

IEA Heat Pump NEWSLETTER

CENTRE

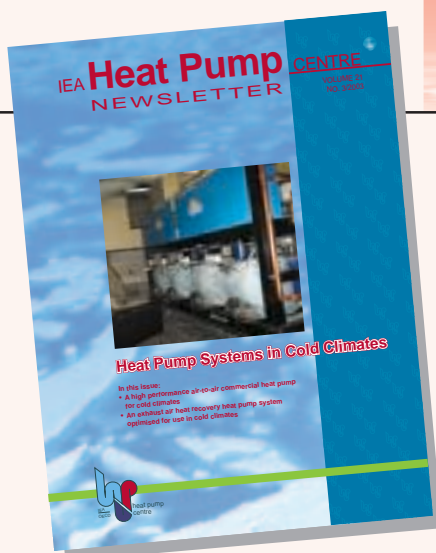
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Heat Pump Systems in Cold Climates

In this issue:

- A high performance air-to-air commercial heat pump for cold climates
- An exhaust air heat recovery heat pump system optimised for use in cold climates



In this issue

Heat Pump Systems in Cold Climates

This newsletter focuses on Heat Pump Systems in Cold Climates. In cold climate regions, conventional electrical heat pump systems are often unable or uneconomic to operate at low ambient temperature. Research into heat pump systems working at low and high ambient temperature has resulted in the development of new types of heat pump systems and systems with improved heating capacity.

Front cover: Compressor module of heat recovery heat pump

COLOPHON

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HEAT PUMP NEWS

General	4
Technology & Applications	6
Markets	7
Working Fluids	7
IEA Heat Pump Programme	9

FEATURES

Foreword	3
Books & Software	22
Events	24
National Team Contacts	26

TOPICAL ARTICLES

- A high performance air-to-air commercial heat pump for cold climates
Kensaku Oguni, Japan 11
- An exhaust-air heat recovery heat pump system optimised for use in cold climates
Vasile Minea, Canada 14

NON-TOPICAL ARTICLES

- New Annex 28 shifts into gear
C. Wemhöner, Th. Afjei, Switzerland 18



Heat Pump Systems in Cold Climates



Cold Climates have always presented a challenge to heat pump systems. Heating capacity is generally lowest at the time of highest heating demand. In cold climates, the heating requirements are generally significantly greater than the cooling requirements. Often much cheaper heating fuels are

available and it is difficult to justify the higher initial cost of the heat pump system through operating savings.

Heat pump markets in cold climate regions have been relatively small. In Canada, for example, with a mix of continental (cold winters, hot summers) and maritime (mild winters, cool summers) climate zones, annual heat pump shipments are typically in the range of 30,000 units. Of these, about two-thirds are air source heat pumps. The remaining one-third is water-to-air heat pumps used in two-pipe water loop commercial systems or in ground-source systems. Recent growth in the commercial / institutional markets is encouraging and is often driven by energy efficiency considerations.

Heat pump performance in colder climates has improved dramatically over the years. Air source heat pump coefficients of performance at the standard rating condition of -8°C have increased from a high of around 2.0 in the early 1980's to today's 2.7, largely due to compressor and heat exchanger improvements. Different approaches have been commercialized to increase heat pump capacity at lower outdoor temperatures - two-speed

compressors, dual capacity compressors, variable-speed compressors. These changes significantly improve the annual performance of air source equipment in cold climate applications by making more heating capacity available at low temperatures. Conventional combustion heating equipment, on the other hand, reached the technological limits of efficiency in the early 1980's with the commercialization of condensing technology.

The continued growth in development of ground source heat pumps provides another system ideally suited to cold climate application. With ground source systems, there is no longer as much concern in cold climates, as the heat exchanger is buried below the surface and sees a relatively stable temperature regime year-round. Ground source systems make larger buildings more architecturally pleasing due to the absence of external equipment such as cooling tower or condensing units. They also require less mechanical room space and require less maintenance than boiler / chiller systems. Most importantly they are very energy efficient. In typical applications, annual heating energy savings are as high as 60 percent (seasonal COP of 2.5).

Doug Cane, P. Eng.
Principal,
Caneta Research Inc.
Canada



Heat pump news



General

US Federal Agencies nearing renewable energy goals - Geothermal heat pumps strong

USA - Federal Agencies are using 663 GWhs of renewable energy, almost halfway to reach the goal of 2.5% of electricity consumption by 2005. The geothermal heat pump systems are ranked the fourth highest of all renewable technologies being used by the federal government, with 88.8 GWh. Renewable energy purchases and credits plus biomass power/thermal stay ahead. The FEMP (Federal Energy Management Program) plans to analyse recent Federal geothermal heat pump installations and add to the renewable energy total.

Source: Earth Comfort Update, Summer 2003, Volume 10, Issue 2

Japan undertaking plan for geothermal heat pumps

Japan - The Japanese Environment Ministry has introduced a programme to use geothermal heat pumps in public facilities. The programme will involve using geothermal heat pumps in hospitals, libraries and city halls in 60 sites across the country. The government and local authorities will fund the major part (2/3) of the installation costs. The Ministry estimates that using geothermal heat pump technology will reduce energy usage by more than 40%. Besides saving energy, the systems address the so-called heat island effect of excessive warming of urban areas.

Source: Earth Comfort Update, Summer 2003, Volume 10, Issue 2

Clear Skies in the UK

UK - The clear-skies programme now has lists of recognised products and accredited installers for ground-source heat pumps: see <http://www.clear-skies.org>

The programme has selected several projects for funding through its community project route. This is additional to its provision of grants for individual ground-source heat pump installations. The projects that include heat pumps are:

- Belgrave Baheno (registered charity), a building in Leicester designed to be low energy, high sustainability (rainwater recycling, natural ventilation, CO₂ neutral).
- Penwith Housing Association. Replacement of existing solid fuel heating systems in 16 elderly persons bungalows where no gas supply is available. It also includes 8 new build family houses. This project is the pilot for the role of a renewable technology in combating fuel poverty in a rural area.
- The National Energy Foundation. The grant will go towards creating a second low energy office building at the National Energy Centre housing the National Energy Foundation, Knowhill, Milton Keynes.

More information: <http://www.clear-skies.org>

New ground-source heat pump organisation

UK - A new organisation, the UK Ground Source Heat Pump Association (UKGSHPA), has been set up to represent the ground source heat pump industry in the UK. Their mission is to promote ground

source heat pump best practice in the UK. The member companies of UKGSHPA provide the design and installation of ground-source heat pump systems, help promote appropriate and effective use of this technology, and focus on the issues to be considered when selecting systems and components and estimating system performance.

More information: <http://www.ukgshpa.com>

The following website gives a good shortlist of recent UK ground-source heat pump activities: <http://www.earthenergy.co.uk/eegrswel.html>

Design tool for standardised heat pump systems

Switzerland - The Swiss have developed an important design tool for standardised residential heat pump system layouts (heating-only). This tool, suitable for systems smaller than 25 kW heating, enables the selection of one out of seven standardised, optimised hydronic designs. The result is a tabular design aid, which makes system selection and overall design much easier. The standard system concepts were developed for air and ground-source heat pumps and supply temperatures of 35-45 °C (new construction) and 55-65 °C (retrofit), with or without domestic water heating. The tool also makes it easier to compare offers from contractors. The Swiss hope that the number of different system designs used in practice will herewith drastically reduce and only the recommended system designs are being applied.

Source: ENET NEWS April 2003

<http://www.waermepumpe.ch/fe>



Adjustment of European Standard 378

Netherlands – Standard EN 378 “Safety and environmental requirements for refrigeration systems and heat pumps” will be adjusted. These adjustments are necessary to implement EN 378 as a harmonised standard within the European guidelines.

Source: Koude & Luchtbehandeling, No. 6 – June 2003

Call for Papers

Natural Working fluids 2004: 6th IIR Gustav Lorentzen Conference will be held in Glasgow, UK on August 29 - September 1, 2004. Main themes: ammonia, carbon dioxide, hydrocarbons, water, air, sorption systems, Stirling systems, ice slurries, and heat transfer and fluid flow. Abstract deadline: February 1, 2004; full-paper deadline: June 1, 2004.

Source: Miriam@ior.org.uk

<http://www.ior.org.uk/gl2004>

21st IIR International Congress of Refrigeration in Washington DC

IIR International Congresses of Refrigeration are highlights in the life of all those interested in refrigeration technology and applications. The 21st Congress, held in Washington DC on August 17-22, 2003 was a resounding success:

More than 430 papers were presented by 1031 authors from 46 countries and all 5 continents were represented.

Among key topics covered in papers and posters presented during the congress:

- new applications for CO₂ refrigerant
- improved energy efficiency of

- refrigeration systems
- safety and quality of food refrigeration
- new developments in refrigerated transport
- performance and health issues of air conditioning
- heat pump equipment and applications
- cryogenic systems and components.

Six plenary sessions were highlights. The well-known plenary speakers were Dr William Phillips, Dr Elsa Murano, Dr S. Forbes Pearson, Dr François Billiard, Mr William Sutton and Mr David Herbek.

Thirteen highly appreciated short courses were held. Mr Jos Bouma (HPC) was a speaker at the short course on Advances in Supermarket Refrigeration organised by Mr Van Baxter (ORNL).

Attendees were able to choose from a wide range of interesting technical tours and a full, varied social programme was run for accompanying persons.

The congress was attended by 750 persons from 58 countries.

The 21st International Congress of Refrigeration was officially opened on August 17 by Mr Jerry Groff and Mr Mark Menzer, co-chairs of the Organizing Committee, and Eric Granryd, President of the General Conference of the IIR.

Another congress highlight was the presentation of IIR awards and distinctions during the delectable Awards Banquet that brought together over 500 people.

Dr S. Forbes Pearson was presented with the IIR Gustav Lorentzen Medal.

Professors Ray Cohen and Lino Mattarolo were awarded IIR Medals of Merit.

Dr Piotr Domanski (USA) was awarded the IIR Science and Technology Medal.

The Young Researchers Award winners are:

Young Researchers Awards	Award winner	Country
Peter Kapitza	Tauno Knuutila	Finland
Alexis Carrel	Eric Marquardt	USA
Clarence Birdseye	Brian Fricke	USA
James Harrison	David Tanner	Australia
Carl Von Linde	Yonglin Ju	China
Willis H. Carrier	Igor Krajci	Slovakia
James Joule	Travis Horton	USA

Other key aspects of the congress were the meetings of the statutory committees of the IIR. All IIR Commissions also held business meetings.

Robert Heap was appointed President of the Science and Technology Council (new name). He took over from Prof. Alberto Cavallini, who had been President of the Scientific Council since 1995. Alberto Cavallini became an Honorary President of the Scientific Council. Three new section Presidents (V. Bondarenko, D. Cleland and S. Van der Sluis) and 6 new Commission Presidents (V. Chrz, C. Bullard, J.P. Homasson, B. Nicolai, D. Tanner, and Long Weiding) were appointed.

An extraordinary meeting of the Executive Committee was held in order to enable the candidate for the position of Director of the IIR, who will take over from Mr François Billiard in October 2004, to introduce himself. Mr Didier Coulomb, delegate of France, was elected Director at the meeting of the Executive Committee (ordinary session).

Attendees highly appreciated the seamless organisation of the congress – thanks to the Organizing Committee and the US National Committee for the IIR chaired by Mr Philip Fairchild – and the warm atmosphere they encountered throughout the event. Each registrant received the proceedings of the congress in CD-ROM on arrival. The CD-ROM can be ordered on the IIR Web site: <http://www.iifir.org>

The 22nd IIR International Congress of Refrigeration will be held on August 21-26, 2007 in Beijing, China.

Source: International Institute of Refrigeration

Technology & Applications

Geothermal energy in Lund – past and future

Sweden – The first geothermal heat pump plant was put in operation in 1984. It has been successful from the technical, economic and environmental points of view. It is therefore not surprising that Lunds Energi AB (LE) is again choosing the geothermal energy option to expand its heat production. The groundwater of the existing system has an initial temperature of about 22 °C and is re-injected back at around 2 – 4 °C. The new system will utilise deep geothermal wells, using geothermal water of > 100 °C, from about 3500 m deep. The energy system analyses show that as much as 250 GWh/year can be extracted from the high temperature fraction (using geothermal water of > 100 °C) and 140 GWh/year from the low temperature fraction (with initial temperature of about 22 °C). The district heating system in Lund will then get about 65% of its total energy from geothermal energy. The new geothermal energy system will reduce the use of geothermal energy from the older heat pump system.

Prof. L. Bjelm
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Lund Institute of Technology
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<http://www.geothermal.tg.lth.se>

Source: Geothermische Energie, No. 40, March 2003

Innovative cooler avoids refrigerants and uses solar power

Australia – An Australian manufacturer has made an innovative air conditioning cooler that is ozone-friendly and requires so little power that it can be used with solar energy. The Coolmax CM50 is an evaporative cooler, so it uses no refrigerant. It requires only 220 W when running at high speed – around 90% less than conventional units. Such a low power requirement allows the

unit to be solar powered. The cooler is better suited to hot dry climates than to humid ones and works well up to a wet bulb temperature of around 22 °C, with a standard rated capacity of 3 kW.

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<http://www.coolmax.mx.com.au>

Source: OzonAction Newsletter, No. 43, December 2002

Quick Install System (QIS) Rooftop central

Netherlands – Carrier BV and Carrier Holland Heating have worked together and combined their specialised knowledge to develop the standard QIS Rooftop central. The QIS maximises the energy savings and minimises the installation costs. When this system is combined with a special feedback control system, a coefficient of performance (COP) of 6.5 is feasible

More information: Carrier B.V. and Carrier Holland Heating

Source: Koude & Luchtbehandeling, No. 6 – June 2003

Thermal energy storage system for Oslo development

Norway – Oslo's Nydalen development combines thermal energy storage and heat pumps in a bid to reduce the consumption of energy for heating and cooling. The Nydalen thermal energy storage project is one of the largest of its kind in Europe. Its 180 bedrock wells and associated heat pumps will play a key part in providing both heating and cooling to a building area that, when completed, will cover almost 200,000 m².

The combination of heating and cooling,

using the bedrock thermal storage with a capacity of 1.8 MW, ensures a high degree of system utilisation. Oil and electric boilers are used for peak loads, and for back-up purposes. With the thermal storage system and heat pumps covering the major part of energy required, annual energy consumption is expected to be 60 – 70% lower than the consumption of an equivalent system based solely on electricity, oil or gas. About half of the wells are now in operation. The remainder will be connected in 2004/2005.

Source: Energy Efficiency Renewable Energy, CADDET Infopoint, June 2003, Issue 2/03

New gas engine heat pump for World Trade Center Amsterdam

Netherlands – In newsletter Vol. 8, No. 3 the gas engine heat pump system for the WTC Amsterdam was introduced. The installation, the biggest in the Netherlands, was realised in the middle of the 80s. The 2.9 MW thermal output (1.1 MW cooling) heat pump has been operating very favourably with high heating Primary Energy Ratios of 1.8-1.9.

The WTC Amsterdam building has recently been renovated and extended with a tower and central entrance building. The new heating and cooling system now includes a gas engine heat pump (2.8 MW), district heating (1.75 MW) and heating boilers (5 MW). The new gas engine driven heat pump provides space heating and cooling (2 MW). Chillers (5.5 MW) provide additional cooling. As before, the engine also serves as an emergency driver for power production. The new installation was commissioned in June 2003.

A special feature of the heat pump is that it is charged with slightly less than 200 kg of ammonia as the refrigerant, which is unique for a big office building in the city of Amsterdam. The charge could be minimised by using plate heat exchangers.

Source: TVVL Magazine, Sept. 2003, No. 9



Markets

Earth energy potential in Europe

France – Green heat offers dynamic growth in Europe. This report says earth energy could exceed European (EU) targets for 2010 by 70%, predicts a coalition of four groups.

The installed thermal capacity of geothermal, including heat pumps, in the European Union last year was 4,332 MW, compared with 883 MW electric capacity from geothermal, and growth is “on the right track” to achieve the 2010 objectives outlined in the EU White Paper, says the report.

By the end of this decade, the White Paper wants 2,500 MW of thermal to come from low energy geothermal (such as heating water in fish farms and greenhouses) and another 2,500 MW from earth energy (ground-coupled heat pumps). If growth continues at current rates, the report predicts low energy applications will grow by 50 MW a year to reach 1,450 MW and earth energy will grow by 10% per year to reach 7,030 MW by 2010.

That 8,480 MWth would exceed EU targets by 70%, with ground-coupled heat pumps providing 83% of the total.

In the European Union, Italy leads with 426 MW of thermal capacity, with France in second spot with 330 MW, Austria at 93 MW (an increase of 45% over 2001) and Germany in fourth spot with 71 MW. However, the ranking for ground-coupled heat pumps is entirely different.

Earth energy calculations count installed units rather than capacity, with a cumulative total of 356,000 ground-coupled heat pump systems among EU members. Sweden leads with 176,000 units and annual sales of 29,000 heat pumps, followed by Germany with 73,455 units. France has 36,000 units and annual sales of 8,000, with annual growth of 30% in recent years. Ninety-five percent of new homes in Sweden are equipped with heat pumps versus 5% in France, and Europe has an average of 0.134 heat pumps for every 1,000 people.

Sweden installs 3.27 ground-coupled heat pump systems per 1,000 inhabitants, but Austria's penetration rate is 0.37 and Finland is 0.28 installations per thousand, with France moving to fourth place with 0.14. Europe has numerous heat pump manufacturers, and some solar thermal companies are diversifying their equipment line to take advantage of “today's high interest for geothermal heat pumps.” Sweden's IVT sold 22,000 heat pumps last year of which two-thirds were earth energy, while Germany's Viessmann is marketing a ground-coupled heat pump that can provide heat to 65 °C.

“Among the three large geothermal sectors, the heat pump industry is currently the most dynamic one,” the report notes, and its potential to meet the targets is “unlike the other renewable energy sectors.”

Source: Systèmes Solaires, No 156, July – August 2003
<http://www.observe-er.org/eufores/baro156.pdf>
 Summary: Refocus Weekly, 17-9-2003
<http://www.sparksdata.co.uk/refocus/archive.asp?accnum=1>

Italian market statistics 2002

Anima/CoAer has released the air conditioning market statistics for 2002. Unfortunately, no separate figures on heat pumps are given. They are included in the air conditioning statistical data. In general the market is growing steadily for residential/light commercial and central air conditioning (mostly chillers) systems. The Italian market, excluding components, is worth approximately USD 1.6 billion. In the residential sector there is a clear trend of disappearing window-type systems, increased use of mobile systems and a rapid growth of room-type split systems. Eighty percent of the split units are imported. Multi-split and variable refrigerant flow systems in the residential/light commercial sector are increasingly used for the building retrofit market in Italy. Italian industry is continuing to upgrade its products for improved energy efficiency and the use of environmentally friendly refrigerants.

Source: JARN, Vol. 35, No 7, July 25 2003

US air-source heat pump market up in July

USA – Even though total shipments for the first seven months of 2003 were down 1% from those of last year, air-source heat pump shipments of 147, 634 were up 15% compared to July 2002. Air-source heat pump shipments up to July totaled 1,017,992 units, up 5% from January-July 2002.

Source: Koldfax, Sept. 2003
<http://www.ari.org>

Working fluids

EU regulation fluorinated gases

Brussels – On August 11, 2003 the EU released its proposal for the regulation (containment, use and marketing) of F-gases (HFCs, PFCs and SF6). The goal is to reduce the emission of F-gases. Measures include:

- minimisation of emission reduction through technical and economic means;
- regular inspection of stationary refrigeration, air conditioning and heat pump installations;
- refrigerant leak detection system for stationary installations with a charge of more than 300 kg;
- reporting of top up quantities for installations with a refrigerant charge higher than 3 kg;
- recycling, reclamation or destruction of F-gases from all refrigeration equipment
- recovery of unused F-gases in refillable containers;
- training, education and certification of installers and service technicians;
- reporting of produced, imported and exported F-gases;
- ban on F-gases with a GWP higher than 150 for new car air conditioning, effective 1 January 2009.

Source: Heat pump Centre



Switzerland forbids HFCs

Switzerland – Following the lead of Denmark, Luxemburg and Austria, Switzerland is now also restricting the use of HFCs. Switzerland forbids HFCs in cooling and refrigeration systems, heat pumps and chillers. Also other applications of fluor-containing materials like insulation will be forbidden in the future. There is a time schedule for the coming years with the requirements and restrictions.

More information:
<http://www.uvek.admin.ch>

Source: Koude & Luchtbehandeling, No. 6, June 2003

UNEP launches “Green Customs” project

Nairobi – Customs officers around the world are getting some extra backup in the on-going battle to beat the multi-billion dollar illegal trade in ozone depleting substances, toxic chemicals, hazardous wastes and endangered species.

With a focus on training border guards to better spot and apprehend criminals trafficking in “environmental commodities,” a new “Green Customs” web site has been launched (see <http://www.unepie.org/ozonaction/customs/>). The web site is part of an initiative to help tackle the growth of environmental crime, one of the most profitable and fastest growing new areas of international criminal activity.

Klaus Toepfer, Executive Director of the United Nations Environment Programme (UNEP), which is driving the new initiative, said that “criminal groups smuggle among others environmentally harmful products like ozone-depleting chlorofluorocarbons (CFCs) whose legal trade is subject to stringent international restrictions.”

The size of the global black market for ozone-depleting substances is estimated to range from 20,000 to 30,000 metric tonnes annually. Illegal imports of these substances are far cheaper than CFCs that are legally recycled or obtained from

limited existing stocks.

The dedicated web site where interested organizations and the customs officers themselves can get information such as lists of upcoming training, environmental trainers, and training presentations and more is a key feature of the project.

More information: Robert Bisset, UNEP Press Officer/Spokesperson for Europe
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<http://www.unepie.org/ozonaction/customs/>

Source: UNEP News Release 2003/37

Business and government on lookout for illegal CFCs and HCFCs

Washington, D.C. - Illegal HCFC imports may be on the rise, according to the Alliance for Responsible Atmospheric Policy (ARAP), which cautioned industry and the public to be certain that their chlorofluorocarbon (CFC) and hydrochlorofluorocarbon (HCFC) refrigerant purchases are legal, and to refuse to buy illegally imported refrigerants.

Source: The HVAC&R Industry, 14 August 2003

High Norwegian fee on HFC

Norway - The Norwegian government has decided on a new fiscal fee, NOK180 per kg CO₂ equivalent ton, on the HFC, starting 1 January 2003. The consequences for the Norwegian refrigeration sector may be severe and smuggling from abroad may become a problem.

Refrigerant	GWP-value	NOK/CO ₂ eqv. kg	Fiscal fee NOK/kg	Approximate fiscal fee Euro/kg
R-134a	1300	0.18	234.00	28.33
R-404A	3260	0.18	586.80	71.04
R-407A	1770	0.18	318.60	38.57
R-407B	2285	0.18	411.30	49.79
R-407C	1525	0.18	274.50	33.23
R-410A	1725	0.18	310.50	37.59
R-507	3300	0.18	594.00	71.91

Source: Scanvac Newsletter, 1/2003

Destruction Technologies

Canada - Eco Logic and Fielding Chemical Technologies Inc. partnered to conduct a test using Eco Logic's Gas-Phase Chemical Reduction (GPCR) technology to demonstrate that the technology could be used for disposal of CFCs and halons. The CFC-12 was selected because it is a highly stable compound and is believed to be one of the most difficult to destroy. The purpose of the test was to demonstrate that CFC-12 could be destroyed using GPCR without the creation of problematic residuals. Results confirmed that there was no CFC-12 detected in the liquid or gaseous outputs, and no residual compounds were created. A copy of the test report can be provided upon request from Eco Logic.

Contact: Fred Arnold EcoLogic International, Inc.
E-mail: fred.arnold@ecologic.ca
<http://www.ecologic.ca>

Source: Ozonaction, no 44 June 2003
<http://www.unepie.org/ozonaction/>

CO₂ heat pump system tested in Japan

Japan - Chubu Electric Power and Maekawa Seisakjo Co. Ltd have been working together to develop a heat pump system using CO₂ as a refrigerant for air conditioning and hot water supply. They have completed development and will start field testing of the system. The excellent

features of the system as well as the development of a screw compressor that can handle high pressures, enable the heat pump to supply high-temperature water (85 °C) and cooling energy to make ice (-6 °C) at the same time. The coefficient of performance (COP) of this system is 4.0 or more.

The system is ideal for consumers who use air conditioners and large volumes of hot water simultaneously and who employ both cooling and heating processes extensively.

Source: Italy Refrigeration World, March 2003, No. 2,

CO₂ keeps it cool on the road

USA – New transport refrigeration systems that employ cryogenics technology and liquid carbon dioxide (CO₂) have been announced. The new systems achieve more efficient temperature control without the need for ozone-depleting refrigerants. European customers have been using such units on trailers successfully for more than four years.

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<http://www.thermoking.com/abouts/pressrel>

Source: OzonAction Newsletter, No. 43, December 2002

IEA Heat Pump Programme

Annex 28 website

Annex 28, Test Procedures and Seasonal Performance Calculation for Residential Heat Pumps with Combined Space Heating and Domestic Water Heating, has its own website, <http://www.annex28.net>, but the site is still under construction. Information about the IEA HPP Annex can also be found at <http://www.heatpumpcentre.org/activity/home.htm>

Successful Supermarket Refrigeration short course

The IEA Heat Pump Programme has made use of the opportunity to promote itself at the 21st IIR Congress in Washington, DC through displayed publications and contributions to the Short Course on Advances in Supermarket Refrigeration. Papers presented at the Short Course included:

- Secondary Coolant Systems - A Path towards Perfection in Supermarket Refrigeration (G. Kazachki)
- Supermarket Spreadsheet Model (S. Fischer)
- Advances in Supermarket Refrigeration – Summary of International R&D Activities under IEA Annex 26 (V. Baxter – operating agent).
- System Solutions for Supermarkets (P. Lundqvist)
- Refrigerant Management Policies and Practices – Results of an HPC International Assessment Study (J. Bouma).

The CD ROM congress proceedings include most of the short course presentations. For ordering details, see Books and Software.

New Annex being shaped

The Graz University of Technology in Austria organised a kick-off meeting on 22 September in Vienna, Austria to discuss the outline and activities of a newly proposed Annex with the title “Ground-Source Heat Pumps – Overcoming Market and Technical Barriers”. The overall objective of the Annex is to identify ground-source systems with improved performance and market attractiveness and demonstrate their economic and environmental benefits. The project should produce targeted publications for policy makers, planners, designers and installers, as well as end-users (in local languages). It has been proposed to work together with related IEA Programmes dealing with buildings, Demand-Side Management and energy storage. It is expected that the Annex will be approved by the Executive Committee at its meeting in October 2003. For more information, contact the HPC.

Ongoing Annexes

Red text indicates Operating Agent.

Annex 25 Year-round Residential Space Conditioning and Comfort Control Using Heat Pumps	25	FR, NL, UK SE, US
Annex 26 Advanced Supermarket Refrigeration/Heat Recovery Systems	26	CA, DK, SE, UK, US
Annex 27 Selected Issues on CO ₂ as a Working Fluid in Compression Systems	27	CH, JP, NO , SE, UK, US
Annex 28 Test Procedure and Seasonal Performance Calculation for Residential Heat Pumps with Combined Space Heating and Domestic Water Heating	28	AT, CA, CH , DE, FR, JP, NO , SE, US, UK

IEA Heat Pump Programme participating countries: Austria (AT), Canada (CA), France (FR), Germany (DE), Italy (IT), Japan (JP), Mexico (MX), The Netherlands (NL), Norway (NO), Spain (ES), Sweden (SE), Switzerland (CH), United Kingdom (UK), United States (US). All countries are member of the IEA Heat Pump Centre (HPC). The Netherlands is Operating Agent of the HPC.

A high performance air-to-air commercial heat pump for cold climates

Kensaku Oguni, Japan

A new and improved heat pump system for use in cold climates is developed jointly by the Hokkaido Electric Power Co., Tohoku Electric Power Co. and Hitachi Air Conditioning System Co. Ltd. of Japan.

The newly developed system has the following features:

- operates at ambient air temperatures as low as -20°C ;
- maximum heating capacity at -15°C ambient air temperature is equal to nominal capacity;
- heating COP at -15°C ambient air temperature is 2.0;
- refrigerant used is R-407C, which has zero ODP (ozone depletion potential).

The new system is equipped with a high-efficiency scroll compressor controlled by an inverter and a liquid injection valve.

Introduction

In cold climate regions in Japan, heating equipment utilizing gas or kerosene as fuel has traditionally been used. Due to their ease of handling and excellent safety features, electrically powered heat pump-based systems should offer excellent alternatives in such areas. However, conventional electrical heat pump systems are often unable to operate at the very low ambient air temperatures involved or unable to provide sufficient heating capacity. To solve this problem and satisfy market demand, the Hokkaido Electric Power Co., Tohoku Electric Power Co. and Hitachi Air

Conditioning System Co. Ltd. jointly developed a new heat pump system for cold climates.

Asahikawa and Sapporo in Hokkaido are examples of the cold climate locations for which the new system was developed (see **Figure 1**). Ambient air temperatures between 5°C and -10°C occur quite frequently during the heating period, and minimum temperatures can drop to -20°C .

In order to function effectively in such locations, heat pump-based systems should retain the following characteristics at ambient temperatures as low as -20°C :

- full functionality;
- high degree of reliability;
- high heating capacity and high air outlet temperature of the indoor unit.

System configuration

The refrigerant flow diagram and the pressure-enthalpy diagram of the heat pump system are shown in **Figure 2**. The system consists of an outdoor unit and an indoor unit as shown in **Figure 3**. The outdoor unit contains a scroll compressor, an outdoor heat exchanger, control valves, an inverter, and an outdoor fan. Rotational speed of the scroll compressor is controlled by the inverter. The indoor unit includes an indoor heat exchanger, a control valve, and an indoor fan.

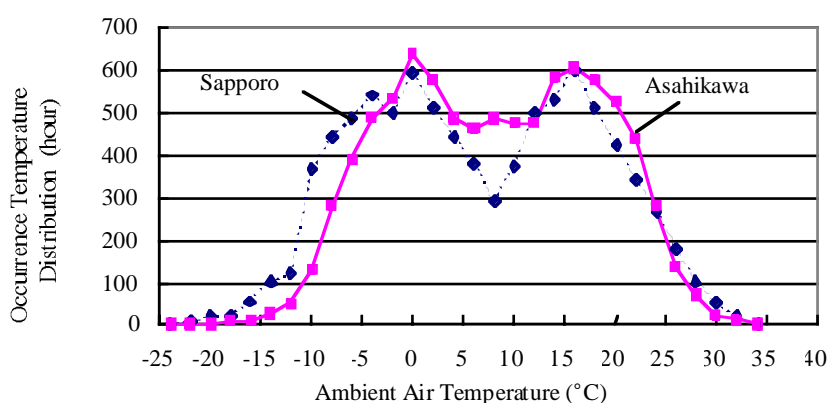


Figure 1: Ambient Air Temperature in Hokkaido.

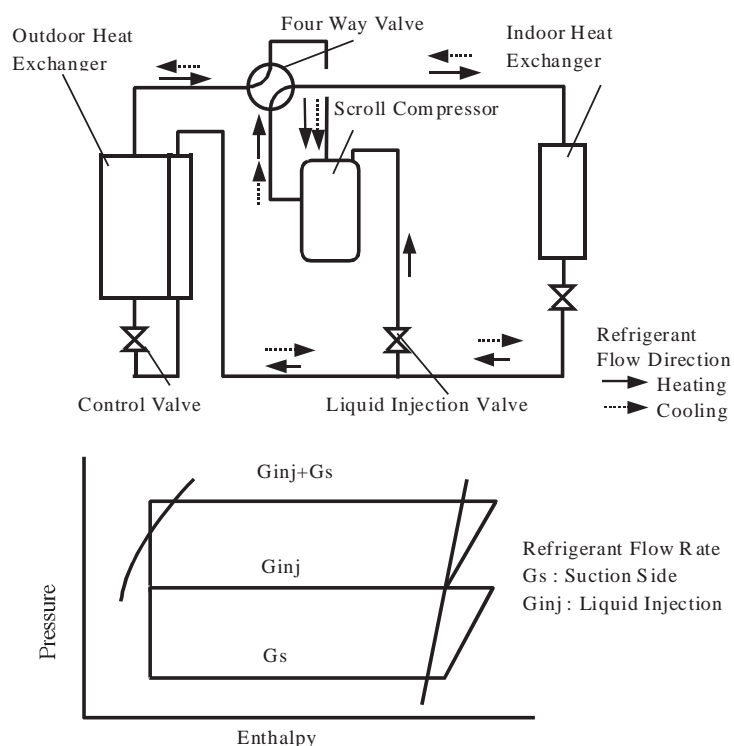


Figure 2: Refrigerant Flow Diagram and Pressure-Enthalpy Diagram of Developed System.

In heating mode, refrigerant discharged from the compressor flows through the four-way valve, the indoor heat exchanger, the bottom part of the outdoor heat exchanger, the outdoor control valve, the outdoor heat exchanger, the four-way valve, and the compressor. Some of the refrigerant condensed in the indoor heat exchanger is injected into the scroll compressor. In heating mode, supply flow rate into the indoor heat exchanger is equal to the sum of the compressor suction flow rate and the liquid injection flow rate.

As ambient air temperature decreases, heating load increases and the scroll compressor speed also increases. Electric power input then increases, and the motor temperature and compressor discharge temperature rise. The motor and discharge temperatures are controlled and optimized with the help of the liquid injection valve. At low ambient temperature, drainage liquid resulting from defrosting may become frozen at the outdoor heat exchanger. To avoid this problem, the outdoor heat exchanger is designed so that high-temperature liquid refrigerant flows through the bottom section.

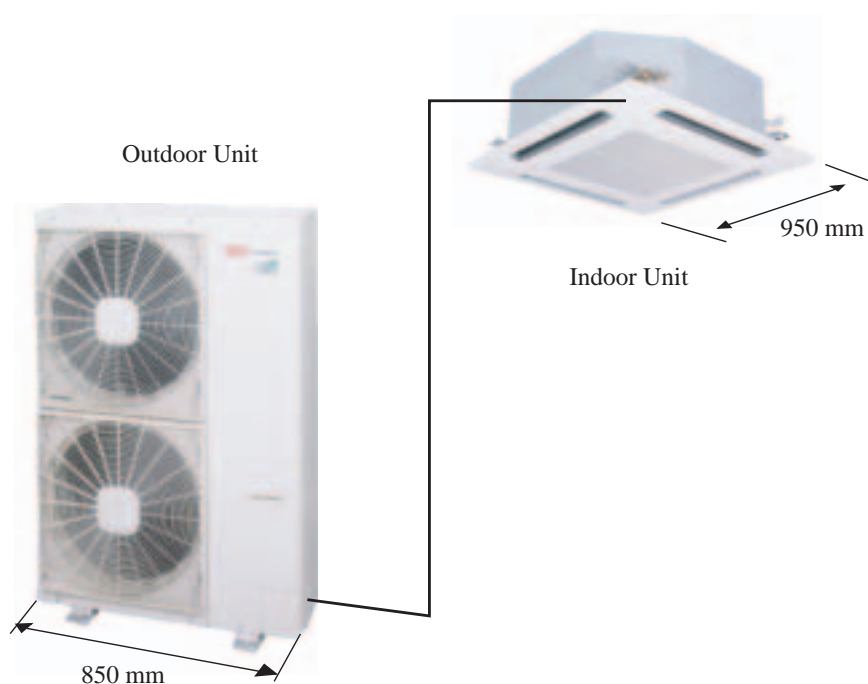


Figure 3: Outdoor Unit and Indoor Unit External View of Model-A.

System specifications

Specifications for the new heat pump system are shown in **Table 1**. Model A is the new system. For purposes of comparison, data is also presented for an older cold climate heat pump system, Model B, which has been marketed since 1996 [1]. The new model uses R-407C (which has zero ODP) as refrigerant instead of R-22, has a higher efficiency, and has been on the market since 2002.

Table 1; Specifications of developed Systems.

System			Model-A	Model-B
			New Model	Old Model
Nominal Cooling Capacity		kW	11.2	11.2
Refrigerant		-	R-407C	R-22
Motor	Compressor	-	DC	AC
	Fan	-	DC	AC
Outdoor unit	Width	mm	850	1060
	Depth	mm	315	315
	Height	mm	1240	1275
Heating	Toa = 7 °C (Nominal)	Capacity	kW	13.2
		COP	-	3.82
	Toa = -15 °C	Capacity	kW	13.2
		COP	-	2.00
	Toa = -20 °C	Capacity	kW	11.8
		COP	-	1.55

Figure 4 shows the heating capacity characteristics of the cold climate Models A and B in comparison to the standard model. The standard model shown in the figure is also driven by an inverter but does not have a liquid injection valve. Both cold climate models A and B can be operated at ambient air temperatures as low as -20 °C. The standard model can operate only down to -15 °C. For both cold climate models, heating capacity at -15 °C is equal to nominal capacity at 7 °C, and this heating capacity is about 43% higher than that of the standard model. The COP in heating mode for the newer Model A has been improved compared to the older Model B by using a magnetic DC (direct current) motor for the compressor and fans.

Toa= Ambient Air Temperature; Indoor Air Temperature = 20 °C

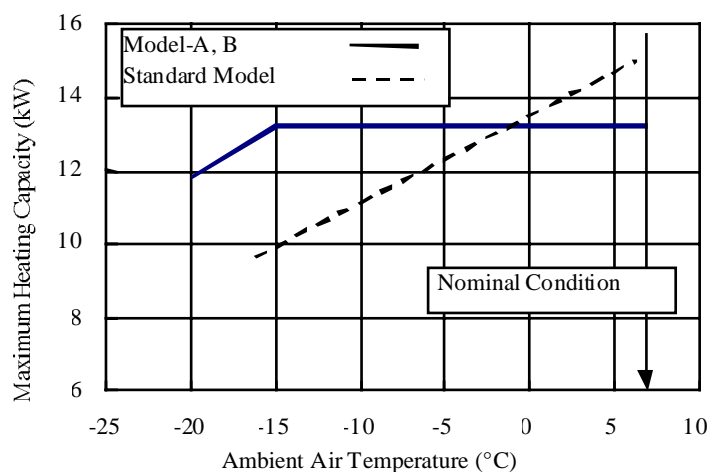


Figure 4: Characteristics of Heating Capacity.

Field Test Results

Although not yet available for the newer Model A, field test results are available for the Model B system. **Figure 5** shows the results of field tests carried out at Asahikawa in 1995, down to an ambient air temperature of about -20°C . During the test period, indoor air temperature was maintained at 25°C to 30°C , and the outlet air temperature of the indoor unit was kept constant. The newer Model A is expected to provide even better field test results in future.

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Test period: January to April

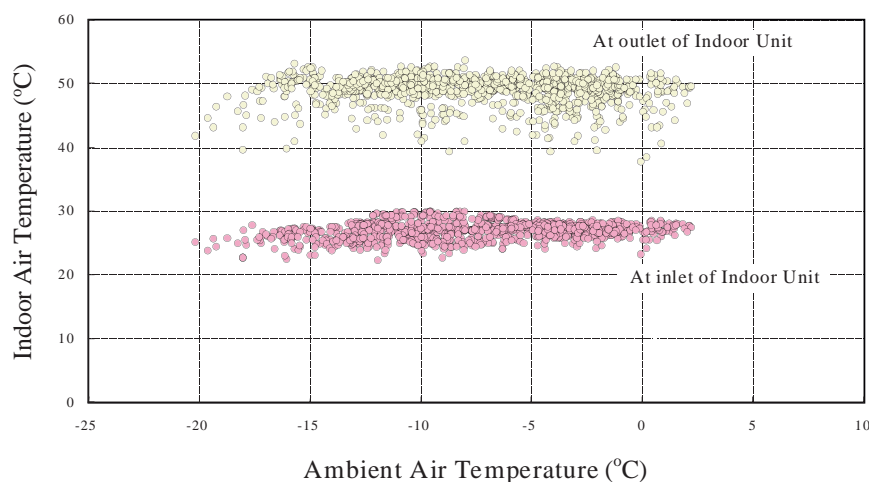


Figure 5: Field Test Results.

The above-mentioned systems have been designed to work with various models of heat pumps, such as 6.3, 8.0, and 11.2 kW capacity split type air conditioners for use in shops as well as multi-split type air conditioners for use in offices. The older Model B heat pump system, marketed since 1996, has already proved its worth in cold climate regions and enjoys a solid reputation with customers. We expect the newer Model A system to provide even better results.

Reference

[1] N. Horiuchi et al., 1996.
Development of Heat Pump Air Conditioner for Cold Climates, Proc. of JSRAE Annual Conference, p. 81-84

An exhaust-air heat recovery heat pump system optimised for use in cold climates

Vasile Minea, Canada

A highly energy-efficient heat pump based system that can be used for heating and cooling general service buildings such as hospitals, recovers most of the energy otherwise lost through ventilation and is optimised for use in cold climates. The system has two stages for pre-heating the incoming air for ventilation: a supplementary glycol-to-air heat exchanger and a reversible air-to-air heat pump circuit for recovering energy from the exhaust air flow. The heat pump system has two independent circuits, each of which can be used for heating or cooling, as well as a supplementary condenser for extreme weather conditions. It uses a flexible demand-driven control strategy that regulates system capacity and also avoids cycle inversion when defrosting is required. The prototype system was followed for 12 months, and simple payback time was estimated to be four years.

Introduction

Exhaust air from institutional building provides a low-cost heat source for heat pumps [1]. As large-scale consumers of energy, hospitals have high potential for energy savings, estimated to range from 20% up to 44%. In Canada, the average specific energy consumption in hospitals is about 339 kWh/m² (1995), more than the average for the five leading industrialised countries [2]. The high energy consumption can be explained by: cold climate conditions; the age, type and size of buildings; less interest in energy conservation in the past due to the low cost of conventional energy sources; the primacy of medical considerations over other aspects. However, energy conservation issues will probably become more important as the cost of energy is likely to rise and environmental effects are receiving increasing attention [3]. Therefore, recovery of the low-grade waste heat energy available in exhaust air, when retrofitting older buildings or building new facilities, is likely to become increasingly attractive. Heat pump based systems can provide an efficient means of realising this as well as reducing total energy costs. Before choosing the solution described below, other heat recovery methods (rotary wheel, fixed plate and heat pipe exchangers, run-around coils) were also considered, but the related risk of cross air contamination or low energy efficiency favoured choosing a heat pump based system [4].

The location

The system was designed and installed into the HVAC system of a hospital wing built 70 years ago in a Canadian cold-climate region. Prior to the last major retrofitting of

the ventilation system (1999), indoor air evacuation was accomplished only by using the bathrooms' direct exhausts and the kitchen hoods. Most areas, however, were naturally ventilated by opening windows. Since all the outdoor air intakes and indoor air exhausts were due to be integrated for the 1999 retrofit, the implementation of an efficient heat recovery system became a logical option.

The solution

The solution chosen employs a supplementary initial pre-heating stage with a glycol heat exchanger (GHEx) and a second stage with an air-to-air heat pump that captures energy from the exhaust air to heat the outside ventilation air entering the building (Figure 1). The first stage, using a hot glycol/water solution from the hospital's closed loop, was generally operational when the incoming outdoor air temperature was less than -10 °C.

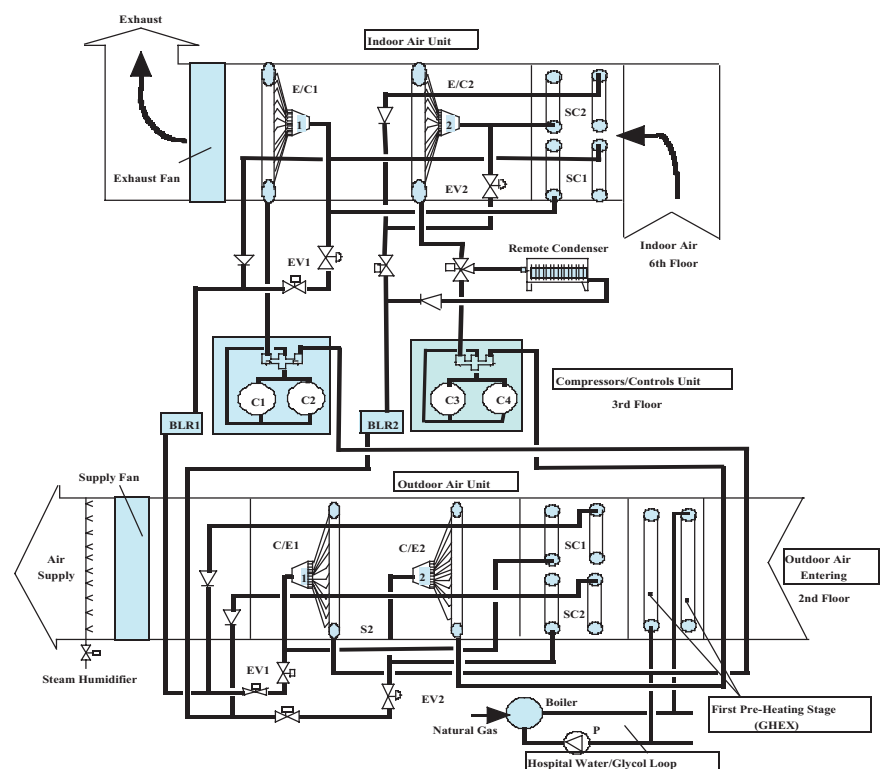


Figure 1: General layout of the heat pump heat recovery system.

C: compressor; BLR: bi-directional liquid receiver; E/C: evaporator/condenser coil; SC: sub-cooler; EV: expansion valve

Three distinct modules: The system was designed around three distinct modules: compressors/controls; indoor air exhaust unit; outdoor air inflow unit (**Figure 1**). The three modules were adapted to fit the available space in an old stairwell. Outdoor air enters at the 2nd floor level, while exhaust air leaves the building at the 6th floor level. Heat pump compressors and controls, located on the 3rd floor (**Figure 2**), allow recovery of sensible and latent heat and transfer of energy between two air streams located at a relatively great distance from each other. The heat pump system was sized to meet 100% of the cooling load and to supply about 70% of the maximum pre-heating requirements.



Figure 2: View of the compressor module of heat recovery heat pump

Flexible and multi-functional: The cooling circuit (**Figure 1**) contains two parallel lines, vertically spread, each with two 31.65 and 56.3 kW, in-tandem, scroll hermetical compressors (C1 to C4). The two lines can be controlled to vary the system's nominal capacity between 31.65 and 175.8 kW, depending on the building's actual heating or cooling demand. The availability of two separate lines also allows defrosting to take place without inversion of the thermodynamic cycle. Each line contains its own evaporator/condenser coil (E/C). The system is designed to operate in both heating and cooling mode by reversing the

refrigerant direction flowing.

Special air-cooled heat exchangers for reinforcing the liquid sub-cooling and improving the overall energy performance of the system have been included on both lines (SC). This arrangement is particularly useful in heating mode when the liquid has to flow vertically for about 12 m and the risk of gas flashing exists. With the aid of a check-valve assembly, the liquid can circulate in both directions through bi-directional receivers (BLR). These are also used for compensation of the refrigerant charge between heating and cooling modes and for refrigerant storage purposes during pump-downs.

month period to monitor about 30 thermal, hydraulic and electric parameters, using sensors, data acquisition and transmission devices. The parameters measured were scanned every 15 seconds, then averaged and saved at 2-minute intervals. During the first 12-month experimental period, the heat pump operated 72% of the time in heating mode and the rest in cooling mode, with incoming and exhaust airflow rates of about 5,430 l/s each.

Heating mode: During winter, the compressors were run in various combinations in order to maintain the air supply temperature close to the set point and thus minimise energy consumption for heating. If the set point could not be realised, then the GHEX unit supplied the additional energy necessary. The average temperature of the incoming fresh air supplied during the dominant heating mode varied between 15 and 18 °C. The increase in average temperature of the incoming air across the heat pump was about 16 °C, while the maximum instantaneous gap reached 19 °C, a very good result for such a heating device. The average temperature of the exhaust air was high enough (13°C) to conclude that the system still has additional heat recovery capacity available. This capacity can be utilised by raising the air supply set point, adjusting the capacity of the first stage of heating, or by additional control of the heat pump discharge pressure during colder periods. The compression ratio varied around 2 (**Figure 3**), and the average liquid sub-cooling temperature was about 6.6 °C.

Control and measurement: The system's solid-state control operates independently of, or in conjunction with, the building's DDC (direct digital control) system. It also regulates the changeover from heat recovery mode to cooling mode and allows sequential operation of the compressors. If compressors 3 and/or 4 are running and the outdoor temperature is above 25 °C, a 3-way valve allows activation of a supplementary condenser in order to reject heat to the ambient air.

Extensive measurements were carried out on the heat recovery system over a 12-

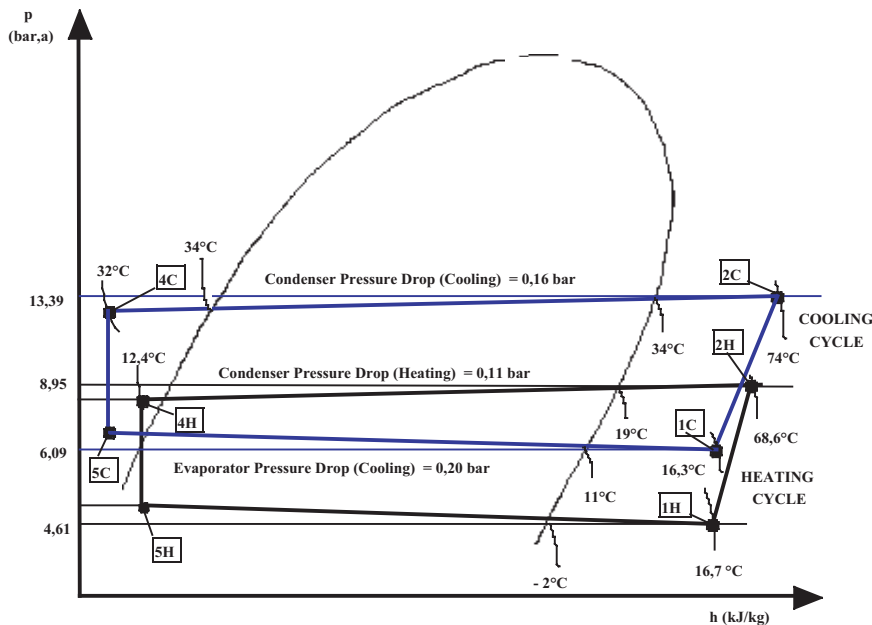


Figure 3: Average p - h of thermodynamic cycles. H: heating mode; C: cooling mode

A seasonal coefficient of performance (SCOP), defined as total heat supplied/total energy used by the heat pump, was realised equal to 7.5 (Figure 4).

about 82 kW of heating power or 425,616 kWh/year of thermal energy. To this energy supplied by the heat pump system must be added the annual energy supplied by the supplementary GHEx preheating unit (13%

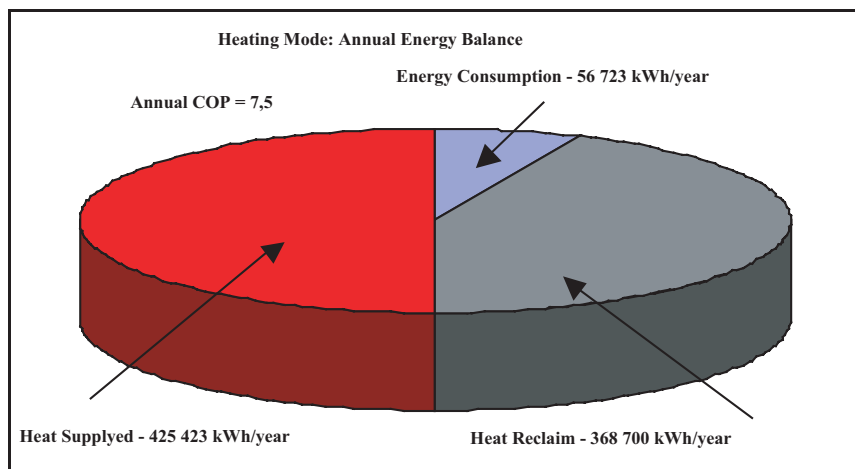


Figure 4: Heat pump system's annual energy balance in heating mode (dominant & transitional heating periods)

The high SCOP value achieved can firstly be attributed to a relatively high potential energy source with a practically constant dry temperature (22.5 °C) and a high moisture content. Secondly, a very efficient capacity control and a defrosting process without any back-up electrical or fossil fuel energy source also contribute to this performance. The compressor's annual electrical power consumption in heating mode averaged 11 kW, which provided

of the total). The actual temperature differential between the saturated evaporating and condensing temperatures in heating mode averaged 20 °C.

Using the annual electrical energy consumed by the heat pump system for preheating the incoming air and the seasonal COP previously defined, one can calculate the energy savings compared to an equivalent conventional natural gas

preheating system (70% of seasonal energy efficiency). The annual costs savings amount to about USD 15,100 (2000). The simple payback period was estimated to be about 4 years, based on the total installed cost and without any subsidy utility grant or incentive.

Cooling mode: During summer, the compressors were also run in various combinations in order to maintain the air supply temperature close to the set point and minimise energy consumption for cooling. During the cooling dominated period, from June 15 to September 15, no significant switching in heating mode was observed. The average compression ratio averaged about 2.2, and the condenser liquid sub-cooling temperature never exceeded 2 °C. The incoming fresh air was cooled to an average dry temperature of 14.3 °C.

The only design problem experienced was with the condenser capacity during the hottest days. Its capacity was insufficient and the discharge pressures were very high during a warm week in August. After the supplementary condenser was installed, discharge pressure and compressor shaft power decreased and cooling efficiency improved. The electrical power consumption of the heat pump compressors averaged about 15 kW. This includes the suboptimal period of operation before installation of the supplementary condenser. The seasonal energy efficiency ratio (SEER), defined as total heat extracted (sensible and latent in cooling mode)/total energy used by heat pump system, averaged 16.3.

Defrosting

If a preset adjustable minimum refrigerant temperature was detected at the outlet of the evaporators, both compressors on the line in question were shut down, while the compressors of the other line continued to run. The indoor 'hot' air was then sufficient to defrost the evaporator units in question. The compressors involved were started up again only after the refrigerant temperature reached a preset adjustable minimum value, for example 12 °C.

Improvements

The first 12-month period of testing has shown that some improvements are necessary at the cooling and control levels involving the following elements: electronic expansion valve, better compensation of the

charge and more effective set-point management, replacement of the HCFC-22 refrigerant, improving first stage preheating control, and better co-ordination with the building's other energy efficiency systems.

Conclusions

A prototype air-to-air heat pump system, optimised for use in cold climates and suitable for heating and cooling general service buildings such as hospitals, was tested for a period of 12 months. The results showed that the system, due in part to the flexible demand-driven control strategy utilised, was very efficient in recovering 'waste energy' from the outflow of ventilation air. The prototype achieved a high operating rate (72% in heating mode) with minimum routine maintenance, a seasonal coefficient of performance of 7.5 in heating mode, and a seasonal energy efficiency ratio of 16.3 in cooling mode. Annual energy savings in heating mode provide a simple payback period of 4 years. These results demonstrate that heat pump-based systems can be a highly efficient means of recovering heat from central ventilation systems in the institutional and commercial sectors, while providing reliable heating and cooling and saving significant quantities of (fossil fuel) energy.

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New Annex 28 shifts into gear

C. Wemhöner, Th. Affei, Switzerland

The IEA Heat Pump Programme's new Annex 28, 'Test Procedures and Seasonal Performance Calculation for Residential Heat Pumps with Combined Space and Domestic Hot Water Heating', started its work in January 2003. A total of 10 countries are participating. The kick-off meeting, which took place in MuttENZ, Switzerland, was a significant first step in coordinating the work to be done in the various projects and the contributions by the individual participants. This article describes the objectives and structure of Annex 28 and gives an update on its activities.

Introduction

Equipment that can provide both space heating and hot water has been generating increased interest. The reason is simple. Government energy directives, aimed at reducing the heating energy requirements of new buildings, have resulted in a considerable decrease in energy consumption for space heating since the beginning of the 1990s. As a result, the energy used to produce domestic hot water (DHW) has had a growing impact on total thermal energy demand. This is reflected in the increased number of dual-purpose system configurations on the market and under development. In addition, new developments in the field of natural working fluids, in particular CO₂, have made the combined production of space heating/hot water more attractive by making new process layouts possible in which high temperature heat is decoupled from the process to produce DHW.

To assess the energy savings potential of producing space heating and domestic hot water in a combined fashion, adequate test procedures for the system components as well as an effective calculation method for the overall Seasonal Performance Factor (SPF) must be available in the form of a common standard. The European standard test procedures presently available apply separately to space heating (or cooling) and to domestic water heating. As a result, these standards cover the operation of combined working systems only in alternating mode, i.e. either for producing domestic hot water or for space heating.

Objectives, structure and time schedule

In Annex 28, testing procedures will be investigated for the most common integrated heat pump systems that use the following operating strategies:

- switching the heat pump between space heating and DHW (alternating mode);

- cascade heat pump with condensate subcooling of the lower stage as heat source for the upper stage;
- desuperheating for DHW and condensing for space heating.

There is no restriction to system configurations using the above strategies.

The objectives of Annex 28 (see legal text [1]) are twofold:

- to establish a test procedure that provides the data needed to calculate the overall SPF of such heat pump systems, while minimizing the requirements for testing equipment and testing time;
- to develop an easy method of calculation for the SPF of the heat pump systems.

To realize the above objectives, the Annex has been structured around three tasks.

Task 1:

a thorough analysis of the state of the art with regard to combined space heating/hot water production using residential heat pumps

This task includes:

- carrying out a market survey of commercially available systems in the participating countries as well as systems under development;
- establishing a definition of system boundaries based on the systems found

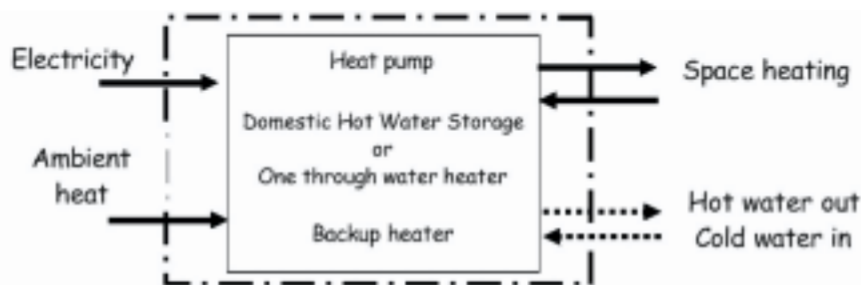


Figure 1: System boundary as black box (taken from [1])

The system boundary is shown in **Figure 1**. The system includes the heat pump, the hot water storage (or a once-through water heater respectively) and an optional supplemental back-up heater. With regard to heat distribution, the Annex has also been opened to air systems.

To avoid unnecessary work and duplications, the results should be communicated to national and international standardization institutions as soon as possible. The overall aim is to establish a test procedure and calculation method in the form of comprehensive and uniform standards.

and a decision as to whether only values at the system boundary are to be used in the methods (black-box concept, see **Figure 1**) or whether information from inside the system boundary should also be available (grey-box concept);

- carrying out a survey of existing standards for component testing and for calculating SPF values for space heating and domestic hot water application;
- formulating boundary conditions that may have an impact on the design and performance of the systems, e.g. hot water temperature, hot water tapping profile, interrupted electricity supply, building load etc.;

- defining the parameters required to calculate the overall SPF of the system.

Task 1 was started in January 2003 and is to be finished by June 2003. Country reports will then be sent to the operating agent by September 2003, and the results will be discussed at the second meeting in October 2003. Tasks 2 and 3 will be worked out in parallel, as they depend on each other. They were started in July 2003 and will continue until December 2004, when a workshop to present the results of Annex 28 will be held.

Task 2:

development of the test procedure, which will provide the relevant input data needed for calculating the SPF

Output data from the test procedure may also serve to further characterize the components involved, e.g. operational limits etc.

Subtasks of Task 2 are:

- assessment of existing test procedures for space heating and domestic water heating with heat pump systems, e.g. EN 255, ASHRAE 124 or ARI 470;
- determination of missing items for the testing of combined space and water heating;
- development and detailed documentation of a comprehensive test procedure for heat pump systems with alternate or simultaneous space and domestic water heating functions, and defining the test parameters needed.

Task 3:

development of a calculation method for the overall SPF based on publicly available data, in particular the component characteristics provided by the test procedure or manufacturer data

Subtasks of Task 3 are:

- assessment of existing calculation methods for the SPF;
- determination of missing items for combined space heating and hot water requirements;
- definition of data that have to be provided by the test procedure;
- development and documentation of the calculation method for alternate- and simultaneous-mode combined heat pumps.

Exchange of interim results and coordination of the tasks in progress will be done during two meetings, which will take place in October 2003 and June 2004.

Participants and working fields



Figure 2: Participants of the kick-off meeting in Muttens, Switzerland

The Operating Agent for this Annex is Switzerland, represented by the Institute of Energy at the University of Applied Sciences Basel (FHBB). The other participating countries with the respective institution are: Austria (Arsenal research), Canada (LTE Hydro Quebec), France (EdF, CETIAT), Germany (Viessmann Werke GmbH), Japan (University of Tokyo), Norway (SINTEF), Sweden (SP), UK (Kensa Engineering Ltd.) and USA (DOE).

The activities/contributions of the participating countries include different areas of interest, thereby increasing the opportunity to create a comprehensive standard that is applicable to a large number of systems. The activities of the various countries and the focus of their contributions to Task 2 (test procedure) and Task 3 (calculation method) are briefly described below. **Table 1** gives an overview of the various projects and their focus.

Table 1: Overview of the contributions to the Annex

	Task 2: Test procedure		Task 3: Calculation	Heat source	Refrigerant	System
	Test rig	field				
AU	X	X	X	ground		Direct expansion, Desuperheating
CA	X	X		B/W		Desuperheater, Heating/cooling/DHW
FR						
CE	X	X		A/W, B/W	CO ₂	Alternative and combined
EdF			X	A/A		Heating and cooling
DE						
TUD	X			A/W, B/W		Desuperheating/Condensate subcooling
Viess.			X	exhaust air		passive house systems
JP	X			A/W	CO ₂	Alternative and combined Event. inverter drive
NO	X	X		ground	CO ₂ /R407C /HC	Heating and DHW, desuperheating, condensate subcooling, internal HX
SE	X		X	exhaust air A/W, B/W		Heating and DHW
CH	X		X	A/W, B/W		Heating/DHW, condensate subcooling
UK	X		X	W/W, B/W		DHW/cooling/desuperheating
USA						Project development

Austria: Direct expansion systems with desuperheating in storage testing; field measurements; calculation;

Canada: Field test for monofluid heat pumps with desuperheater for domestic hot water (DHW) as well as test rig measurements for ground source heat pumps for space heating, DHW and cooling;

France: Test rig measurements of alternately operating air/water heat pump with CO₂ as working fluid; field measurements of air/water and brine/water heat pumps (CETIAT); SPF calculation method for air/air heat pumps for heating and cooling combined with test procedure (EdF);

Germany: calculation method for unitary systems for passive houses using exhaust air; (Viessmann Werke GmbH);

Japan: Test rig measurements for alternate and simultaneous systems with CO₂ as working fluid and, if relevant, inverter driven heat pumps;

Norway: Test rig measurements of heat pump with hydrocarbons as working fluid and simultaneous operation mode; field test of CO₂ / R-407 C systems; development of an adequate test procedure;

Switzerland: Test procedure for small-scale systems with alternately and simultaneously operating units with condensate subcooling (WPZ); calculation method for these systems (FHBB);

Sweden: Test rig measurement and calculation method for exhaust air systems;

UK: Test rig measurement for combined DHW and cooling heat pumps with desuperheating, twin condenser; calculation method for water/water and brine/water heat pumps with combined DHW and cooling;

USA: The USA was not able to attend the kick-off meeting. The USA is currently in the phase of project development to join the Annex.

Results of the kick-off meeting

In addition to allowing the participants to get to know each other and familiarize themselves with organizational issues, the meeting yielded the following information:

Motivation of the participants to join the Annex is based on the need for:

- characterization of system behaviour through evaluation of standardised test conditions;
- studies of system behaviour;
- a common standard for different countries (to facilitate commerce);
- calculation of a key indicator for evaluating SPF;
- sensitivity analysis for different boundary conditions (meteorological data, DHW ratio, building standards, temperature requirements, etc.);
- comparison of different heat pump systems (with regard to application);
- comparison of different heating systems (background: market penetration).

The following preliminary criteria for the definition of systems to be investigated were worked out:

- **energy used:** with focus on heating and DHW (cooling: add-on modules for cooling and inverter-driven systems);
- **heat sources:** ground (DX, brine), water, ambient air, exhaust air;
- **system boundary:** heat pump heating system excluding distribution system.

The following preliminary guidelines were formulated for the test procedure and the calculation method:

Test procedure:

This should include definition of standardised testing points for all countries as defined in EN 255 or prEN 14511, respectively.

One possible approach discussed is to divide the procedure into:

- **basic testing procedure:** always required;
- **comprehensive test procedure** with add-on modules for specific systems, consisting of special test procedures required for specific systems or boundary conditions, e.g. a mandatory testing point at -15°C ambient air temperature only for cold climates.

The basic procedure should at least:

- define testing points;
- include measurement of the operating limits;
- consider boundary conditions e.g. with regard to the prevention of legionnaire's disease.

Calculation method:

The method should:

- be amenable to manual calculation techniques (spreadsheet);
- be transparent, i.e. the parameters and/or variables required and their source should be clearly defined;
- be applicable to:
 - different usage patterns of DHW (characteristic number for fixed tapping pattern, but sensitivity analysis for other tapping patterns or DHW ratio possible);
 - different building standards;
 - bivalent systems;
 - different boundary conditions (meteorological data, temperature requirements);
- be backed up and validated by computer simulations and field measurements.

Definitive decisions regarding the above aspects of the test procedure and calculation method will be taken at the next meeting in

October 2003. This meeting will focus on the system definition formulated as a result of Task 1 and on the interim results from Task 2 and Task 3.

Contact with European standardisation institutions

In order to coordinate the standardization activities in the field of testing and calculating performance factors for heat pumps and domestic hot water systems, close cooperation is planned with the relevant working groups. CEN/TC 228/WG 4 is working within the framework of prEN 14335 [2] on calculation methods for heat pump heating systems. CEN/TC 113 will form a new working group for the revision of EN 255-3 [3], i.e. the current standard for testing heat pump water heaters. Moreover, a mandate from the EU to CEN/CENELEC [4], in connection with EU Directive 92/75/EEC [5], directs them to elaborate, adapt and adopt European measurement standards for water heaters, hot water storage appliances and water heating systems, while taking into account the requirements of Council Directive 92/75/EEC. This mandate will be dealt with in the above group or in new working groups of the CEN.

Summary

Annex 28 was started in January 2003 with Task 1, which includes a survey and analysis of existing systems and existing standards for the combined production of space and water heating with heat pumps. Tasks 2 and 3, which started in July 2003, aim to provide concise test procedures and a manual calculation method for the introduction of international standards. Final results will be presented at a workshop in December 2004, and the final report is scheduled to appear in May 2005.

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References

- [1] Zogg, M. et al (2003), 'test procedure and seasonal performance calculation of residential heat pump with combined space and hot water heating', legal text Annex 28, IEA HPP, Paris
- [2] prEN 14335:2002, 'Heating systems in buildings, methods for calculation of system energy requirements and system efficiencies'
- [3] EN 255-3:1997, 'Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors - Heating mode - Part 3: Testing and requirements for marking for sanitary hot water units'
- [4] 'Mandate to CEN and CENELEC (2002) for the elaboration and adoption of measurement standards for household appliances: Water heaters, hot water storage appliances and water heating systems', TREN D1 D(2002), Brussels
- [5] 'Council Directive 92/75/EEC of 22 September 1992 on the indication by labelling and standard product information of the consumption of energy and other resources by household appliances', Official Journal L 297, 13/10/1992 p. 0016 - 0019)



Books & Software

New guidance on ground-source heat pumps - ASHRAE 2003 handbook contains new chapter on electrical systems

The handbook contains updates to Chapter 32, Geothermal Energy. New subsections were added to accommodate research and special publications undertaken since the last revision.

The chapter includes new information on site characterisation, commissioning, thermal properties testing, equivalent full load hour load calculations, borehole completion options, open loop design strategy, ground water quality and well pump control along with an expanded section with two new tables for horizontal closed loop systems.

This information will aid engineers, designers and contractors in designing, installing and operating geothermal systems in a more cost-effective and efficient manner.

Published: ASHRAE News Release, June 2003

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ASHRAE Public Relations
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Commissioning, preventive maintenance and troubleshooting guide for commercial ground-source heat pump systems

This book covers the project implementation stage and reviews the necessary technical information for geothermal or geo-exchange heat pump systems. Commissioning, maintenance requirements, and troubleshooting for these energy-efficient systems are covered in detail. This guide is a valuable reference for those involved in the design, installation, operation, and maintenance of commercial building ground-source heat pump systems.

Published: 2002, ASHRAE Research Project 94.

Price: USD 69.00 (Member: USD 55.00)

Code: 90302 (ISBN 1-931862-09-5)

*More information: Caneta Research Inc.
7145 West Credit Ave.
Suite 102, Building 2
Mississauga, Ontario
Canada L5N 6J7
E-mail: caneta@compuserve.com*

Domestic Ground Source Heat Pumps: Design and installation of closed-loop systems (GPG339)

Properly designed and installed, ground source heat pumps represent a very carbon-efficient form of space heating. This comprehensive review helps designers, housing developers and installers understand the financial and environmental benefits of ground source heat pumps whilst also providing practical guidance on developing a robust system. Includes a useful list of Dos and Don'ts.

<http://www.housingenergy.org.uk>

World Market for Air Conditioning

This updates of the 1998 world study gives essential top line information for the most important country markets in the world. Research has been performed jointly by BSRIA Worldwide Market Intelligence in the UK and by JARN (Japan Air Conditioning, Refrigeration and Heating News) in Japan. The study covers the residential/light commercial, unitary and chiller markets. Reports are available by product market or by geographical region.

Price: The whole study for € 11,200.00 and per section for € 8,000.00

*More information: Andrew Giles
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E-mail: wmi@bsria.co.uk*

Source: BSRIA (Building Services and Research Information Association)
<http://www.bsria.co.uk>

KMKreis 6.0 software programme for cooling cycle and heat pump

In the Netherlands, TNO-MEP has introduced the KMKreis 6.0 programme, developed by its German partner FKW GmbH from Hanover.

The programme will determine various properties of refrigerants such as pressure, temperature and volume. The programme already contains 50 standard refrigerants and mixtures. KMKreis can easily determine the thermodynamic characteristics and the coefficient of performance (COP) of the cooling cycle. General standard configurations are also included in the programme.

Price: USD 907.00 for the complete version of KMKreis 6.0

*More information: Peter Oostendorp
TNO-MEP
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Tel: +31 (0)55 549 3771
Fax: +31 (0)55 549 3201
E-mail: Peter.Oostendorp@mep.tno.nl
http://www.mep.tno.nl/software_for_information_and_a_downloadable_demonstration_version*

Proceedings of the 21st IIR International Congress of Refrigeration

The overarching theme of the Congress was Serving the Needs of Mankind. The Congress was a celebration of how refrigeration has -- and continues to -- serve the world's need for safe food, efficient industry, widespread medical care, and physical comfort. The papers presented herein and the attendees at the 21st Congress are focused on improving the conditions under which mankind live.

Price CD ROM: USD 150.00

*Order through: IIR at www.iifir.org, or through ASHRAE at:
<http://resourcecenter.ashrae.org/store/ashrae/newstore.cgi?itemid=18786&view=item&catogoryid=295&page=1>*

Wärmepumpen

FIZ Germany has produced a CD ROM containing information about heat pump systems and applications. It includes a literature database, around 19,000 heat pump entries from the STN-database ENERGY, and links to relevant websites

Price CD ROM: Euro 68.00

Order from: FIZ Karlsruhe

Tel: + 0 72 47 80 82 22



Events 2003

ICCR'2003 International Conference on Cryogenic & Refrigeration

28 October – 1 November 2003 / Hangzhou, China

Contact: ICCR'2003 Office

Tel: +86 571 5795 1771

Fax: +86 571 8795 2464

E-mail: iccr2003@cmee.zju.edu.cn

<http://www.cmee.zju.edu.cn/ICCR2003.htm>

11th International Stirling Engine Conference (ISEC)

19 - 21 November 2003 / Rome, Italy

Contact: Conference Katuscia Cipri

Fax: +39 06 4881 759

E-mail: katuscia.cipri@uniroma1.it

<http://dma.ing.uniroma1.it/isec2003>

Deutsche Kälte-Klima-Tagung 2003

19 - 21 November 2003 / Bonn, Germany

Contact: Deutscher Kälte- und Klimatechnischer Verein – DKV e.V.

Pfaffenwaldring 10

70569 Stuttgart (D)

Fax: +49 (0)711 685 3242

E-mail: dkv@itw.uni-stuttgart.de

2004

3rd International Symposium on Heat Transfer Enhancement and Energy Conservation (ISHTEEC 2003)

12-15 January 2004 / Guangzhou, China

Contact: Prof. Dongsheng ZHU,

ISHTEEC'03 Secretary General

Chemical Engineering Research Institute

South China University of Technology

Guangzhou, 510640, P.R. China

Tel: +86 20 8711 4568

Fax: +86 20 8711 4140

E-mail: ishtee@scut.edu.cn

<http://www.ishtee.gd.edu.cn>

ASHRAE Winter Meeting and AHR Expo

24 - 28 January 2004 / Anaheim, California, USA

Contact: ASHRAE meetings section

Tel: +1 404 636 8400

E-mail: jyoung@ashrae.org

<http://www.ashrae.org>

Interclima, HVAR International Exhibition

3 - 9 February 2004 / Paris, France

Contact: Philippe Brocart

Tel: +33 1 4756 5088

E-mail: philippe_brocart@reedexpo.fr

<http://www.interclima.com>

International Seminar on Natural Refrigerants

5 February 2004 / Tokyo, Japan

E-mail: jfwang@k.u-tokyo.ac.jp, or

Li@hptcj.or.jp

Mostra Convegno Expocomfort

2 - 6 March 2004 / Milan, Italy

Tel: +39 02 48555 01

Fax: +39 02 4800 5450

E-mail: mce@planet.it

The Asia International Geothermal Conference

7-9 April, 2004 / Beijing, China

Contact: Ms Vivian Li

Tel: +86 10 6439 0338

Fax: +86 10 6439 0339

International Sanitary and HVAC Exhibition

6 - 9 May 2004 / Istanbul, Turkey

Tel: +90 212 216 08 90

Fax: +90 212 212 06 93

E-mail: info@hmsf.com

<http://www.hmsf.com>

ASHRAE Annual Meeting

26 - 30 June 2004 / Nashville TN, USA

Tel: +1 404 636 8400

E-mail: jyoung@ashrae.org

<http://www.ashrae.org>

17th International Compressor Engineering Conference/10th International Refrigeration and Air Conditioning Conference at Purdue

10 - 11 July 2004 (short courses) / 12-15

July 2004 (conferences)

Abstract submission: 15 December 2003

Contact: Virginia D. Freeman

Tel: +1 765 494 6078

Fax: +1 765 494 0787

E-mail: herlconf@ecn.purdue.edu

Natural Working Fluids - 6th IIR Gustav Lorentzen Conference

29 August-1 September 2004 / Glasgow, UK

Contact: Miriam Rodway, secretary

Institute of Refrigeration

Kelvin House, 76 Mill Lane

Carshalton, Surrey SM5 2JR

Tel: +44 (0)20 8647 7033

Fax: +44 (0)20 8773 0165

E-mail: oir@ior.org.uk

<http://www.ior.org.uk/gl2004>

5th International Conference on Compressors and Coolants – Compressors 2004

29 September-1 October 2004 / Nitra, Slovak Republic

Contact: Peter Tomlein

SZ CHKT, Hlavná 325

900 41 Rovinka, Slovak Republic

Tel: +421 2 4564 6971

Fax: +421 2 4564 6971

E-mail: zvazchkt@isternet.sk

<http://www.isternet.sk/szchkt>

2007

22nd IIR International Congress of Refrigeration

21 - 26 August 2007 / Beijing, China

<http://www.iifiir.org>

For further publications and events, visit the HPC internet site at

<http://www.heatpumpcentre.org>.

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Next Issue

Advances in Heat Pump
Water Heaters

Volume 21 - No. 4/2003



International Energy Agency

The International Energy Agency (IEA) was established in 1974 within the framework of the Organisation for Economic Co-operation and Development (OECD) to implement an International Energy Programme. A basic aim of the IEA is to foster co-operation among its participating countries, to increase energy security through energy conservation, development of alternative energy sources, new energy technology and research and development.

IEA Heat Pump Programme

International collaboration for energy efficient heating, refrigeration and air-conditioning

Vision

The Programme is the foremost world-wide source of independent information & expertise on heat pump, refrigeration and air-conditioning systems for buildings, commerce and industry. Its international collaborative activities to improve energy efficiency and minimise adverse environmental impact are highly valued by stakeholders.

Mission

The Programme serves the needs of policy makers, national and international energy & environmental agencies, utilities, manufacturers, designers & researchers. It also works through national agencies to influence installers and end-users.

The Programme develops and disseminates factual, balanced information to achieve environmental and energy efficiency benefit through deployment of appropriate high quality heat pump, refrigeration & air-conditioning technologies.

IEA Heat Pump Centre

A central role within the programme is played by the IEA Heat Pump Centre (HPC). The HPC contributes to the general aim of the IEA Heat Pump Programme, through information exchange and promotion. In the member countries (see right), activities are coordinated by National Teams. For further information on HPC products and activities, or for general enquiries on heat pumps and the IEA Heat Pump Programme, contact your National Team or the address below.

The IEA Heat Pump Centre is operated by



Netherlands agency for energy and the environment

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