
Jun Xia and Kai H. Luo
Regina Zoby, Imperial College
Evaporation rates of droplet arrays in turbulent reacting flows
M. R. Gomes Zoby, S.R. Navarro-Martinez, A. Kronenburg and A. Marquis

I hope that my further analysis of the program is not flawed, in particular not to have acknowledged all other co-authored papers from Section members, as follows.

Gautam Kalghatgi: Autoignition quality of gasolines in partially premixed combustion in Diesel engines, by G. Kalghatgi, L. Hildingsson, A.J. Harrison and B. Johansson.
Nondas Mastorakos: Capturing localized extinction in Sandia flame F with LESCMC, by A. Garmory and E. Mastorakos
Salvador Navarro-Martinez and Stelios Rigopoulis
On adaptively reduced chemistry in large eddy simulations, by T. Løvås,S. Navarro-Martinez and S. Rigopoulos.
Alison Tomlin: Uncertainty driven theoretical kinetics studies for CH_3OH ignition: HO_2 + CH_3OH and O_2 + CH_3OH, by S.J. Klippenstein, L.B. Harding, M.J. Davis, A.S. Tomlin and R.T. Skodje.
Also, our “dual nationality” Section member, **Frederique Battin-Leclerc**, has three papers in the Symposium: Modeling study of the low temperature Oxidation of large methyl esters from C11 to C19, by O. Herbinet, J. Biet, M.H. Hakka, V. Warth, P.-A. Glaude, A. Nicolle, and F. Battin-Leclerc.
A detailed kinetic modelling study of toluene oxidation in a premixed laminar flame, by Z. Tian, W.J. Pitz, R. Fournet, P.-A. Glaude and F. Battin-Leclerc.
New experimental evidences about the formation and consumption of ketohydroperoxides, by F. Battin-Leclerc, O. Herbinet, P.-A. Glaude, R. Fournet, Z. Zhou,L. Deng, H. Guo, M. Xie,F. Qi.

.**John Griffiths**

BRITISH SECTION AUTUMN MEETING AND AGM

Combustion In Gas Turbines Present And Future Challenges

Cambridge Engineering Department, 15 September 2010

Meeting co-promoted with the IOP Combustion Physics Group

The Autumn meeting of The Combustion Institute (British Section) will take place at the Department of Engineering at the University of Cambridge. The one-day meeting will cover current research in industry and academia related to problems in gas turbine combustion. The AGM for the Combustion Institute will also take place during the meeting, and all members are encouraged to attend. A poster session will be held during the meeting, and a prize will be awarded to the best contribution. Poster abstracts should be emailed to the organizer by 7 September, 2010 via the information and registration site:

http://www-g.eng.cam.ac.uk/gtcombustion/cibs/.

Time	Speaker	Topic
10:15-10:30	Coffee and posters	
10:30-11:10	Khawar Syed, ALSTOM	The impact of carbon capture on gas turbine combustion
11:10-11:50	Ruud Eggels, Rolls-Royce	Application of CFD for gas-turbine combustor design
11:50-12:30	Bill Jones, Imperial College	Towards Large Eddy Simulation of Gas Turbine Combustion Chambers
12:30-13:30	*Lunch and Poster Session*	
13:30-14:00	*AGM*	
14:00-14:40	Epaminondas Mastorakos, U. Cambridge	Spark ignition in spray flames
14:40-15:20	Laurent Gicquel, CERFACS	Recent contributions of LES to the understanding and the design of Gas Turbines
15:20-16:00	Christoph Hirsch, TU Munich	Thermoacoustic experiments and modelling
16:00-16:40	Robert Miller, U. Cambridge	Pressure gain combustion for gas turbines
17:00	*Adjourn*	

Organizer: Simone Hochgreb Engineering Department, University of Cambridge Trumpington St, Cambridge, CB2 1PZ. Email: simone.hochgreb@cam.ac.uk.

TURBULENT COMBUSTION TODAY AND TOMORROW

15 December 2009, Selwyn College Cambridge

This meeting was organised to celebrate the occasion of Ken Bray's 80th birthday and also to hear presentations from invited speakers on the current status of turbulent combustion modelling. The emphasis was mainly on premixed combustion and especially on recent developments that have followed on from Ken Bray's many original contributions. The morning session was chaired by Chris Lawn and the afternoon session by Kai Luo.

Derek Bradley opened the technical programme with a talk on "Autoignitive Propagation". He outlined the thermochemical conditions that produce fast-moving reaction fronts that are unlike ordinary premixed flames, and went on to describe their structure and properties. An illustrated account of a discussion with Ken Bray formed a key part of the presentation and was greatly appreciated by the audience.

Kai Luo then delivered a talk on "A multiscale view of multiphase combustion", giving a wide-ranging account of recent work mainly on droplet combustion using a variety of numerical simulation and modelling approaches. This was followed by a talk from **Michel Champion**, Poitiers. He spoke on "Recent results concerning the modelling of partially premixed turbulent reactive flows", describing a modelling approach for partially-premixed flames based on an extension of the Bray-Moss-Libby formulation, and showed results for a series of successful validation test cases.

Over lunch, a demonstration of a new stereoscopic imaging technique was provided by Prof Yang Zhang and Ms Qian Wang.

The first speaker of the afternoon was **Stewart Cant** whose topic was "Countergradient transport in premixed turbulent flames". He covered some recent results from Direct Numerical Simulation of turbulent premixed flames that demonstrated the validity of Ken Bray's original ideas on turbulent transport and explored the effects of Lewis number.

Luc Vervisch from Rouen then gave a entertaining account of recent work on "Chemistry tabulation for the coming DNS of real combustion", showing how novel approaches to the treatment of chemistry coupled with successively finer resolution of the flow field can lead to major savings in computational effort. It seems that punting on the Cam with Ken Bray was a key element in the development of the method.

The main talks were rounded off by **Oliver Darbyshire**, who spoke on his work with co-authors H Kolla and N Swaminathan on the topic, "Calculations of lean premixed and stratified flames". He described a model for premixed flames based on scalar dissipation rate and showed some recent computational results obtained using two different stratified flame configurations.

A session of short presentations was chaired by Stewart Cant.
Penny Edge from Leeds described her work on coal combustion modelling using LES.
Yang Zhang from Sheffield provided further details of his stereoscopic imaging method.
Zhixin Hu from Shell spoke on chemical aspects of PCCI engine combustion modelling.
Friedrich Dinkelacker from Hannover showed some recent experimental results on premixed flame propagation and proposed some novel explanations, leading to an interesting discussion.

A Celebration Dinner was held in the evening, and a total of 27 people attended. Derek Bradley gave a highly entertaining after-dinner speech, and Bill Jones read out a message of congratulations from Felix Weinberg.

Stewart Cant

COMBUSTION PHENOMENA IN FIRE SCIENCE

One-day meeting of the Combustion Institute, British Section
9 April 2010, BRE Centre for Fire Engineering, University of Edinburgh

Meeting co-sponsored by IOP Combustion Physics Group

Seven invited speakers from home and abroad represented research interests spanning experimental studies and modelling of fire phenomena. The meeting opened with a good context-setting talk on "Enclosure fires modelling: where are we and where are we going?", by **Prof. Bart Merci** of Ghent University, Belgium. The capabilities of models are progressively advancing but equally, if not more important.t is the knowledge of the user. Options to increase knowledge of FSE were discussed and the value of Masters programmes in Fire Safety Engineering emphasised. The complexity of fire phenomena and the strong dependence of fire development on details of the input must be recognised. The need for systematic validation exercises working up from simple cases, and recognising measurement uncertainties, remains vital. Discussion focussed on the problem of models validated for benchscale scenarios being misused in other large-scale applications.

The current limits of our knowledge became rapidly apparent in the next talk on the Buncefield incident by **Dougal Drysdale**, Emeritus Professor at Edinburgh University. Lavishly illustrated by impressive images of tank fires and explosion aftermath, Dougal highlighted a number of thought-provoking aspects of the incident: the possibility that the vapour had been ignited by the pumps turned on to disperse it, with initially puzzling damage features elucidated as pertaining to the reverse flow in the rarefaction wave, all pointing at the pumphouse, and the environmental impact of the use of remaining stocks of old foam concentrate, which had been banned from further use. The severity and exact nature of the explosion has still not been satisfactorily resolved via modelling studies, complete with very detailed, but Cartesian, hedgerows. Despite opinions expressed at the time that this incident was unique and could never happen again, Dougal noted that there have already been two more of a similar nature. Hedgerows may indeed have had a role in providing turbulence generation mechanisms and perhaps we need to consider their removal!

Dove-tailing nicely with Dougal's conclusions, **Dr Savio Vianna** of Cambridge University picked up the theme of dealing with complex geometries in accidental explosion modelling. Peak pressures have been well predicted in a range of applications using a Modified Porosity Distributed Resistance (MPDR) model for approximating the flow effects due to complex obstructions (thus potentially of value for Dougal's hedgerows?). Work is ongoing on addressing further aspects of the combustion modelling and the impact of suppression phenomena via deluge and micromist systems.

With another slick progression **Prof. Kai Luo** of Southampton University then took us deeper into the challenges of modelling fire suppression. Liquid phase effects tend to invalidate most of our existing

modelling tools for diffusion flames and attempting to include them we are immediately confronted by severe computational challenges. Nevertheless, by adopting an Eulerian-Lagrangian Approach with an LES/DNS framework, valuable insights into mechanisms have now been achieved – highlighting the need to supply sufficiently small drops which are able to effectively reach the reaction zones and the fact that the cooling effects are dominant over dilution and direct kinetic impacts. Thus fine mists with large evaporation enthalpies will tend to be most effective but optimum droplet size is dependent on the nature of the fire flows.

Having exhausted the topic of suppression we returned to fluid dynamics and the particular problems of entrainment of air into thermal spill plumes, studied in great detail by **Dr Roger Harrison** in his work at the University of Canterbury, New Zealand. These are very relevant practical problems for design of large public spaces but hitherto the spill plume formulae have been constrained by insufficient empirical knowledge, and the application of advanced numerical models, i.e. CFD, limited by other uncertainties. It was found that spill plume behaviour and entrainment are dependent on the characteristics of the layer flow below the spill edge. Roger's work has also resulted in a range of new and improved simplified design formulae for a variety of spill plume scenarios and new guidance on the use of CFD models for these applications.

Coming back to fundamental fire phenomena, **John Griffiths**, Emeritus Professor at Leeds University addressed the topic of lagging fires, a common problem in industrial environments when potentially flammable fluids leak from pipe work into the surrounding insulation material. Such fires may have devasting consequences, and are neglected at our peril! The participating phenomena are highly complex, but John's experimental, numerical and theoretical investigations have revealed the role of different processes related to the nature of the combustion (gas or liquid phase) and the dependence on the fluid properties in interaction with the heating environment, i.e. the energetic effects of vaporisation and the possibility of fluid and vapour movement and recondensation within the porous media. Thus fuel volatility, overlooked in previous studies with mainly involatile liquids, is a key parameter.

The day concluded with a wide-ranging talk on Forest Fire Research by **Prof Domingos Viegas** of the University of Coimbra, Portugal. We were informed of the fundamental experimental research on fire spread dependencies which have clarified basic sensitivities to effects of wind and slope. At full-scale level the role of convection is vital. The mechanisms involved in spot fires have been individually examined and fire tornados have been studied in the lab and at full-scale. The concept of eruptive fire behaviour was described, and the extreme dangers arising from sudden transitions in fire development illustrated by a number of sobering case studies. The talk concluded with lessons learned from the Australian fires in Victoria in 2009, which claimed 173 lives and destroyed 4000 km^2 within 10 hours.

All of the talks raised our awareness of the potentially serious consequences of fire in various arenas and the challenge to the fire community in furthering our understanding and knowledge of the fundamental underpinning fire phenomena. We add to this our responsibility to educate and inform and clearly we have our work cut out and much to do. In concluding the meeting the awards committee recognised some of the outstanding work already being done in these areas in conferring the best poster awards on **Dr A. Snegirev** of St-Petersburg State Polytechnic University, 1st prize for his work on modelling spray fires, and **Jamie Stern-Gottfried** of Edinburgh University / Arup, runner-up for his studies of non-homogeneous fire environments.

Presentations are accessible at http://www.eng.ed.ac.uk/fire/combustion2010

Stephen Welch
Edinburgh University

EARLY PUBLICATIONS RELATED TO COMBUSTION

You will recall that, in a previous Newsletter, I thought it might be interesting to trace and, where possible, to reproduce the earliest accessible combustion articles that have been published. Following from the first entry, I have a bit more speculation to offer about the link between Michael Faraday and the botanist,Sir William Jackson Hooker ("old Hooker", though senior to Faraday by only six years), in connection with studies of the candle flame (see Newsletter, Spring 2009).

The Royal Institution was founded in 1799 by the "scientific community", at the house of Sir Joseph Banks (Chemistry World, March 2010). Banks, also one of the most distinguished botanists of the day, was extremely close to Sir W.J. Hooker and, through the Royal Institution, may well have been the conduit for the Faraday – Hooker link rather than The Royal Society connection, as I had speculated. Perhaps, in reality, the closeness of the scientific community at the time meant that the connections and sharing of experience across diverse disciplines was inevitable, but if anyone has further information, I would be interested to learn of it.

Staying with combustion and the history of Royal Institution for a moment, Sir Humphry Davy was appointed lecturer in 1801 and became the first appointed Professor of Chemistry at the Institution (in 1802). Davy's initial work at the Royal Institution was on electrochemistry, but it was his development of the miners' safety lamp that led to his discovery of heterogeneous, catalytic combustion. In a paper to The Royal Society, in 1817, he described the catalysis experiment as follows (which appears also to indicate that Davy was aware of and investigated flammability limits. Is this the earliest record?)

"I was making experiments on the increase of the limits of the combustibility of gaseous mixtures of coal gas and air by increase of temperature. For this purpose, I introduced a small wire-gauze safe-lamp with some fine wire of platinum fixed above the flame, into a combustible mixture containing the maximum of coal gas, and when the inflammation had taken place in the wire-gauze cylinder, I threw in more coal gas, expecting that the heat acquired by the mixed gas in passing through the wire-gauze would prevent the excess from extinguishing the flame. The flame continued for two or three seconds after the coal gas was introduced; and when it was extinguished, that part of the wire of platinum which had been hottest remained ignited, and continued so for many minutes, and when it was removed into a dark room, it was evident that there was no flame in the cylinder. It was immediately obvious that this was the result which I had hoped to attain by other methods, and that the oxygen and coal gas in contact with the wire combined without flame, and yet produced heat enough to preserve the wire ignited, and to keep up their own combustion.

I proved the truth of this conclusion by making a similar mixture, heating a fine wire of platinum and introducing it into the mixture. It immediately became ignited nearly to whiteness, as if it had been itself in actual combustion, and continued glowing for a long while, and when it was extinguished, the inflammability of the mixture was found entirely destroyed. A temperature much below ignition only was necessary for producing this curious phenomenon, and the wire was repeatedly taking out and cooled in the atmosphere till it ceased to be visibly red; and yet when admitted again, it instantly became red hot."

Many other combustible vapours mixed with air were found by Davy to respond to catalytic oxidation at a platinum surface, leading also to the first observation of cool flames. "When the experiment in the slow combustion of ether is made in the dark, a pale phosphorescent light is perceived above the wire which of course is most distinct when the wire ceases to be ignited. This appearance is connected with the formation of a peculiar acrid volatile substance possessed of acid properties."

The development of Davy's safety lamp began in1815. Experiments with samples of fire-damp, sent from Newcastle, revealed that "explosive mixtures of mine-damp will not pass through small apertures or tubes"; and in another paper presented to the Royal Society Davy explained that metal tubes were superior to glass ones for dissipating heat, and that "the heat lost by contact with a large cooling surface brought the temperature of the first portions of gas exploded below that required for the firing of the other portions". Subsequently, he showed that wire gauze was more satisfactory than narrow tubes. In 1816 the gauze safety lamps were brought into use in coal mines.

This part of the history of combustion studies, and the Newcastle connection, leads neatly to the offering that Guillermo Rein sent me, which eclipses my contribution of early combustion literature. The text appears to follow from an earlier communication to which Robert Boyle had responded with a series of questions.

"A Letter written by D. Lucas Hodgson, Physician at Newcastle, containing some observations made by him of a subterraneal fire in a coalmine near that city", published in Philosophical Transactions.

Sir, *Newcastle,* May the 15, 1676.

I had long since returned my humble thanks to the Royal Society for their candid acceptance of my paper; and particularly to you for your most obliging Letter, had I not thought a farther account of what I have observed in the fire, would be more acceptable to that illustrious Body; particularly to the Honourable Mr.Boy/e, for whose ingenious queries I give him most hearty thanks, accounting my self happy, that by this occasion any thing of mine should come under the consideration of so worthy a person. To the end therefore that I might return more than words, (as my occasions would permit) I have several times visited the fire, diligently observing what might occur at the various places of its eruption, whereby I am in some measure enabled to give a particular Answer to his desire in that matter.

Qu. 1. *Whether the vents of the Subterraneal fire are not subject to paroxysms or great fits of eruption at times?*

2. *Whether those notable eruptions do happen regularly at any set times, or fortuitously*; *and if at set times, whether these times be at the beginnings, middle or endings of any of the four seasons of the year?*

3. *Whether from the eruption, the silence or suppression, or the smoking of the Subterraneal fires, any certain or probable prognostick can be made of changes, of weather, or of Meteors; and if they can, how long they are wont to precede the things they presage ?*

Ans. This Fire keeping no analogy with other Vulcanio's in any of the particulars mentioned in these three queries, I thought fit to answer them altogether to avoid prolixity, seeing all that I can observe is, that it increaseth or decreaseth according to the subject it feedeth on; which is for the most part *Day Coal**, as they call it, so that you may light a candle at it in some places, in others it is some fathoms deep, according as the day Coalheightens or deepens; in other things it is no ways instructive. (* *The upper seam of the Coal, next exposed to the Air.*)

4. *Whether the Marcesites that are found in or next to the Burning" Coalpits be of such a nature, as being laid on heaps small or qreat, and drenched with rain or other water, they will be of themselves actually take fire?*

Ans. I remember that Dr. *Pewer*, in his book of *Microscopic Observations,* page 62, takes notice of such an accident; but I do not understand that any with us have observed the like.

5. Whether in those Coalmines they find any actual Sulphur in its proper form, that may safely be concluded not to have been produced by the action of the fire upon the Marcasites?

Ans. I never saw any, nor any man else that I can hear of.

6. *Whether the Sal armoniac be found any where thereabouts, have in those places where an actual fire hath come, and also which have been accessible to the Air?*

Ans. No Sal armoniac, nor any thing like it to be found, except at the fire.

7 Whether at the mouth of these Igneducts, where flowers of Sulphur and Sal armoniac are found there do issue forth any steams or exhalations that may be rather looked upon as the productions of actually kindled Sulphur, than of Sulphur barely sublimed? Which may be tried by holding ever the vent Red rose leaves, or any of tbose other bodies that are wont to be blanched, or made pale by the fume of burning Sulphur?

Ans. There being such a mixture of the steams of Sal armoniac and Sulphur rising together in most places, it is hard to distinguish them; for though the flowers of Brimstone seem to rise first, yet there is commonly a crust of Sal armoniac under them; as for the Experiment, I shall try it as soon as any Roses are blown.

8 Whether the milky substance that is mentioned in the paper, be ever found among the Metallin oars, or merely among stones; and whether it be found so surrounded every way with stone, that no channel or other visible passage can be found, at which it may probably be suspected to have entered into the Cavity wherein it was lodged?

Ans. The Milky substance is found no where but where the Sal armoniac and Sulphur are totally gone, and the acid part or Aluminous Spirit of that white mass will also take wing by the increase of the fire, leaving a *caput Mort.* dry, stiptick and as hard as a stone; yet I account that a pound of this mass, before the fire press too much upon it, will go near to afford by Solution, etc. half a pound of tolerable crystallin Allum; but why this substance should rise so high as the surface of the Earth, though I have some reasons, yet they not being satisfactory to my self, I shall not trouble you with them.

9. Whether in the places where the Sal armoniac is found, the neighbouring soil be nitrous, or yield any store of common salt?

Ans. The neighbouring soil differs little from other grounds, having neither common salt, nor Niter in it; for though there be Salt-weil with us, yet it is both on other side of *Tyne* (ed. *for overseas readers, meaning the river running through Newcastle*), and a considerable distance from the fire.

…and so it goes on with a lengthy question, and even more lengthy answer, concerned with the possibility that "Sal armoniac" may have leached into the mine from springs, as follows…

Ans. I have industriously observed the Springs that are near the fire and none of them that give the least suspicion of Sal armoniac. The water that runs from the adjacent Colyeries is vitroline, giving as deep a tincture with Galls as *Scarborough Spaw* (ed. *i.e. natural spring water discovered in Scarborough, 1626, and thought to have medicinal and healing properties*). In other word, it differs nothing from the waters that ordinarily drown our Colyeries, and cost our Coal-owners so much to be quit of them…..

COMBUSTION LINKS AND CALENDAR

http://www.combustioninstitute.org; http://www.combustion.org.uk;
http://www.afm.asso.fr; http://ukelg.ps.ic.ac.uk/; http://www.iop.org/activity/groups/subject/comb/index.html
http://www.see.ed.ac.uk/fire/links.html

2010

1-6 August
Tsinghua University, Beijing, China
33rd International Combustion Symposium
Details: http://www.combustion2010.org/

6-8 September
University of Leeds
8th European Conference on Coal Research and its Applications
Details: http://www.coalresearchforum.org

15 September
Department of Engineering, University of Cambridge
British Section Autumn Meeting and AGM: "Combustion in Gas Turbines Present and Future Challenges"
Details: Simone Hochgreb [simone.hochgreb@eng.cam.ac.uk]

22 September
Department of Chemical Engineering, Imperial College London
46th UKELG,"Causes, Severity and Mitigation of Aerosol and Particulate Explosions"
Details: http://ukelg.ps.ic.ac.uk/ or email: Graham Schleyer, schleyer@liv.ac.uk

29-30 September
Gothenburg, Sweden
FIVE: FIRES in Vehicles
Details: www.firesinvehicles.com or email: brutskick@sp.se or fredrik.rosen@sp.se

3-8 October
Kos, Greece
ICCMSE2010: Int. conference on computational methods in science and engineering
Details: http://www.iccsme.org

26-29 October
Hangzhou, Zhejiang Province, China
2010 International Symposium on Safety and Technology
Details: Prof FENG Changgen; email LSC@issst.com.cn

10 November
University of Edinburgh, Edinburgh, UK
"Fire Safety Enginering in the UK: The State of the Art"
Details: email Ricky.Carvel@ed.ac.uk

10-13 December
Hyderabad, India
8th Asia Pacific Conference on Combustion (ASPACC)
Details: Pradip Kumar Pandey, Secretary, Indian Section of the Combustion Institute
[Pradip.Pandey@infotech-enterprises.com]

2011

26–29 April
Estoril – Palacio Estoril Hotel, Portugal
9th European Conference on Industrial Furnaces and Boilers
Details: http://www.cenertec.pt/infub

28 June - 1 July
University of Cardiff, Cardiff, UK
ECM 2011: 5th European Combustion Meeting
Details: http://www.ecm2011.org/ (Abstract deadline 30 September 2010)

24-29 July
Irvine, California, USA
23rd International Colloquium on the Dynamics of Explosions and Reactive Systems
Details: http://icders2011.eng.uci.edu