SUSTAINABLE INNOVATION IN REFRIGERATION AND AIR CONDITIONING

SIRAC News

NEWSLETTER – 7

JANUARY 2011

The built environment at Nottingham

SIRAC visited the University of Nottingham Centre for the Built Environment in October as a fast-track introduction to innovation in the sustainable building heating and cooling.

An overview from the Head of Department, Siffa Riffat, just scratched the surface of some of the wide range of new technologies being researched and developed by the Department and which we are likely to see in our homes and offices in the near future.

A number of students presented their work funded under collaborative European projects and EPSRC funded work. Highlights included developments in improving leak tightness of buildings, applying integrated facades for low cost, high efficiency heating and cooling in both new and existing buildings, PV/T evaporators for heat pump systems and the use of solid dessicants in air conditioning systems as an alternative to refrigerant fluids.

Moving from theory to putting ideas into practice, a tour of the University's low to zero carbon model houses was included in the programme. These had been designed and built based on a collaboration of 20 different companies, using experimental technologies evaluated by researchers at the University. Some of the houses are used to illustrate how these technologies can be applied to older 1930's housing stock, others are built to new building regulation standards. All are actually occupied so that realistic measures of energy in use are taken and performance in operation can be evaluated.

Low carbon houses at Nottingham

Low carbon commercial building design also featured with a presentation from Greenfield Technology on their unique closed loop borehole for geothermal heating and cooling. This system has been applied in Sainsbury's Crayford, and is expected to save 30% of the energy bill. We expect to hear more about this interesting case study in the future.

> "Socio-technical issues restricting the choice of new technologies, need to be overcome if we are to move towards a low carbon industry"

Getting to grips with sustainability

Sirac has regularly been attracting 40 – 50 people along to its meetings. The attendees have been able to become involved in a huge range of low carbon technologies that are being developed for, amongst many applications, air conditioning, commercial systems, heat pumps and satellite cooling. Focusing on individual technical improvements is important, but equally important are the"socio-technical" issues – in other words, how the non technical issues interfere with technological developments. These type of issues restrict the move towards becoming a low carbon industry, rather than an industry which can chose from a selection of low carbon options.

In really getting to grips with these difficult issues the group started by identifying some of the barriers or resistances. Some of the ideas generated are shown in the table overleaf.

NEXT SIRAC MEETINGS

7th February 2011 BSRIA Bracknell

11th March 2011 University College Dublin event (rescheduled)

Further meetings for the year are planned at the IIR Congress in Practice and at UK Manufacturers…. Check website for updates.

Sirac networking report continued..

Socio-technical issues affecting take up of new technology

Personal	Professional	Global
Taking responsibility	Influencing others higher up the decision ladder	Enabling legislation and targets
Education and lack of knowledge or understanding	Short term views	Regulation driven by non technical views
Frustration – no one else is doing it so why should I?	Financial barriers and cost	Incorrect public perception or lack of awareness
Complexity of solutions – people respond better to things that make life easier	Vested interests	Lack of incentives
Cynicism – too much effort, lack of support for new ideas	Cynicism – will it work? Is it effective?	Negative consequences of in effective political actions

An overriding theme of the difficulty of changing our own mind set let alone changing those of others, especially when a particular way of thinking or operating is engrained in the values of society was clear. And the conflict between personal sort term interests and the common longer term interest was evident as was the challenge of applying personal objectives in the workplace environment.

The discussion that followed helped to understand just how difficult it is to make changes in how we think, let alone to influence others to make these changes (if it isn't broke don't fix it!). "Its difficult to change your own mindset let alone change that of others, especially when this is engrained in the values of society" said one of the delegates.

Fast failure is difficult but helpful

The next group session picked up the theme of Niche Innovation. Progression can appear random and unstructured because there are so many different technologies and its hard to identify which one is going to be the winner in a complex environment. The conclusion was that it was most likely to be the technologies that are aligned with other aspects such as social pressures and legislation that would be more successful. Although it is recognised that technologies, like ideas, evolve and even the most promising may eventually fail. "Fast failure is difficult but helpful – entrepreneurial failure is often misrepresented,"we need to learn to fail well to be successful entrepreneurs" said Chris Seeley, one of the researchers in the recently published Low Carbon Works project.

To put some of these ideas into practice, those present were encouraged to share ideas about what they would do to help move from the nice innovation to the socio-technical change level. There was a lot of energy around some of the ideas put forward:

Sharing technical expertise more widely

- Talk less and listen more
- Become a champion of innovation by helping to filter and identify market values
- Make more external links, broaden range of contacts and information sources
- Ask people what they NEED not what they think the want
- Model the behaviour to try to encourage change
- Actively seek out ways of helping new technologies to align with market needs
- Press for change internally

These discussions echoed the problems faced and opportunities being pursued in other industry sectors. The project "Insider voices – the human dimension of low carbon technology" was quoted as a good example of how people are addressing these issues.

The 10 ingredients for making low carbon change are ones which the SIRAC group were keen to pursue:

Involving a diverse range of people
Understanding how the whole system works and identify the right opportunities
Identifying champions and translators between the innovators and business

- Having a wide vision
- Preparedness to do something different and take risks
- Operating in a positive , proactive and enabling culture
- Daring not to know and finding out the answer
- Networking externally and finding connections
- Applying feedback and using positive feedback loops
- Tenacity!

Industry visits programme

Denmark continues to drive for natural refrigerants

The UK refrigeration, AC and heat pump industry benefits considerably from research activities by global organisations. Much of this activity takes place at centres outside the UK.

Aarhus in Denmark is home to two centres of research excellence - the headquarters of Sabroe, now part of Johnson Controls and famous for industrial compressors, is just outside the city and a short distance away is the Danish Technological Institute's Aarhus site which undertakes a wide range of experimental projects.

Denmark's outlook on new refrigerants is tempered by a national regulatory and tax structure under which HFCs are banned from new equipment containing a charge of more than 10kg. HFCs can only be used in equipment with a charge below 150g, so only very small sealed HFC systems are permissible. In addition they have an environmental tax which means that the cost of R404A is approximately £60/kg.

The focus is on improving efficiency and flexibility of carbon dioxide systems

It is not surprising therefore that Danish industry considers that technological issues related to the use of CO2 as a refrigerant are now mainly resolved and their focus has moved to improving efficiency and flexibility. These developments are necessary to enable improvements in cost effectiveness in industrial and commercial systems using natural refrigerants as alternatives to the traditional HFC refrigerant.

Johnson Controls

Whilst not ignoring HFC developments, the focus for Sabroe is firmly on ammonia, CO2 and hydrocarbons. In particular Sabroe is committed to developing the full potential of ammonia as a refrigerant with reciprocating and screw compressors and chillers.

A Sabroe CAFP (CO_2 and Ammonia Cascade Freezer Package)

Reciprocating compressors play a key role ensuring that high efficiency systems with new refrigerants are commercially viable.

With variable speed drive, each parameter affecting the efficiency and boundaries of operation is carefully explored. Screw types benefit from economisers and slide valve control, and combining this with high speed operation gives tremendous flexibility – in a chiller control system.

A typical Sabroe screw compressor package of the current generation

Sabroe's Aarhus facility allows development work on all sizes of machine to be verified in the test house.

JCI's extensive R&D work currently involves over 20 projects; from new product development to improving existing products. Two recent examples relate to continued improvements to reciprocating compressors. Significant new work has been undertaken to measure and map the behaviour and performance of the compressor valves in operation. This has provided an improved understanding the valve behaviour and enabled the development new valve geometry and management. This has improved the operating efficiency over a wide range of refrigerants and operating conditions, without any penalty to the operating lifetime, has been achieved.

A substantial body of new research and testing has developed a new design of base frame and coupling that allow reciprocating compressors to be operated over a wider range of speeds and without any 'black spot' frequencies that traditionally have had to be avoided.

Measuring and mapping compressor valve operation

Part of Sabroe's extensive R& D facilities in Aarhus

Those interested in compressor history will find plenty to see in the Sabroe collection where immaculately restored models dating from the earliest days to the present also can be viewed by prior arrangement!

Industry visits programme

Danish Technological Institute

DTI is an independent not-for-profit organisation providing technical services to a wide range of businesses. It was formed in 1906 by a group of companies coming together to share development costs.

The Refrigeration and Heat Pump section is a recognized leader in this field with modern lab facilities for equipment up to 2500kW. Projects are carried out in co-operation with Danish and international industrial partners - typically with approximately 50% of funding from government sources.

The work is shared between facilities in Copenhagen and Aarhus in Denmark. A team totalling 30 people are engaged on projects ranging from novel evaporative condensing to heat pump drying applications. The range of applications is also wide, from plug-in units to industrial processes.

With the introduction of restrictions on HFCs in Denmark it was inevitable research into systems that would avoid their use has intensified in recent years. Carbon dioxide for supermarket applications is one area that has received a special focus and several fully operational CO2 transcritical test rigs have been built for this purpose.

100 kW industrial low temperature CO2 plant used for testing and training

The Aarhus laboratories are also investigating flow in two-phase ammonia suction risers and CO2 heat pumps for raising district heating water temperatures.

Domestic energy research

The performance of innovative domestic energy systems is being compared with more traditional solutions in real life conditions thanks to a specially designed and built "Energy Flex House" which is actually occupied by a family.

The Energy Flex House in Copenhagen at The Danish Technological Institute

A dwelling and a high-tech laboratory

This is simultaneously a dwelling and a high-tech laboratory where complete systems for the building industry can be developed, tested and demonstrated. Building components and installations can be changed, for example boilers to heat pumps; radiators to underfloor distribution, with both on-line visualisation and data fully logged.

You can watch on-line measurements of the energy systems of the flex-house on this website

http://datalog.energyflexhouse.dk/pview/index.html

A training resource

Training courses have been an on-going activity for the DTI, and the development of their expertise in carbon dioxide systems has led to the development of specialized courses in transcritical systems (theoretical and hands on) which have been extended to several countries in Europe.

Research review and database

"There are many examples of excellence and innovation in the R&AC industry and the whole sector must continue to work together to deliver significant carbon and energy savings. By gathering this evidence we can make a robust case for greater government investment to deliver the reductions required." Graeme Maidment at a recent SIRAC meeting.

Work is continuing on the review of publicly funded refrigeration research in the UK, and a database is being developed. To the original listing of 50 projects from the SIRAC website, a further 77 projects have been added, based on data obtained from the Carbon Trust, EU FP6, DEFRA Link, and current EPSRC project databases. The largest value awards have been from the EU, averaging 1.23 million euros. However, these projects normally involve a number of project partners from an average of 5.5 different countries. A particularly large recent project received a 7.28 million euro award to investigate small and medium scale trigeneration systems.

This was a German led project involving 10 different countries, although not including any UK partners. Another recent project received a 2.67 million euro award to investigate thermally operated mobile air conditioning systems. This was an Italian led project involving 7 countries, including one UK partner. A more detailed analysis of the data obtained from the SIRAC refrigeration research review will be provided at the end of the project.

Details of 49 projects undertaken by SIRAC members have been provided to date, a number of which correspond to those already identified. However, these represent the responses of only a small number of SIRAC members. It would be very helpful in identifying all sources of funding for refrigeration research, if all SIRAC members could complete the form circulated in November and return it to me as soon as possible.

Further details of the refrigeration projects identified to date will be presented at the next SIRAC meeting.

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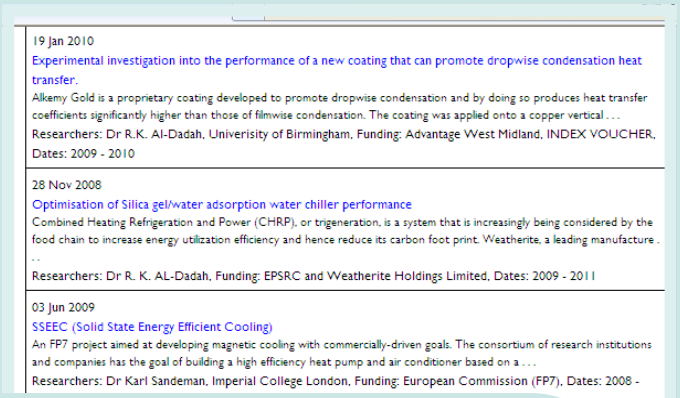


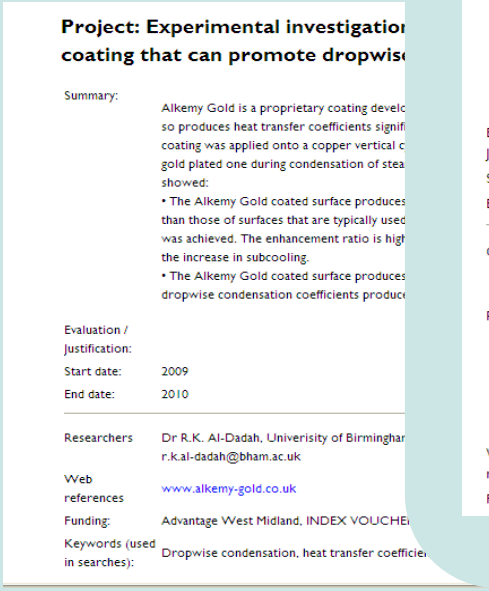
19 Jan 2010
Experimental investigation into the performance of a new coating that can promote dropwise condensation heat transfer.
Alkemy Gold is a proprietary coating developed to promote dropwise condensation and by doing so produces heat transfer coefficients significantly higher than those of filmwise condensation. The coating was applied onto a copper vertical . . .
Researchers: Dr R.K. Al-Dadah, Univerisity of Birmingham, Funding: Advantage West Midland, INDEX VOUCHER, Dates: 2009 - 2010

28 Nov 2008
Optimisation of Silica gel/water adsorption water chiller performance
Combined Heating Refrigeration and Power (CHRP), or trigeneration, is a system that is increasingly being considered by the food chain to increase energy utilization efficiency and hence reduce its carbon foot print. Weatherite, a leading manufacture . . .
Researchers: Dr R. K. AL-Dadah, Funding: EPSRC and Weatherite Holdings Limited, Dates: 2009 - 2011

03 Jun 2009
SSEEC (Solid State Energy Efficient Cooling)
An FP7 project aimed at developing magnetic cooling with commercially-driven goals. The consortium of research institutions and companies has the goal of building a high efficiency heat pump and air conditioner based on a . . .
Researchers: Dr Karl Sandeman, Imperial College London, Funding: European Commission (FP7), Dates: 2008 -

Project: Heat driven refrigeration and air conditioning

Summary:	Warwick is at the forefront of research in adsorption refrigeration, heat pumps and air conditioning. Currently, there are projects running in such diverse fields as tri-generation from biomass in developing countries to waste heat driven car air conditioning and the development of gas fired heat pumps for domestic boiler replacement in the UK. The design of heat driven systems relies on optimising heat and mass transfer within them. This work has concentrated on optimising heat transfer through developing patented heat exchanger designs and working with materials suppliers to improve the characteristics of their products. Patents have also been awarded for novel system operating and design methods. We are continuing our innovative approach with research into new refrigerant mixes and hybrid sorption-compression systems.
Evaluation / Justification:	
Start date:	2009
End date:	2009
Outputs	Adsorption Refrigeration - *16 Apr 2007* presentation in pdf http://www2.warwick.ac.uk/fac/sci/eng/research/seed/heat-pumps/warwick_critoph.pdf
Researchers	Bob Critoph, University of Warwick mailto:R.E.Critoph@warwick.ac.uk Zacharie, Telto mailto:Zacharie.Tamainot-Telto@warwick.ac.uk Stan Shire, University of Warwick mailto:Stan.Shire@warwick.ac.uk
Web references	University of Warwick SEED
Funding:	various, EPSCR, DEFRA, Royal Society, ATMI



Project: Experimental investigatio
coating that can promote dropwis

Summary:	Alkemy Gold is a proprietary coating develo so produces heat transfer coefficients signifi coating was applied onto a copper vertical c gold plated one during condensation of stea showed: • The Alkemy Gold coated surface produces than those of surfaces that are typically used was achieved. The enhancement ratio is high the increase in subcooling. • The Alkemy Gold coated surface produces dropwise condensation coefficients produc
Evaluation / Justification:	
Start date:	2009
End date:	2010
Researchers	Dr R.K. Al-Dadah, Univerisity of Birminghar r.k.al-dadah@bham.ac.uk
Web references	www.alkemy-gold.co.uk
Funding:	Advantage West Midland, INDEX VOUCHE
Keywords (used in searches):	Dropwise condensation, heat transfer coefficie

SIRAC looks to the future

The SIRAC steering group are continually evaluating how the network is moving forward on its key objectives and how it will become sustainable in the future

Objectives	Actions	Achievements so far	Next steps
For Industry and academia to work more closely together to benefit from knowledge, funding opportunities and innovation	Regular network events, International Conference, Case studies written up, Programme of academic and company visits	KTP for the IOR set up Carbon Trust Roadmap, Kick Start projects funded, Links with ICEE, REAL Zero, FRISBEE	Identify missing linkages between industry / academia – Engagement with SIRAC members – have other outcomes have been achieved?
To understand and plan a strategy for a sustainable refrigeration industry	Futures event Network events Industrial visits Dragon's den Technology Review at the International Conference on Sustainability and the Cold Chain	Carbon Trust Roadmap for the commercial refrigeration sector has been developed and the Carbon Trust is considering further refrigeration road map projects for related sectors.	Develop a national RAC strategy/ policy with SIRAC members identifying UK current position and future needs Identify and influence policy makers Link with other related industries – construction, mechanical, buildings Understand how other networks have successfully helped people make connections to accelerate technologies and overcome barriers
To identify and enhance funding opportunities and R&D needs	SIRAC Website with list of funding opportunities and presentations Examples of funded projects at Network meetings "Exchange" section on the website	Website presence is strong for SIRAC Raised the profile SIRAC with companies and academic visits programme written up as Research 5 Technology sheets on the website	Identify specific collaborative projects set up as result of SIRAC - survey Research Review project to identify what funding is supported and compare this to other industries
To help develop research ideas into projects	Kick start projects Network sessions	Four Kick Start projects funded Other possible collaborations.	Reports on kick start projects to be disseminated at future network meetings
To disseminate and communicate information on RAC and its environmental sustainability	Network events Site tours Newsletters Technology sheets Press articles	9Network events held 7 Site tours as part of events 7 Newsletters and regular e-news 5 Technology sheets published 300 website subscribers 280 attendees at events	Research review project interim report in September to be promoted Additional Technology review sheets planned Regular innovation articles in trade magazines

About the SIRAC Network

SUSTAINABLE INNOVATION IN REFRIGERATION AND AIR CONDITIONING

SIRAC is a networking organisation for promoting new technology in refrigeration and air conditioning. It will increase the flow of information between those with problems to solve and those with the ideas to solve them. Come to the meetings and join in the web discussion to exchange ideas with others who seek better ways of cooling our world.
The current membership is just the start. How does It work? Come to the meetings, visit the website and start networking.

E-mail: sirac@ior.org.uk Website: www.sirac.org.uk

founded by the IOR **funded by ESPRC**

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