Annexes, ongoing

Final working meeting of IEA HPP Annex 32

The topic of IEA HPP Annex 32 is the investigation and further development of multi-functional heat pump (HP) systems for application in residential low and ultra-low energy buildings, covering the different building services of space heating (SH), domestic hot water (DHW) and partly the ventilation (V) and space cooling (SC) functions, including dehumidification and humidification (DH/H).

The 7th Annex 32 working meeting was held in Montreal, Canada on Sep. 14–16, 2009. The meeting agenda included a two-day expert meeting and a one-day technical tour to visit two field monitoring objects, so-called EQuilibrium houses, which are Canadian Net Zero Energy Buildings (NZEB) with integrated solar technologies.

The aim of the expert meeting was to exchange current results from the national projects and to discuss deliverables from Annex 32. The national contributions can be mainly separated into system analysis, prototype developments and field testing of new and existing system solutions. In the following some of the results from the national project are presented.
Within the framework of the prototype developments an integrated brine-to-water CO_2 heat pump for space heating (SH), domestic hot water (DHW) and space cooling (SC) was developed and is currently being lab-tested as part of the Austrian contribution at the Institute of Thermal Engineering at TU Graz. After the finalisation of lab-tests, system simulations to evaluate seasonal performance and control issues will be performed.

The USA has developed prototype systems of an air-source (AS) and ground-source (GS) integrated heat pump (IHP) for net zero energy building application which cover all building functions including dehumidification. Net zero energy building simulations showed a reduction of system energy consumption of above 50% compared to DOE minimum-requirement, state-of-the-art technology. Field tests of the AS and GS-IHP prototypes are currently in preparation and are planned to start in 2010.

Norway performed different feasibility studies for the application of CO2 heat pumps in low energy buildings. An SPF of 3.8 was calculated for DHW applications in particular, resulting in savings potentials of about 75% compared to common direct electric water heating in Norway.

Within the framework of the field monitoring projects the Austrian Institute of Technology (AIT) completed field monitoring of 10 SH and combined SH&DHW heat pumps with different source and emission systems. Seasonal performance factors (SPF generator based on energy produced by the heat pump and electrical back-up divided by the electrical expense for the generator(s) and the source system) for ground water-coupled systems and SH mode are above 4, and for A/W systems above 3. DHW performance ranges between 2.2 and 3.5 and overall performance is in the range of 3 to 4.2.

In the Swiss project, preliminary field monitoring results from the two-year measurements of a ground-coupled heat pump with passive cooling function in a multi-family building, according to the Swiss MINERGIE-P® standard, were completed. In the second winter period, an optimisation of the heating curve led to an improvement in the overall SPF generator (based on produced energy) for space heating, DHW and space cooling from 3.8 to 3.9 and of the SPF system (based on delivered energy) from 3.3 to 3.5.

Germany is carrying out two large field tests of around 100 heat pumps in low energy buildings and around 75 heat pumps in existing buildings as replacements for boilers. Table 1 gives the resulting overall seasonal performance values (system boundary SPF generator) for the different system configurations.

Table 1: Seasonal performance generator in the two German field tests.
** Average of 17 systems, **average of 61 systems*

Field monitoring	HP Efficiency (low energy buildings)			HP existing buildings (high flow temperatures)	
Period	7/2007-7/2009		1-12/2008	1-12/2008	
HP-Type	A/W	B/W	W/W	A/W	B/W
SPF SH&DHW	2.9*	3.8**	3.5	2.6	3.3

In Japan a new design and calculation method for heat pump air conditioners (HPAC) developed in the framework of Annex 32 has been adopted in the Act Concerning the Rational Use of Energy in 2009. The method enables a better design of HPAC for low energy buildings, since the old method led to oversized systems. In the Hokkaido area, two field tests with ground-coupled heat pumps confirmed that low energy buildings with the respective heat pump systems can reduce primary energy consumption by more than 50% compared to oil boiler heating in conventional buildings in the region. A design tool for this typical system solution for broad introduction in cold climate zones has been developed and work continues on the design of a compact integrated heat pump including ventilation function.

Sweden is starting field monitoring in low energy buildings with heat pumps, where measurements of the winter period can be included in the Annex 32 results. As a consequence of new requirements regarding energy use in new Swedish buildings, improved inverter-controlled exhaust air heat pumps will be introduced on the Swedish market. These heat pumps will have a size and price that make them ideal as an economic heating system for low energy buildings. Results from completed field tests of ground source heat pumps and exhaust air heat pumps in existing and new-built standard Swedish single-family houses will be translated and made available to Annex 32.

Work in most of the national projects was concluded by the end of 2009. Main Annex 32 deliverables will refer to system solutions and designs, new system developments in the prototype state, documentation and best practices in field test activities in the different countries. Final results will be presented to the ExCo in June 2010 and made available in autumn 2010. It is intended to present the final results at a workshop on the 10th IEA Heat Pump Conference in Tokyo in May 2011. Updated information on the IEA HPP Annex 32 project and the national contributions, publications and links are provided on the Annex 32 website at http://www.annex32.net.

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Fig. 1: Participants at the 7th working meeting of IEA HPP Annex 32 in the centre of Montreal

ANNEX 33: COMPACT HEAT EXCHANGERS IN HEAT PUMPING EQUIPMENT

The Final Report is being checked by Participants at present, but the provisional conclusions may be of interest to readers:

"The outcomes of Annex 33, which was concerned with compact heat exchangers (CHEs) in heat pumping equipment have been many, quite diverse in their nature and comprehensive.

The objective of this Annex was to present a compilation of possible options for compact heat exchangers, used as evaporators, condensers and in other roles in heat pumping equipment. The aim of the work was to highlight technologies and techniques to minimise the direct and indirect effect on the local and global environment due to operation of, and ultimate disposal of, the equipment.

The Annex involved five countries – Austria, Japan, Sweden, the United States and the United Kingdom, the latter acting additionally as Operating Agent. The Annex ran for three years, the final Annex meeting being held in the UK in September 2009.

The Annex deliverables consist of a wide variety of data ranging from fundamental research on boiling in narrow channels to guidelines for selecting and using CHEs in heat pumping systems. There are considerable market data available within the Report and the cited references, and a number of novel heat exchanger concepts, including the use of new materials and the application of process intensification methods, should allow equipment manufacturers in the future to achieve the Annex aim.

Particular aspects that it is considered worth highlighting in the Conclusions are:

1. The increasing interest in, and use of, CO_2 as a working fluid. This has interesting implications in terms of the equipment used and the concepts for heat pumping that might be applied – see particularly the inputs from Austria and Japan.
2. The growing market for domestic heat pumps, where efficiency, arising in part out of the increased use of CHEs, is critical to further sustained market growth, particularly in countries where heat pump use has been slow to materialize.
3. The vast portfolio of research on heat transfer and fluid dynamics in narrow channels in CHEs. The research highlighted in Sweden, Japan and the USA are of particular note.
4. The role heat pumps could play in industry, where reduced payback times could be aided by CHEs. The UK study highlights the market possibilities.
5. There is a need to educate the heat pump industry in the use of CHEs, their merits and limitations, and the types that are available. The use of new materials, as indicated in some of the research in the USA, could reveal new opportunities.

The project has brought together many experts in the heat pump/CHE field and the Annex Report will, it is believed, be a major and constructive source of data for those interested in using CHEs in heat pumping equipment."

Recently the industrial heat pump aspects have received support from the UK EPSRC with a project linking Brunel, Newcastle and Northumbria Universities to optimize the selection and placement of process heat recovery equipment (including heat exchangers and open and closed cycle heat pumps). CHEs will have a major role to play here.

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