IEA Heat Pump CENTRE
NEWSLETTER

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Test Procedures and Energy Efficiency Labels

In this issue:

U.S. standards, testing and labelling procedures

Standard monitoring procedure for heat pump systems

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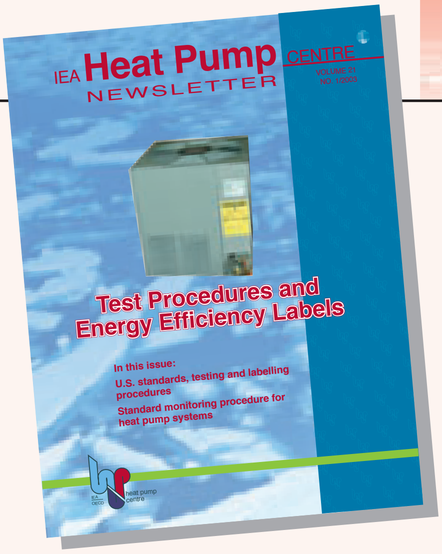

Front cover: *Energy Guide label on a split system heat pump.*

In this issue

Test Procedures and Energy Efficiency Labels

This Newsletter focuses on test procedures and labelling for heat pumps. These procedures and labels can make an important difference for the development of markets, particularly for consumer-oriented products. In the end, standardisation and labelling will help consumers to compare products and to make a more rational choice.

COLOPHON

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HEAT PUMP NEWS

FEATURES

TOPICAL ARTICLE

NON-TOPICAL ARTICLE

Heat pump test procedures and energy efficiency labels

Though they do not usually make the headlines, testing and labeling procedures are more important than ever before and can decisively influence the way markets develop. This is particularly true for consumer oriented products such as heat pumps, which can be used for either heating or cooling. Most buyers cannot be expected to really understand how such products operate, and it is rather difficult to determine their performance at point-of-sale. Efficiency is the primary performance parameter for people looking for ways to reduce their energy bill. Efficiency in relation to investment/ operating costs and (alternative) energy prices will determine if a heat pump is commercially viable and, if so, which model is the best choice. Even when a heat pump is purchased primarily to provide comfort cooling, the energy bill, determined primarily by the level of efficiency, will still have to be paid.

Manufacturers have different policies in presenting performance data for their products. The conservative manufacturer's goal is that every delivered unit must be on a par with or better than the statement in the data sheet. Other attitudes include: the data sheet represents a typical unit; at least one unit should comply with the figures given; the data should at least be theoretically possible. My own experience indicates that in many cases VAT is levied not only on the sales price but also on performance data.

Unfair competition in the air conditioning sector prompted Eurovent, the European association of manufacturers, to initiate its own certification programme. Relying mainly on European test procedures, this programme has contributed to a much improved market situation with many certified products such as residential air conditioners, chillers, et cetera. In the USA, an Energy Guide label indicates a unit's seasonal heating and cooling performance in comparison to other commercial models available. Similar schemes are also in place in Canada, Australia and Japan. Austria, Germany and Switzerland use a label to verify product data on heat pumps according to European test standards, whereas countries like Denmark and Sweden include not only product data, but manufacturing quality and sizing and installation procedures as well.

Of course, test procedures must yield results that are relevant to the individual consumer. Bearing in mind the global diversity of climatic conditions, heating and cooling systems, building technology and user habits, this is quite a challenge. It therefore comes as no surprise that international standardization has been fairly slow. However, harmonized test procedures and labelling schemes are important and must cover not only energy efficiency per se, but also a number of other functional criteria. This will help consumers make a rational choice, stimulate fair trade and benefit society as a whole. Consumers must be able to choose products that perform well not only on paper but also in the real world.

Per Fahlen,
Chalmers University ot Technology
Building Services Engineering
Gothenburg, Sweden

Heat pump news

General

UK, Wales and Northern Ireland - new grant funding for domestic heat pumps

Great Britain - The Governments in England, Wales and Northern Ireland have launched new capital grant programmes for community and household applications of renewable energy technologies. The Department of Trade and Industry (DTI) has announced the 'Clear Skies' programme (www.clear-skies.org). This programme offers capital grant support for a range of renewable energy technologies (solar thermal, wind, hydro, wood pellet stoves and wood fuel boilers) including closed-loop ground-source heat pumps. 'Clear Skies' offers € 1,200 per installation for approved closed-loop, ground-source heat pumps.

This DTI programmes is managed by Building Research Establishment (BRE). In Scotland a parallel grant programme has been launched, called the 'Scottish Community Renewables Initiative' (or 'SCRI', www.est.org.uk/scri/). Its scope is very similar. For 'SCRI', ground-source heat pumps must operate on a 'green electricity' supply.

Source: UK Heat Pump Network Newsletter, Issue 7, March 2003

Heat pump technology in China

China - During the 7th IEA heat pump conference in Beijing, China, it became apparent that the heat pump market in China is huge. The Chinese market has matured to a degree unknown in Europe, as each year millions of heat pumps are manufactured and installed under complicated system conditions. China offers low labour costs and therefore low prices, but the economics of scale and flawless system design (because of the enormous amount of experience available) also contribute to the heat pump's success.

China is in some ways similar to Europe. The climate varies from cold and wet to hot and dry and in between. Also there is a wide variety of geological and geographical situations. Integrated heating and cooling systems benefit from situations with simultaneous heating and cooling demand.

The market leader in China, Fuerda, has developed many concepts for heat pump sources: river, sea, ocean, earth, and waste (heat) recovery. It can draw on a large reservoir of experience in the engineering of complete systems in a great variety of settings, including district heating applications for Olympic accommodations, hospitals etc. In cold climate zones, the often aging radiators in district heating systems require heat pumps suitable for supplying temperatures > 65°C, after the old fashioned (coal) boilers have been removed. It is the company's policy to include at least basic system engineering whenever its heat pumps are applied. The units range in capacity from 8 to 1,100 kW heating capacity.

Compared to China, USA and Japan, there is less knowledge of heat pumps available in Europe. Europeans tend to over-engineer their systems, which often causes problems. In addition, the lack of knowledge leads engineering firms and contractors to charge higher prices to compensate for possible unforeseen effects and claims. This, together with the economics of smaller scale, hampers swift and smooth heat pump penetration in Europe.

More information: www.warmtepompen.nl or alberts@nordic-europe.com

HVAC&R Research - Call for papers

ASHRAE's International Journal of Heating Ventilation, Air-Conditioning and Refrigerating Research seeks papers on original, completed research not previously published. Papers must discuss how the research contributes to technology. Papers should be about 6,000 words. Abstracts and papers should be submitted online at www.ashrae.org. Click on HVAC&R Information, go to sites shortcuts and click ASHRAE Manuscript Central.

More information: R. Radermacher, ashraeresjour@glue.umd.edu
Source: ASRAE Journal, December 2002.

Erratum

Newsletter Vol. 20 - No 3/2002 - p. 26

Please note that the first paragraph of the section on 'US activities' contains errors. The last two sentences of that paragraph should read as follows:

The lowest TEWIs were achieved by the distributed system and the secondary loop systems with CO_2 emission reductions of about 13 - 14 million kg, or 57 - 60%. The low-charge multiplex system had estimated TEWI reductions of about 24% or 43% depending upon the refrigerant loss assumption.

Source: D. Baxter, baxtervd@ornl.gov

21st IIR Congress announces Social Programme and Cultural Tours

The Organizing Committee for the 21st International Congress of Refrigeration (ICR 2003) has announced the social programme and cultural tours for registrants and accompanying persons. The congress will take place on August 17-22 in Washington DC, one of the most beautiful cities in the world, with impressive monuments, memorials, parks and museums.

Congress registrants and registered accompanying persons will have welcoming receptions on Sunday evening at the congress hotel, the historic Marriott Wardman Park, and on Monday evening at the Ronald Reagan International Trade Center which is near the White House. A gala awards banquet on Thursday evening will feature the presentation of IIR awards and recognition of dignitaries.

Social events for registered accompanying persons include a 'get acquainted luncheon', tours of the National Gallery of Art in multiple languages, and a Washington city tour including Capitol Hill, the Library of Congress, the Supreme Court, Georgetown, Embassy Row, and the National Cathedral.

Congress participants and guests will also have the opportunity to register for a number of optional sightseeing and cultural tours. These tours include Washington by Night, Annapolis and the US Naval Academy, the Holocaust Museum, museums at the Smithsonian complex, Mount Vernon (the impressive estate of George Washington), the historic sites of Alexandria, and the Hillwood Mansion museum and gardens.

Technical tours associated with the congress will be announced shortly.
For more information on the congress, visit the conference website at www.icr2003.org.

Source: Richard Ertinger
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Programme 21st IIR Congress shapes up

Plenary (keynote) speakers have been secured for the Congress. Dr William D. Phillips of the National Institute of Standards and Technology, USA will be the plenary speaker at the opening session. Other keynote speakers are Dr Elsa A. Murano, under-secretary for the US Department of Agriculture Food Safety, Dr Stephen Forbes Pearson, president of Star Refrigeration Ltd, Prof. Fritz Steimle, Head of the Laboratory for Applied Thermodynamics and Air Conditioning at the University of Essen, Germany, William G. Sutton, president of the US Air Conditioning and Refrigeration Institute and David G. Herbeck, member of the Space Station Office technical staff in the Office of Space Flight at NASA.

Part of the programme is a short course supported by the IEA Heat Pump Programme, with the title: Advances in Supermarket Refrigeration – Improved Refrigeration/Heat Recovery Systems, Analytical Methods, Refrigerant Management and Secondary Fluid in International Context. For details on the programme of the congress, visit: www.icr2003.org

Source: IEA Heat Pump Centre

Technology & applications

Hundreds of heat pumps in Breda

Netherlands - In the city of Breda, 350 new homes will be equipped with heat pump systems for space heating. It's the first time that heat pump systems will be used on such a large scale. The municipality has asked REMU, a power utility, to install the systems. The heat pumps will provide increased living comfort and reduce CO_2 emission by 25%, compared to conventional heating systems. Novem and probably the provincial government will provide financial support. The monthly costs of the new system for the residents will be the same as for conventional heating. REMU retains ownership of the heat pump systems and carries out maintenance while the resident pays for the source and the write-down of the heat pump. Novem has awarded the project the status of national model project.

Source: Cobouw, no 43,March 2003 (Dutch)

Watter$aver

USA - ECR International has won the R&D 100 award for its Watter$aver Drop-In Residential Heat Pump Water Heater. This prestigious honour in applied research is bestowed to the 100 most 'technologically significant' new products of the year. The Watter$aver is designed as a full 'drop in' direct replacement for existing electric water heaters but operates with an Energy Efficiency rating of 2.47, nearly three times as efficient as a conventional electric water heater. Due to this efficiency gain, the Watter$aver pays for itself within 2 to 5 years. Widespread use of the Watter$aver could reduce US energy consumption by 1%.
ECR has successfully tested the Watter$aver for reliability and durability and it is now ready for market release.

Source: Enviromaster International Corporations – What's New, Feb 2003
www.enviromaster.com/whatsnew.asp

Developed test-procedures for hot water heat pumps

Netherlands - Commissioned by Novem, TNO drew up a test directive for hot water heat pumps in 1998. The aim of this directive was to determine the annual operational efficiency of hot water heat pumps in a standardised manner. To achieve this, the test method used four different tap patterns that were already in use in the Netherlands for testing gas-fired appliances for hot tap water preparation. Recently, this test directive, which complies with the Energy Performance Standard (NEN 5128; 2001), was modified on the basis of TNO's experience in the past three years with the tests. The directive is now also available in English. The Internet site of TNO Environment, Energy and Process Innovation provides additional information about heat pumps, as well as the Dutch and English versions of the test directive.

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New climate control system

United Kingdom / Netherlands - Caloris is a new energy efficient climate control system that permits fully independent local conditioning of the internal space, utilising the best in modern heat pump technology.

In response to the need for ever lower costs and greater operating efficiency, coupled with the need for improved working conditions, the new system offers considerable benefits to the developer, the builder and the occupier.

The system can consist of many individual heat pumps linked together in parallel. There is no limitation in the number of units that may be connected, unlike traditional Variable Refrigerant Flow (VRF) systems. A neutral temperature water loop links the units and provides the means of energy transfer, with a central heat pump regulating the temperature of the loop.

Furthermore, low cost highly durable polyethylene pipes can be used to connect the units. Unlike sensitive refrigeration pipework, these pipes do not even need to be insulated. A further benefit is that the building's mass can be used to help to maintain the temperature of the water loop, providing even greater energy efficiency.

The system is de-centralised and thereby permits fully independent local conditioning of the workspace. The room heat pump is slim, only 245 mm in height, and is available in a range of sizes, starting with an output of 2 kW. The system is suitable for all applications, from small cellular offices and hotel rooms to large open plan spaces.

A remote room controller sets the temperature and mode (heat/cool/recirculate), and full Building Management System compatibility is available.

As for the central roof-mounted heat pump, its purpose is to maintain the temperature in the loop between 20 and 25 °C, a range that ensures a higher COP (coefficient of performance) rating than other systems. Since the building's mass can be used to maintain the water loop temperature, the device is not turned on that often. In summer it operates as a chiller, dissipating heat energy, and conversely it provides energy to the loop in winter.

The low water loop temperature assures a high COP of between 4 and 6, which has been confirmed by the independent tests.

Development of gas-driven heat pump system for domestic use

Netherlands - TNO-MEP and boiler manufacturer Remeha are working together to develop a gas-driven heat pump system using air as its heat source. This heat pump can be used in residential applications, in renovation projects as well as new homes. A working test model has already been made. The next step will be to take the absorption heat pump into production.

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Powergen GSHPs

UK - On 30 Sept 2002, Powergen announced its intention to install 1,000 ground source heat pumps at selected locations. The project will target social housing using a new heat pump design commissioned from Calorex Heat Pumps Ltd.
The estimated cost of a system for a 100 m^2 3-bedroom property is about USD 7,000.

Source: UK Heat Pump Network Newsletter, Issue 7, March 2003
www.powergen.co.uk and www.calorex.com

The system also complies with the ISO 7730 comfort standard.

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Renewable energy used in best multi-family building in Canada

Canada - Earth energy heat pumps used in a West Coast residential complex have helped the developer to win top honours in a national building competition. The CAD 100 million Shoal Point complex on Victoria's harbour won the award from the Canadian Home Builders Association for its use of earth energy systems to reduce energy by 50% over conventional buildings. It is considered one of the most environmentally and technically advanced residential buildings in North America.

Source: www.renewables.ca

Distributed energy market has softened

USA - Fewer industrial and commercial businesses expressed interest in adopting onsite electric generators (distributed energy) this year, according to a study by Primen, a Boulder-based energy market intelligence company. The study reveals that while the North American market for distributed generation looks significantly different than it did just one year ago, a small population of knowledgeable companies are still very concerned about energy.

Source: ASHRAE Newsletter, Feb 2003, issue 7, volume 2

UK heat pump conference

UK - The UK Heat Pump Network held its annual conference in Edinburgh in December 2002. Some 77 delegates took part, and a wide range of heat pump interests were represented. The conference topics were: heat pumps in the UK, natural refrigerants, ground-source heat pumps using 'slinky' collector pipes, ground-source heat pumps: a practitioner's view, heat pump to produce low-pressure steam for use in industrial processes, gas engine heat pumps, adsorption heat pump research at Warwick University, Swedish market experience, mine-water heat pumps for district heating, and heat pump education.

For more information contact www.actionenergy.org.uk or
tel: +44 0800 58 57 94

Ottawa - Earth energy / solar building wins top national award

Canada - A national award has been presented to a firm in Nova Scotia, Canada, for building an energy-efficient home that incorporates earth energy and solar heating. The top award in the 'Housing' category was presented for a home that relies on radiant warm water from active solar collectors and an open-loop earth energy heat pump. The home also generates its own electricity from solar PV panels.

Source: www.renewables.ca

Technology award winning project focuses on energy and water preservation

USA - Development of a laundry water recovery system that saves between 1.2 and 1.6 million litres of hotel wastewater annually has a significant environmental impact. The system recovers more than 90% of the water and uses a 338 kw cooling heat pump to recover energy from the building's chilled water return mains and transfers it to the system. The heat pump also provides cooling of water.

Source: ASHRAE News Release, 25 Jan 2003

Markets

World air conditioning market

The global air conditioning market is worth USD 34 billion. It increases annually by 4%, and is predicted to reach USD 39 billion by the end of 2004, according to a recent report from the Building Services Research and Information Association (BSRIA).

East Asia and Southern Europe are among the fastest growing regions. Minisplits, by far the largest product segment by value, are the world fastest growing market segment with large units growing at 10% annually and smaller units at 7%. China is the world's largest minisplit market and production centre. Increased competition from Korea and Thailand are driving down prices by 4% a year in real terms.

Window units have lost share to minisplits around the world except in the USA, which now accounts for more than half of the world market and is expected to account for most of the increase over the next few years.

North America also accounts for 96% of the unitary market, though growth in unitary products has slowed, primarily as a result of the economic slowdown in the region.

The market supply structure is experiencing major changes, with the Koreans and more recently the Chinese challenging the Japanese and other manufacturers in the Far East right across the global minisplit market. For window units, unitary products and chillers, U.S. companies have strengthened their share of the world market. The recent trend of alliances and mergers will continue.

For more information, visit BSRIA's Worldwide Market Intelligence Division online (www.bsria.com).

Source: Ashrae, March 2003

Air conditioners and heat pumps set record – 6,746,326 units shipped in 2002

USA - Shipments of central air conditioners and air source heat pumps jumped 7% in 2002 to a record 6,746,326 units, eclipsing 2000's record shipments of 6,685,481 units and last year's total of 6,281,443, according to ARI statistics. Heat pump shipments of 1,483,599 units had a record year, up 2% from 2001's 1,442,355 units. Combined shipments of 373,284 central air conditioners and air source heat pumps for December were up 10%, compared to December 2001.

Source: Koldfax, February 2003

The Spanish market development

Spain - With over $ 960 million equipment turnover, the Spanish HVAC market is one of the largest in the world, second only to Italy in Europe. However, the most impressive feature of this huge market, now approaching 2.4% of the global HVAC equipment market, is its constant steep growth. The annual growth rate of the Spanish market is predicted to be 12% for the next 10 years, and Spain is predicted to be the number 1 country for the next 10 years with the highest forecast volume of new cooled space (added or replaced). All sectors are more or less on the same growth path. Spain, which already has one of the highest 'm^2 of air-conditioned space per inhabitant' (6.1 m^2 A/C per person, European average 3.05) is expected to have 7.5 m^2 A /C per person by 2010.

Source: Yarn, volume 35, no. 1

Working fluids

A heat pump system for heat recovery from manure/slurry in stables

Poland - A Polish company has worked out a new system for various heating/cooling uses. The installation is designed for heating houses, for preheating drinking water and general purposes. It can also be used for cooling rooms and technical equipment. The energy in exothermic bedding, in which relatively high temperatures occur, is recovered by means of a heat pump, which can fully replace other heating systems. The company is interested in cooperation or joint venture agreement.

A heat pump system that uses heat recovery from manure litter in stables can provide all of the energy needs of the farmhouse. The production cost of energy is significant lower in comparison to other energy carriers. The temperature in the exothermic bedding, e.g. in deep litter, is 20°C to 50°C and it is constant during the production process. The energy produced in this process can be used for heating compartments for animals in the same building, houses, and social buildings, or for heating water for cleaning and drinking (particularly for new born animals).

The heat produced during fermentation is recovered by the heat exchanger installed in the floor under the deep litter. The energy is collected by the heat pump and transferred to the heating circuit. The temperature in the heating loop is preset according to the user's needs. The heat pump works fully automatically. The user can programme the temperature as well as the time of heating for specific objects.

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Source: Cordis Focus, Issue n° 40, Feb. 2003

Denmark: first HFC-free restaurant

Denmark - In January 2003, McDonald's Denmark opened the world's first HFC-free restaurant. The restaurant in Denmark is part of a new initiative to help reduce the potential effects of climate change on the environment. This McDonald's is equipped with state-of-the-art refrigeration and ventilation systems using environmentally innovative refrigerants that do not contain (H) CFCs or HFCs (hydrofluorcarbons). This pilot programme is the first of its kind in the quick service restaurant industry.

Denmark was chosen as the ideal country in which to locate the test restaurant, since it had already started initiatives to phase out HFC refrigerants. McDonald's then set to work in close collaboration with the Danish Ministry of the Environment, the Danish Technological Institute, and four Danish companies in order to find the most efficient solution.
The establishment of an HFC-free test restaurant is part of McDonald's overall commitment to social responsibility. The new restaurant is particularly interesting, because never before have so many different kinds of refrigeration equipment in one place been converted to the new refrigerants. Today McDonald's is showing how companies can make a difference by setting new standards for environmental performance, and it is hoped that this will accelerate the use of HFC-free refrigeration and ventilation equipment.

Source: CSR-wire, 16 Jan 2003

Ammonia for geothermal heat pumps

Germany - Over half of the 8,000-10,000 domestic heat pump installations that were expected to be completed in Germany in 2002 are equipped with ground-source coils. A housing estate in Werne (NRW) is said to be the largest geothermal development of its kind in Europe.
A means of lowering the initial cost of these systems and thus reducing their relatively long depreciation period has been introduced by Amotherm, who uses ammonia as the working fluid in the ground coils. The much higher earth/fluid heat transfer rate is claimed to reduce ground work costs by up to 80%.

Source: CCI, 1/2003, Germany

IEA Heat Pump Programme

Refrigerant management programs assessment – Part 2 available

In the past decade, tremendous changes and developments have taken place in working fluids for refrigeration technology. International Treaties (Montreal Protocol, Kyoto Protocol) have provided the framework for these changes.

Governments have developed and implemented specific CFC and HCFC policies and instruments aimed at refrigerant conservation and reducing refrigerant leakage from installations and equipment. However, very little documented information is available in literature about the effectiveness and impact of these programmes. Only during the past few years have quantitative results been published, and then only sparingly. As for the financial aspects of implementing refrigerant conservation policies and measures, the number of publications is almost negligible.

The HPC has conducted an international assessment of refrigerant management programmes and practices in a number of industrialized countries. The rationale behind the study was to enhance insight in different approaches and quantify the impact on emission reduction. The study has been carried out in two parts. Part 1, published in 2002, included the countries Australia, Canada, France, Japan, Netherlands and USA and focussed on refrigerant recovery, recycling and reclamation. The newest report is Part 2 of the study, which also includes refrigerant disposal. The geographical scope of Part 2 includes the same countries as Part 1, but extends coverage to Denmark, Germany, Italy, Norway, New Zealand and Switzerland.

The results of this assessment are of interest to environmental policy makers, industry business executives and refrigerant practitioners. The report provides insight in the international state-of-the-art and impact of refrigerant management programmes and practices. Copies can be ordered from the HPC, quoting publication code: HPC-AR13. The price per copy is € 120. The price for orders from the USA, the UK, the Netherlands, Japan, Austria and Norway is € 40.

Source: IEA Heat Pump Centre

New project initiatives under the IEA Heat Pump Programme

Generating new international collaboration is vital to the Programme and the advancement of heat pump technology. Priorities for collaboration have been identified and are being worked out in project proposals. Proposals can develop into new Annexes or so-called Special Tasks. A summary of new project initiatives:

Compact heat exchangers in heat pumping equipment
The general objective of the proposed Annex is to increase the knowledge of compact heat exchangers for use in heat pumping equipment. Specific objectives are

- to collect information about commercial and evolving manufacturing methods for compact heat exchangers;
- to collect information about calculation procedures for predicting heat transfer and pressure drop in such equipment.

Emphasis will be put on spreading the information collected throughout the participating countries.

The role of heat pumping energy systems for a sustainable society
The objective of this study (a Special Task) is to show and verify - for a wide target group of experts and non-experts - the sustainability and environmental benefits of the increased use of heat pumping energy systems. The positive contributions with regard to reduced greenhouse gas emissions and the climate change process will be shown to the target group at country and end-user level.

Ground-source heat pumps - Overcoming market and technical barriers
The overall objective of this Annex is to investigate innovative ideas and identify advanced systems that could improve the performance and market attractiveness of ground-source heat pump systems. Main market impediments to be focused on are high initial cost and institutional obstacles. Ways will be explored to further enhance system performance, including improved heat transfer and the use of alternative refrigerants. Intended results of the project include: information to assist researchers, utilities, manufacturers and policy-makers, and improved technical and marketing solutions that can help stimulate market development of ground-source heat pump systems.

Heat pump water heaters – Status, trends and potentials
The objective of the proposed Special Task is to conduct a state-of-the art assessment of the situation for heat pump water heaters and to identify trends, as well as the market and environmental potential of heat pump water heaters for use in the residential and commercial market sector. The analysis will form the basis for further work in the form of an Annex.

Long term performance of heat pump systems
The proposed Annex will assess the reason(s) for heat pump performance deterioration over time and will identify ways of improving performance and quality of system design. The performance of heat pump and air conditioning systems can be affected adversely by poor system design/ installation and other factors such as refrigerant charge variation, build-up of contaminants over time et cetera. There is a need to understand the impact of these factors and how they can be monitored and adjusted, in order to minimise performance deterioration. This could be of great value to companies developing methods for on-line monitoring, but also to legislative bodies dealing with refrigerants.

Collaboration and support for these projects are being solicited. Reactions and requests for more information can be sent to the HPC.

Source: IEA Heat Pump Centre

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, UK
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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.

US standards, testing and labelling procedures for residential heat pumps and air conditioners

John J. Tomlinson, USA

The system used in the US to arrive at energy performance standards for consumer products is based on the consensus of all interested parties. Overall, this system works effectively, as witnessed by the recent increase of about 10-20% in the minimum energy efficiency standards for air conditioners and heat pumps. Transparent labelling guidelines are also essential in providing consumers with adequate information.

Summary

This paper describes the system of energy efficiency standards, tests and labelling used in the US for various consumer products, including air-conditioning and heat pump systems. The process of developing and regulating minimum energy efficiency performance standards is based on input from all the affected parties and on consensus. This process generally works effectively, as witnessed by the recent passage of new minimum efficiency standards for residential heat pumps and air conditioners, which raised minimum efficiency levels by approximately 10-20%. The new standards will go into effect in early 2006.

Two energy efficiency metrics, SEER (Seasonal Energy Efficiency Ratio) and HSPF (Heating Seasonal Performance Factor), are used, respectively, for cooling and heating applications. Both metrics reflect the fact that it is the installed or delivered efficiency of a unit that is important. The test procedures for determining SEER and HSPF are important in effectively calculating performance metrics for various models of heat pumps and air conditioners.

Finally, in the US, 12 types of domestic appliances, including heat pumps and air conditioners, are classified by means of the EnergyGuide label. This labelling system has been used in the US since 1980 and plays an essential role in providing appropriate information to all interested consumers.

Introduction

Energy conservation performance standards are applied to 12 types of consumer products sold in the US. These include: refrigerators, water heaters, furnaces, dishwashers, clothes washers, clothes dryers, direct heating equipment, kitchen ranges and ovens, pool heaters, fluorescent lamp ballasts, room air conditioners, and central air conditioners and air-conditioning heat pumps. These standards are based on several US legislative Acts beginning with the Energy Policy and Conservation Act, Public Law 94-163, as well as several amendments that added definition to a process for setting minimum efficiency performance standards for products sold in the US.

Adopting or changing an energy conservation standard requires that the proposed standard be designed to achieve the maximum improvement in energy efficiency that is technically feasible and economically justified. To determine whether economic justification exists, the US Department of Energy (DOE) weighs several factors, including:

- the economic impact of a proposed standard on the manufacturers and on consumers;
- savings in operating costs over the estimated lifetime of a product as compared to maintenance costs and any increase in initial cost;
- the total projected energy savings that would result from imposition of a proposed standard;
- any reduction in utility or performance that would be caused;
- the impact of any lessening of competition that might occur;
- the need for national energy and water conservation;
- other factors that the Secretary of the DOE considers relevant.

In other words, the benefits of a mandate for higher efficiencies must outweigh the burdens with respect to economic and other impacts. The process currently used in the US focuses on analysis and consensus – obtaining input and advice from manufacturers, consumers, trade associations, energy conservation allies and all interested and involved stakeholders – with the aim of formulating standards that are beneficial and balanced.

Test procedures and metrics for air-source heat pumps/air conditioners

The establishment of performance standards requires the development and application of metrics for measuring performance and efficiency. A brief description of the DOE testing procedure for heat pumps and air conditioners is given below. The procedure produces performance metrics that reflect real-world performance, which can be used to set minimum efficiency standards.

Most residential heat pump and central air conditioner systems are split-type, whereby a refrigerant line set and control wiring are used to connect an outdoor unit to an indoor unit [1]. If the capacity of a heat pump or air conditioner always met a constant load, and if the outdoor temperature and humidity remained constant, the unit would run 100% of the time, and calculating the efficiency of the unit would be a straightforward task. In a real world application, however, ambient outdoor conditions as well as the heating/cooling load served by the heat pump vary, which means that:

- the performance of the outdoor coil changes depending on ambient dry bulb temperature and humidity (the coil operates below the dew point thereby producing condensate);
- the heat pump cycles on and off so that the total cooling it produces matches the cooling load of the building.

The former suggests that the test procedure needs to evaluate the efficiency of the heat pump during conditions where the outdoor coil is "wet" and during conditions where the coil remains dry. The latter suggests that the test procedure needs to accommodate the impact of heat pump cycling due to the inherent performance losses associated with turning the unit on and off.

The performance metric used by the DOE in its test procedures is the Energy Efficiency Ratio, or EER. This is a dimensional number that represents the cooling in Btus (or joules) delivered by a unit under steady-state ambient conditions divided by the electrical input in W-h to the unit. **Table 1** lists the ambient conditions under which air-source heat pump units (heating and cooling mode) and air conditioners (cooling mode only) are to be tested as part of the DOE test procedure.

Cycling of either a heat pump or air conditioner is a complicating factor in any test procedure. Cycling reduces the EER of the unit, and since the unit is sized to deal with design conditions, the unit will cycle for the majority of a heating or cooling season.

Let us, for example, consider the heat pump in its cooling mode. The Cooling Load Factor, CLF, is a non-dimensional number that is equal to the ratio of the cooling (in Btu/hr or kW) delivered by the heat pump over an entire cycle, consisting of one compressor "on" period followed by one compressor "off" period, to the cooling that the heat pump would deliver if turned on for the entire cycle. Based on this definition, CLF values range from 1.0 (the compressor operating continuously) to 0 (the compressor "off" for the entire cycle). The CLF is determined under the test conditions specified in **Table 1**.

The longer the compressor is "off" during a cycle, the lower the CLF will be and the more influence cycling will have on the unit's overall performance. In other words, the relative loss in overall EER, which is equal to $(EER_{\text{steady-state}} - EER_{\text{cycling}})/EER_{\text{steady-state}}$, depends on the length of time that the compressor is "off" during a cycle. The DOE test procedure uses a Degradation Coefficient, or Cd, to describe the falloff in unit performance (the relative loss in overall EER) as a function of decreasing CLF. In point of fact, Cd does not have a single value. However, data have shown that Cd is constant for CLF values ranging from about 0.2 to 1.0.

The DOE test procedures calculate a seasonally adjusted EER, or SEER, by assuming that the compressor will be "off" for 50% of the time in typical cooling applications. Therefore, CLF = 0.5 and:

$$SEER = (EER_{\text{steady-state}})\ (1 - 0.5Cd).$$

A default Cd value of 0.25 has been used based on knowledge of heat pumps acquired over the last two decades. The SEER can then be calculated fairly well with the equation above and is equal to 87.5% of $EER_{\text{steady-state}}$. A lower Cd value would provide a higher SEER. Recent improvements in equipment have led to Cd values significantly lower than the default value of 0.25. Equipment surveys conducted independently by ARI (Air-Conditioning and Refrigeration Institute) and the Consortium for Energy Efficiency found that heat pumps currently sold into the US residential market have median Cd values close to 0.1. The median SEER value would therefore increase by about 7% if the current median Cd value were used rather than the default. Manufacturers have the option of using the default Cd value provided by the DOE test procedure, thereby reducing the number of tests required for each model they produce. Alternatively, they can perform the additional tests required to determine the Cd value, probably resulting in a slightly higher SEER rating.

Table 1: Test conditions for single-speed air-source heat pumps and air conditioners.

Test	Outdoor air inflow conditions		Indoor air inflow conditions	
Cooling Mode	Dry bulb	Wet bulb	Dry bulb	Wet bulb
A	95°F (35°C)	n.a.	80°F (26.7°C)	87°F (30.6°C)
B	82°F (27.8°C)	n.a.	80°F (26.7°C)	80°F (26.7°C)
C (steady-state)	82°F (27.8°C)	n.a.	80°F (26.7°C)	<5°7F (13.8°C)
D (cycling)	82°F (27.8°C)	n.a.	80°F (26.7°C)	<57°F (13.8°C)
Heating Mode				
Hi-temp test	47°F (8.3°C)	43°F (6.11°C)	70°F (21.1°C)	60°F (15.6°C)
Cycling test	62°F (16.7°C)	56.5°F (13.6°C)	70°F (21.1°C)	60°F (15.6°C)
Frost test	35°F (1.7°C)	30°F (-1.1°C) dew point	70°F (21.1°C)	60°F (15.6°C)
Low temp	17°F (-8.3°C)	15°F (-9.4°C)	70°F (21.1°C)	60°F (15.6°C)

In a manner analogous to the use of the SEER metric for cooling applications, there is also a metric used in the US for heating applications. This metric, called the Heating Season Performance Factor or HSPF, determines the efficiency of the unit under field conditions by taking into account cycling losses and other factors such as defrosting, which have an effect in most of the US.

Current SEER and HSPF standards for heat pumps sold in the US

The existing minimum standards for residential central air conditioners and heat pumps marketed in the US have been in effect since 1992 and are:

- split system air conditioners and heat pumps: 10 SEER (2.9 COP) and 6.8 HSPF (2.0 COP);
- single-package air conditioners and heat pumps: 9.7 SEER (2.8 COP) and 6.6 HSPF (1.9 COP).

On 23 May 2001, the DOE amended these minimum performance levels as follows:

- split system air conditioners and heat pumps: 12 SEER (3.5 COP) and 7.4 HSPF (2.2 COP);
- through-the-wall split systems: 10.9 SEER (3.2 COP) and 7.1 HSPF (2.1 COP);
- through-the-wall single-package systems: 10.6 SEER (3.1 COP) and 7.0 HSPF (2.1 COP).

These new performance standards will apply to products manufactured for sale in the US as of 23 January 2006 (manufacturers now know the target efficiencies and they must complete redesign and production to meet these new standards by this date).

Based on these new standards, the DOE estimates that an average US consumer would save 384 kWh annually based on the higher efficiency of a 12 SEER (3.5 COP) air conditioner as compared to a 10 SEER (2.9 COP) air conditioner based on the current standard. The purchaser of a heat pump with 12 SEER (3.5 COP) and 7.4 HSPF (2.2 COP) would save 768 kWh annually - a significant saving - due to the higher efficiency for both cooling and heating. These figures are based on the purchase of a split system air conditioning or heat pump system, which represents more than 65% of the US market for air conditioners and heat pumps [1].

Heat pump/air conditioner efficiency labelling in the US

The US Federal Trade Commission manages the guideline that requires all manufacturers of air conditioners and heat pumps to disclose the energy consumption or efficiency information from the DOE Test procedures in the form of the EnergyGuide label or other fact sheets and catalogues. The labelling programme was started in 1980 and currently covers most major home appliances. The EnergyGuide label is affixed to the heat pump or air conditioner so that it is displayed at the point of sale and contains the following information:

- the Model designation of the equipment;
- the SEER of the unit (its cooling efficiency as determined by the DOE test procedure);
- the SEER range of similar models marketed in the US;
- the HSPF of the unit (its heating efficiency as determined by the DOE test procedure);
- the HSPF range of similar models marketed in the US.

An EnergyGuide label for a residential split-system heat pump is depicted in **Figure 1**. The performance of the unit is shown on the horizontal bar and the bar represents the total range of comparison values. The model described by the label is about midway in efficiency between the most and least efficient models marketed for sale.

Figure 1: FTC label for split system heat pump

As heat pump manufacturers regularly add new models to their lines or drop or improve existing ones, the FTC (Federal Trade Commission) database used to calculate the ranges of comparison values is constantly changing. Unless the FTC finds that the upper or lower limits in the ranges have changed by more than 15% over the last year, the old ranges remain in effect. The range of SEER and HSPF values has not changed by more than 15% since 1996, so that the ranges of comparison values used for heat pump/ central air conditioner EnergyGuide labels have not changed since then.

Another example of an EnergyGuide label, on the outdoor section of a split system heat pump, is shown in **Figure 2**.

Figure 2: EnergyGuide label on a split system heat pump

For some appliances, the EnergyGuide label also contains the EnergyStar logo, signifying that the appliance performs significantly better (10% to 50% more efficient depending on the appliance) than the conventional or minimum efficiency model. The EnergyGuide label, used in the US since 1980, plays an essential role in providing information to consumers, irrespective of whether they are contractors, builders or homeowners interested in a replacement system.

The FTC also provides up-to-date energy cost data to manufacturers. This information is used to calculate annual energy consumption for heat pump/ central air conditioner systems for presentation in fact sheets.

References:
[1] Federal Register, Vol. 67, No. 100, Thursday, May 23, 2002, Rules and Regulations, Part III Department of Energy, 10 CFR Part 430, page 36377.

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Standard monitoring procedures for heat pump systems

Peter Oostendorp, the Netherlands

In the Netherlands, TNO-MEP developed monitoring procedures for both the domestic and utility market. This article gives a brief description and presents some of the monitoring results.

Summary
In Newsletter No. 2/2001, we announced that we would report on our experiences with the standard procedures developed by TNO-MEP for monitoring heat pump systems in commercial and residential buildings, referred to as SMP-HP-C and SMP-HP-R respectively. We have applied these ‘standard monitoring procedures’ (SMPs) to individual residential dwellings and to commercial buildings. This article presents a brief description of the procedures themselves as well as some monitoring results.

Standard monitoring procedures
In developing the standard procedures, we tried to find a good balance between costs of monitoring and usefulness of the results. The following requirements had to be met:
- the standard monitoring procedures needed to be simple and clear;
- the procedures should include a clear definition of variables, parameters and procedures;
- *different* objects, when monitored by *different* actors, should provide *comparable* results.

Whereas standard test procedures like EN 255 determine the performance of a heat pump as a component under standard conditions in the test laboratory, our standard monitoring procedure is meant to provide a reliable indication of the performance of the heat pump *system* as a whole, when it is used in a house or building under conditions that vary during the year.

The procedures prescribe uniform methods for measurements, data acquisition and processing. The user can choose from two levels of depth: the *basic option* and the *extended option*. Often, both options are used together. A large number of dwellings in a project are monitored using the basic option, and a few with the extended version.
The procedures are available, as yet in Dutch only, at our website: *www.mep.tno.nl*.

Standard procedures for residential heat pump systems (SMP-HP-R)
For residential systems, we defined 11 different types of heat pump systems, covering virtually all systems presently on the (Dutch) market.

Figure 1 is a schematic diagram of system type number 6, *Reversible heat pump with additional heat source*, which includes functions such as heating, active/passive cooling and domestic water heating.

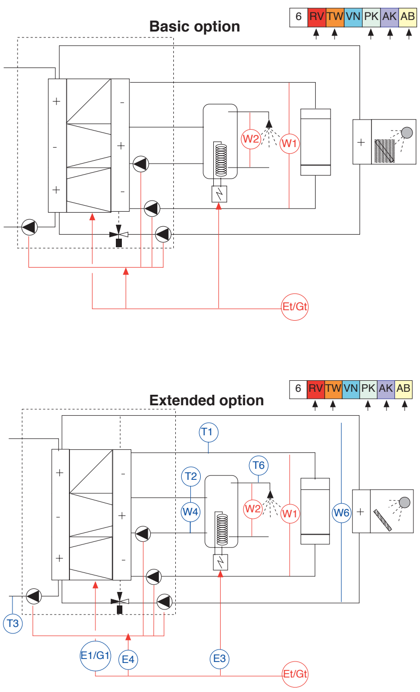

Figure 1: System type 6 - reversible heat pump with additional heat source (domestic system) with basic and extended monitoring options.

The minimum required measuring points are shown for both the basic and extended options.

In the blocks to the left of each scheme, three important functions are shown with (from top to bottom):

- simple heat exchange (+/-)
- heat pump in cooling mode (-/+)
- heat pump in heating mode (+/-)

Heat can be exchanged between the source system on the left and the rest of the system via the heat pump in cooling mode, the heat pump in heating mode, or via direct heat exchange.
In the basic option, only the heat delivered (W1, W2) and the energy input (Et or Gt) are measured.
In the extended option, more detailed information is collected. The heat output is further specified in terms of heat/cold delivered by the heat pump or heat from the extra heat source. The energy input is divided between the heat pump, auxiliary heating, and circulation pumps and control.

In **Figure 2**, a heat pump system is shown that is currently quite popular in the Netherlands. The heat pump is of the 'combi' type, which means that it provides both space and domestic water heating. Ground water serves as a heat source. In summer, the ground water temperature is low enough to provide top-cooling to the dwelling. To prevent condensation on the floor or wall surfaces in summer, fan coils are recommended as heating/cooling elements (or, alternatively, a strict temperature control of the wall/floor heating system). In another variant, the system can be connected to a ground heat exchanger, as a heat source annex cold storage, and may also include a solar collector with as an extra heat source to complete regeneration of the soil in summer. For monitoring purposes, it turns out that the latter system can best be classified as system type 6. Examples of monitoring results for such a system are given in **Figures 3-5**.

In **Figure 3** the heat balance of the ground is given. Heat extraction is positive, and regeneration is negative. The cumulative curve reveals that from January '01 until January '02 regeneration was almost complete. Heat extraction in summer is for domestic hot water production.

Figure 4 presents the cooling efficiency of the system in summer. The average COP_c (defined as the ratio of cooling energy delivered to the electricity consumption of the circulation pumps) is about 21. The 'free' cooling efficiency in summer (using the cold stored in the soil) is therefore quite high. The contribution of the solar collector to soil regeneration in summer can be derived from the difference between the values for *regeneration* in **Figure 3** and the values for *cooling delivered* in **Figure 4**. In addition to the high cooling efficiency (COP_c), another advantage of this system is the higher heating COP in winter, due to regeneration of the soil. Because the cooling option provides high added value for the consumer, these systems are considered quite competitive with (cheap) high-efficiency boilers in the Netherlands.

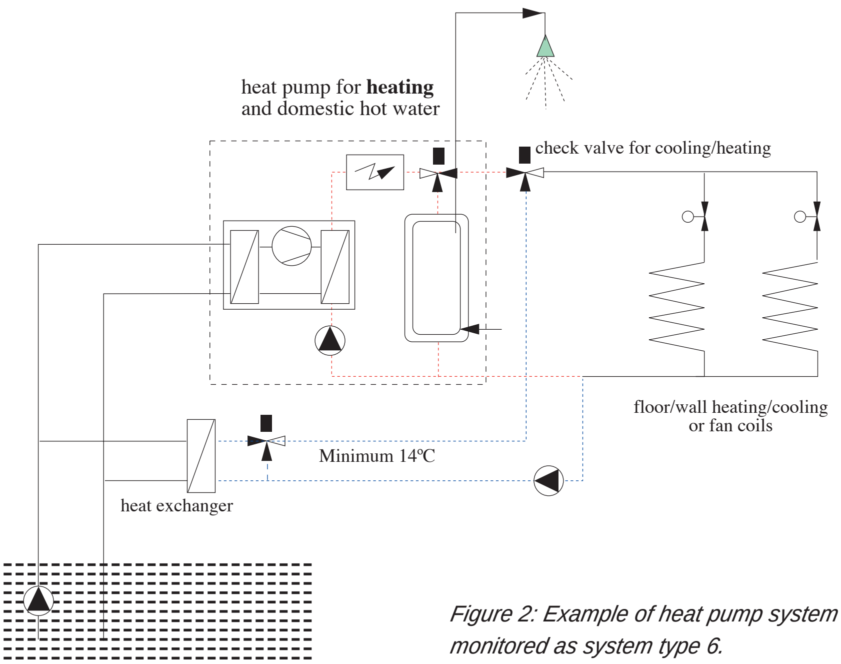

Figure 2: Example of heat pump system monitored as system type 6.

Figure 5 presents the most important parameters of the heat pump system monitored over time. These include the COP of the heat pump and the PER of the total system.

Heat pump sytems in commercial buildings (SMP-HP-C)

A similar 'standard monitoring procedure' or SMP has been developed for the commercial sector. In contrast to the procedure for residential heat pump systems, we have chosen a *modular* approach for the commercial sector, because the variety of systems in this sector is very large. The type of monitoring results obtained is essentially the same.

Final remarks

Both SMP types include report formats, a list of definitions, specifications and installation instructions for measuring equipment, a report format and a standard list of questions for surveying the satisfaction of residents in homes and buildings equipped with heat pump systems.

At present, an SMP is being developed for a third important heat pump market in the Netherlands: heat pump systems in greenhouses.

The SMP standards are available in the Dutch language only. If there is sufficient demand, we will consider translating the Standard Monitoring Procedures. If you are interested, please contact us.

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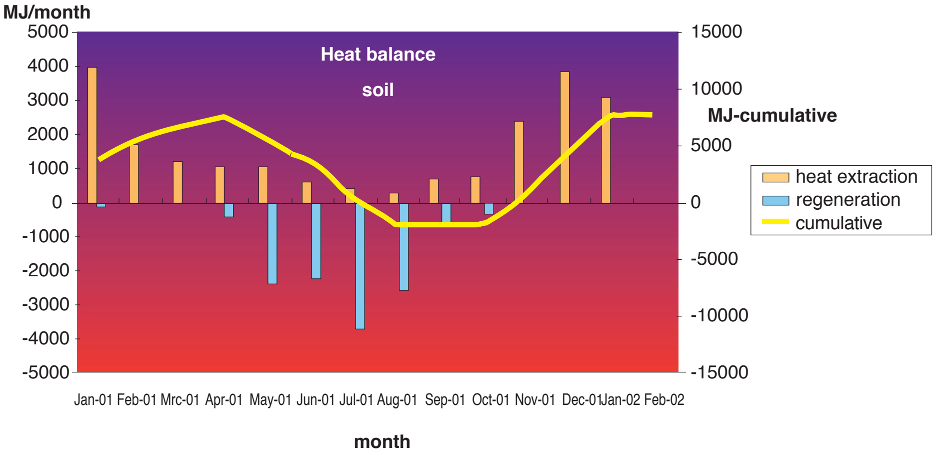

Figure 3: Heat balance of the soil

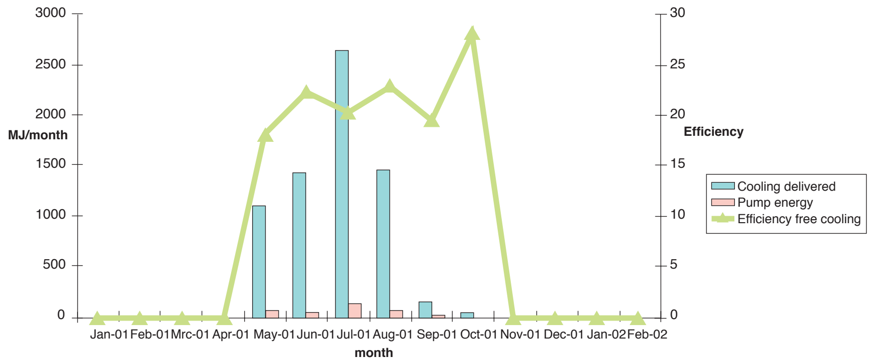

Figure 4: Efficiency of free cooling.

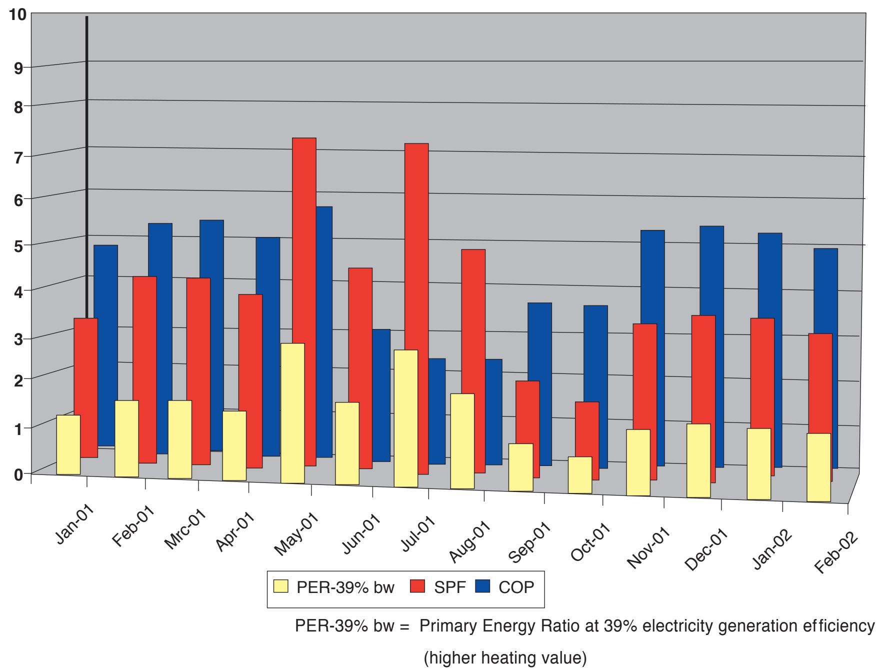

Figure 5: Heat pump system performance over time
COP: Coëfficient Of Performance
PER: Primary Energy Ratio,
SPF: Seasonal Performance Factor

Update on heat pump energy efficiency regulations, labelling and testing procedures in Japan

Takeshi Yoshii, Japan

Introduction

The IEA HPC Newsletter "Standards and Regulations", Vol. 13 (1995) No. 4, featured an article written by the present author and others on the relevant situation in Japan. Since then there have been noticeable changes in energy efficiency regulation and the labelling and testing procedure for heat pumps and air conditioners for residential and light commercial application. These changes were motivated by the need to meet the Kyoto Protocol for reducing greenhouse gas emission as well as the need for international standards harmonization. This update presents an overview of the current situation in Japan with respect to energy efficiency regulation, labelling and relevant testing standards for:

- RACs: Room Air Conditioners (including heat pumps);
- PACs: Packaged Air Conditioners (including heat pumps).

Background

The past couple of decades following the 1973 oil embargo have seen a significant change in the pattern of energy consumption in Japan, resulting in a decrease in the share of the industrial sector and an increase in the share of the residential, commercial and transportation sector. This change has motivated the Japanese government to focus more on energy saving in the residential and commercial sector in order to comply with the Kyoto Protocol.

One of the main causes for increased energy consumption in the residential and commercial sector appeared to be the widespread use of heat pumps and air conditioners in residential and commercial buildings, typically with a high penetration rate of split-type reversible air-to-air heat pumps in the space heating and cooling market. As a result, energy policymakers in the government have recognised how vital it is to improve the energy efficiency of these types of heating and cooling equipment, along with other home appliances. At the same time, the need to harmonize heat pump testing standards has increased due to the increasing globalization of the heat pump market. The Japanese government and industry have been promoting international harmonization of standards during the past decade, treating heat pumps and air conditioners as a product category.

National energy efficiency regulations

The Top Runner Program:
Since the "Law concerning Rational Use of Energy" came into effect in 1979, heat pumps and air conditioners have been subjected to energy efficiency regulations. In 1998, this law was revised and the new "Top Runner Program" was implemented. Eleven product categories are presently covered by the Program: air conditioners (including heat pumps), fluorescent lamps, TV sets, copying machines, computers, magnetic disk drives, passenger cars, trucks, refrigerators and freezers.

The "Top Runner Program" has set energy-efficiency (COP) targets, on weighted average production of each manufacturer, for air-to-air heat pumps and air conditioners (including RACs and PACs) with cooling capacity less than 28 kW. This legislation will come into force in 2004 or 2007, depending on the product category and cooling capacity, as shown in **Table 1**. The new targets were the highest energy-efficiency levels, i.e. the "top runners", for each product category in the market at the end of the reference year 1998.

Table 1: Energy efficiency (COP) targets for heat pumps and air conditioners in the "Top Runner" program: COP values at standard rating conditions for reversible heat pumps (average of heating and cooling), and for air conditioners cooling only (in parenthesis)

Type of heat pumps and air conditioners	Cooling capacity				
	< 2.5 kW	2.5 - 3.2 kW	3.2 - 4.0kW	4.0 - 7.1 kW	> 7.1 kW
Window-type	2.85 (2.67)				
Ductless wall-mounted split-type	5.27 (3.64)*	4.90 (3.64)*	3.65 (3.08)*	3.17 (2.91)	3.10 (2.81)
Other dutctless split-type	3.96 (2.88)	3.96 (2.88)	3.20 (2.88)	3.12 (2.85)	3.06 (2.85)
Ducted split-type	3.02 (2.72)			3.03 (2.71)	3.02 (2.71)
Multi split-type (with independently controlled indoor units	4.12 (3.23)			3.23 (3.23)	3.07 (2.47)

* target year is 2007 except for ductless split-type with cooling capacity less than 4.0 kW which are targeted for 2004

The highest target COP of 5.27 in the "Top Runner Program" was set for the smallest capacity class of residential ductless split-type heat pump with a cooling capacity less than 2.5 kW, and is to be realized by the year 2004. **Figure 1** shows the historical trend of energy efficiency and the "Top Runner" target for heat pumps in the same category. Low-end products with a COP of 3.0 or less are still being sold in the present market. These products are destined to disappear from the market by 2004. As a result of this new regulation, competition among manufacturers appears to have intensified with respect to higher energy efficiency. Remarkably energy-efficient products with a COP of about 6.0, significantly higher than the target COP, have recently been developed and put on the market, typically in the small-capacity classes. This trend is also clearly seen in other larger capacity classes included in the "Top Runner Program".

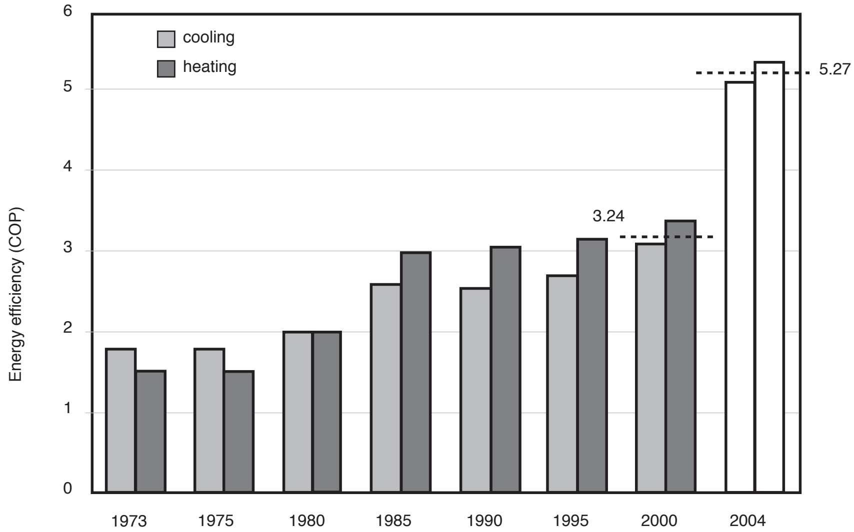

Figure 1: Trend of energy efficiency for residential heat pump (-2.5 kW class).

Figure 2 : "e-mark" label with indication of top-runner target achievement in % and annual power consumption in kWh

Table 2: List of standards in place for heat pumps and air conditioners (RACs and PACs)

Standard number	Title	Content/scope
JISB8615-1	Non-ducted air-conditioners and heat pumps - Testing and rating for performance	Testing and rating of ductless air to air heat pumps and air conditioners: almost identical with ISO5151
JISB8615-2	Dutcted air-conditioners and heat pumps - Testing and rating for performance	Testing and rating of ducted air to air heat pumps and air conditioners: almost identical with ISO13253
JISC9612	Room air conditioners	Product standard for RACs incl. testing and rating of performance
JISB8616	Packaged air conditioners	Product standart for PACs incl. testing and rating of performance
JRA4033	Multi split air conditioners	Product standard for multi-split RACs and PACs incl. testing and rating of performance
JRA4046	Calculating method of annual power consumption for room air conditioners	Standard for calculation annual power consumption for constant speed and variable speed RACs
JRA4048	Calculating method of annual power consumption for packaged air conditioners	Standard for calculating annual power consumption for constant speed and variable speed PACs
JRA4049	Calculation methode of annual power consumption for multi split air conditioners	Standard for calculating annual power consumption for constant speed and variable speed multi-split RACs and PACs

Labelling:
To supplement the "Top Runner" regulations, an energy-efficiency labelling program was introduced in August 2000. Energy efficiency labels, referred to as "e-marks" (either green or orange) are affixed to designated home appliances such as TVs, refrigerators, heat pumps and air conditioners. **Figure 2** shows an example of such a label. A green label signifies that a product complies with the "Top Runner" target, while an orange label signifies that a product has failed to do so. The number in % on the label indicates to what extent the product meets the "Top Runner" energy efficiency targets. The number in kWh indicates annual power consumption at standard operating conditions. This labelling program, though not mandatory for manufacturers, does provide guidelines with regard to placing labels on catalogues or products and is intended to help end users choose energy-efficient products.

Testing and Rating Standards:
Performance testing and rating standards are primarily prepared and authorised by the Japanese Standards Association and published as Japan Industrial Standards (JIS), i.e. national standards in which performance testing and rating procedures are defined, such as JIS8615 for heat pumps and air conditioners. In 1999, during the process of harmonizing JIS standards with ISO standards ISO 5151(ductless) and ISO 13253 (ducted), JISB8615 was revised to JISB8615-1 (ductless) and JISB8615-2 (ducted). See **Table 2** for an overview.

Industry standards

The Japanese Refrigeration and Air Conditioning Industries Association (JRAIA) has its own JRA standards, which have been supplementing JIS standards (**see Table 2**). For example, JRA4033 is a standard for multi-split heat pumps and air conditioners that are not covered by JIS standards. JRA standards also cover gas engine heat pumps and domestic water heating heat pumps with CO_2 refrigerant.

In view of the need to indicate annual power consumption in catalogues and on labels, procedures for testing and calculating annual power consumption at standard conditions, have also been prepared as JRA standards (JRA4048, JRA4049). Since a substantial part of the RACs and PACs shipped in the Japanese market are inverter-controlled models, the procedures developed also cover these models. The procedures are based on a simplified modification from the concept of the ARI Standard 210/240 developed in the US for testing and rating seasonal energy efficiencies SEER and HSPF (see article on p.11).

Under the JRAIA performance certification program, a performance certification mark is placed on all products with a cooling capacity less than 28 kW, tested at a JRAIA standard testing laboratory or at a manufacturer's testing facilities calibrated with the standard testing laboratory. JRAIA also conducts random product sampling inspections to ensure that tests carried out by manufacturers are reliable.

Future Prospects

Increasing concern about climate change is driving the move towards enhanced energy efficiency of air-to-air heat pumps and air conditioners for residential and light commercial application. At present, the performance rating of heat pumps and air conditioners is primarily determined at standard rating conditions harmonised with international standards. However, there is a growing need for a more rational seasonal performance evaluation of heat pumps and air conditioners, notably for variable speed controlled models. Such evaluations must take into account practical operating conditions and heating and cooling load variation throughout the season. A more sophisticated seasonal performance evaluation procedure can be expected in future in the form of internationally harmonised standards that meet the requirements of both customers and manufacturers.

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Successful start to Dutch pilot project introducing heat pump boilers

J.de Wolff and R. Korten, Netherlands

Heat pump boilers are energy-efficient appliances that use renewable energy for providing domestic hot water. Three Dutch organisations have launched a cooperative project intended to make sure that these systems receive the market attention they deserve.

Introduction

Residental energy consumption in the Netherlands is substantial. Public awareness of energy-related issues is growing due to media attention. The first logical steps to be taken in this regard involve energy-saving measures such as the use of improved insulation, lowering thermostat set-points, and the use of energy-efficient light bulbs, water-efficient shower units et cetera.

Another option is the use of renewable energy for domestic applications. Purchasing 'green' electricity is an obvious example. Photovoltaic solar panels and small-scale wind turbines for the urban environment provide the opportunity to actually produce green electricity. However, despite a steadily growing domestic use of electricity, the largest share of Dutch domestic energy consumption is still the use of gas for heating purposes. This heating demand can also be satisfied by renewable energy sources such as heat pumps or heat distribution from a biomass burning power station. In the Netherlands, much experience has already been gained with the use of heat pumps. Due to the specific technical modifications required for installing heat pumps in and around an existing house, they are mainly installed in new houses.

Heat pump boilers

The energy demand for domestic hot water can be satisfied using renewable energy sources, such as solar collectors. In the Netherlands however, even when installed properly, solar energy can provide only part of the energy needed for domestic hot water. Gas or electricity is always needed to bring the water to the desired end temperature. An interesting alternative that uses renewable energy for producing hot water is the heat pump boiler. The water in the boiler is heated with an integrated heat pump. Ventilation air from the house is used as a heat source for the heat pump, and the mechanical ventilation unit is also part of the heat pump boiler system.

The heat pump boiler is a fully developed technology that has been available on the market for many years. An estimated 6,000 households throughout the Netherlands are equipped with such a system. Although the users are generally very satisfied, heat pump boilers have not yet received the attention they deserve. Their main advantages, from the viewpoint of energy conservation as well as indoor climate improvement are not fully appreciated. But that may soon change. The regional energy agency, Energie 2050, in the Dutch province of Brabant has launched a pilot project to focus attention on the heat pump boiler and its benefits. **Figure 1** shows an installed heat pump boiler.

Market introduction of heat pump boilers

In December 2001, Energie 2050 launched the project 'Market introduction of heat pump boilers'. The energy agency worked together with UNETO-VNI, the Dutch employers' organisation for the installation and technical retail sector, who contributed their knowledge and contacts within the installation sector. The Team Sustainable Energy of the KEMA (KEMA specializes in high level technical consultancy, and in testing, inspections & certification. KEMA undertakes research in support of these activities) was consulted for its knowledge and experience in the use of sustainable energy options in the urban environment.

The project's main goal is to encourage the use of heat pump boilers in houses in the Dutch province of Brabant. In practice, heat pump boilers are especially interesting for renovation projects in apartment buildings. Usually, simple mechanical ventilation is present in these types of houses, and a gas water heater is used for hot water. As a result, Energie 2050 is targeting this market sector in particular.

To reach as many houses as possible, the largest housing corporations in Brabant were approached and several installation companies were contacted. After the project was explained, the housing corporations and installation companies were asked to participate in a survey. The results of the survey were used to make an inventory of the market potential for the heat pump boiler in renovation projects and newly built houses.

Workshop

Energie 2050 and KEMA then organised a workshop based on the results of the survey, in which information on heat pump boilers was supplied to housing corporations and installers. During the workshop, the operation of the heat pump boiler was explained, and the conditions were described under which a heat pump boiler is feasible and can offer a comfortable alternative.

Naturally, the financial and economical aspects of the heat pump boiler were also discussed. Calculations show that the cost of a heat pump boiler can be quickly recovered by all the parties involved: the housing corporation, the installation company and the resident. Especially when Dutch subsidy incentives are taking into account, the heat pump boiler turns out to be quite competitive with more conventional solutions such as an electrical boiler or the hot water unit of a high-efficiency boiler.

Figure 1: Heat pump boiler

The workshop ended with the demonstration of several heat pump boilers at a small exhibition. Installation companies and housing corporations were given the opportunity to ask questions and discuss the possibilities for using heat pump boilers in current building projects, renovation projects and maintenance projects.

Initial results

Several housing corporations have decided to take part in this pilot project, and they are receiving assistance from Energie 2050, KEMA and UNETO-VNI. The suitability of individual houses for the use of heat pump boilers is first evaluated. Price indications and product specifications are provided for different types of heat pump boilers to ensure that the right type is chosen. Information is also provided about possible subsidies, and a final calculation of the exploitation costs is made for housing corporations and installation companies that are considering leasing heat pump boilers.

Initial results have been promising, and have shown that heat pump boilers would seem to be very suitable for various housing projects of the housing corporations participating in the study. The residents will also receive information from the KEMA, which emphasises the convenience of the installation. After all, the heat pump boiler offers the resident lower costs for energy and increased comfort. Benefits for the housing corporation include a safe and reliable hot water system and guaranteed ventilation, which improves the climate indoors and reduces the maintenance costs for the building.

In future, other housing corporations can take advantage of the experience and information generated by the Energie 2050 project. The efforts and assistance of all three partners in the project, Energie 2050, UNETO-VNI and KEMA, will likely prove to be very valuable for future projects of a comparable nature.

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Development of a high-efficiency commercial reach-in refrigerator

John D. Ryan, USA

In contrast to the substantial increases in energy efficiency realized in the residential refrigerator sector over the last 20 years, progress in the commercial refrigerator sector was minimal. Thanks to a project initiated by the US Department of Energy together with a commercial manufacturer, commercial refrigerators are now available that are 70% more energy efficient than previous models.

Introduction

Self-contained refrigeration systems used in commercial buildings include a wide range of equipment types such as refrigerated vending machines, beverage merchandisers, ice machines, reach-in refrigerators and freezers. The energy consumption of this type of equipment is close to 146 billion kWh of primary energy used in the U.S. annually or about 4% of the electrical energy consumed in commercial buildings. Despite the significant energy use, energy efficiencies have not increased significantly in this sector. In contrast, substantial increases in energy efficiency have been realized in residential refrigerators over the last twenty years thanks to the National Appliance Energy Conservation Act and changing consumer reactions to energy savings. These increases give an indication of the potential for improvement in the commercial sector. For example, a typical 560 liter capacity, automatic defrost, residential all-refrigerator consumes 1.1 kWh/day, while a typical 560 liter automatic defrost commercial refrigerator (the Delfield 6025S) consumes 5.1 kWh/day.

Partnership project

To close the energy-efficiency gap between residential and commercial refrigerators, the U.S. Department of Energy's Building Technologies Program initiated a project in September 2000 to develop a high-efficiency commercial refrigerator. The project was carried out by TIAX in collaboration with the Delfield Company, a manufacturer of commercial refrigeration products. TIAX applied techniques used extensively for reducing energy use in residential refrigeration to the commercial reach-in refrigerator design.

The aim of the project was to develop a high-efficiency design for a two-door commercial reach-in refrigerator that would meet commercial kitchen requirements. A new refrigerator design was developed which uses 70% less energy than the unit it replaced. The new design was used as the basis for a new line of reach-in refrigerators, freezers and beverage merchandisers referred to as Delfield's Vantage 6000 Series, which is now in production and on sale – see **Figure 1**. Delfield is a major supplier of equipment to the foodservice industry, with sales of more than $100 million annually. Delfield's share of the reach-in market is estimated to be in the 10 to 20% range.

The project started with a thorough evaluation of the baseline Delfield Model 6051S two-door reach-in refrigerator with a volume of 1218 liter. Performance testing established the baseline energy use and the cooling capacity that would have to be met or exceeded by the high-efficiency design. Diagnostic testing (for reverse heat leakage and insulation conductivity, for example) evaluated factors contributing to the cabinet load and energy use.

The energy-saving design options evaluated as part of the development included brushless DC and PSC (Permanent Split Capacitor) fan motors, high-efficiency compressors, variable-speed compressor technology, cabinet thermal improvement (particularly in the face frame area), increased insulation thickness, a trap for the condensate line, improved insulation, reduced-wattage anti-sweat heaters, non-electric anti-sweat heating, off-cycle defrost termination, rifled heat exchanger tubing and system optimization (selection of heat exchangers, fans, and sub-cooling, superheat, and suction temperatures for efficient operation).

Computer modeling was used to assess the energy savings potential of the various design options. Consultations with vendors and cost modeling led to manufacturing cost estimates for each of the options. On the basis of this work, the final refrigerator design included a group of design options such as brushless DC evaporator fans, an improved face frame design, reduced

Figure 1: Vantage 6000 commercial reach-in refrigerator

anti-sweat heater wattage, a condensate line trap and an optimized refrigeration system. There was no net cost premium associated with these design changes, resulting in a high-efficiency design that required no payback of any initial additional investment.

Prototype testing and commercial development

Delfield incorporated these design options in the Vantage line design and built a first prototype that was tested at TIAX. Additional design changes were implemented in the transition to manufacturing, based in part on results of initial prototype testing, and a pilot production unit was sent to TIAX for final testing. The energy use of the pilot production unit was 68% less than that of the baseline refrigerator when tested according to the ASHRAE 117 Energy Test Standard. Subsequent testing by BR Laboratories for official registration of the product in California resulted in a measurement of 2.44 kWh/day, representing a 72% energy saving. This energy consumption is less than half of the Energy Star and proposed Canadian and California standards levels.

Delfield has successfully transitioned the design to production and is manufacturing all configurations of the energy efficient reach-ins (including 1-, 2-, and 3-door refrigerators and freezers) at a rate greater than 7,000 per year, with production quantities projected to double within a year.

More information

A technical paper on the project was presented at the Ninth International Refrigeration and Air Conditioning Conference, held at Purdue University from July 16 to 19, 2002. To obtain an order form for the Purdue conference proceedings, visit http://www.adpc.purdue.edu/PhysFac/prnt/Support/domestic.htm or contact Marti Hatke-Oteham by phone at 1-765-496-2573 or by e-mail at mho@purdue.edu. A PDF version of the technical paper can be downloaded from http://www.tiax.biz/industrydocs/appliance_pres.htm.
More information about Delfield and its products is available at http://www.delfield.com.

Books and Software

Refrigeration Science and Technology Proceedings: Refrigerant Management and Destruction Technologies of CFCs
International Institute of Refrigeration
177. Bd Malesherbes,
75017 Paris, France.
Tel: + 33 1.42.27.32.35
Fax: + 33 1.47.63.17.98
E-mail: iifiir@iifiir.org
www.iifiir.org.

This cd-rom contains the proceedings of 'The refrigerant management and destruction technologies of CFCs' conference, that took place on August 29-31 2001, in Dubrovnik, Croatia. The conference was organised to answer the questions around halocarbon refrigerants and to stimulate the exchange of ideas and discussion between researchers and practitioners involved with management, disposal and destruction technologies of the CFC and HCFC refrigerants. Recovery and retrofitting of the CFC and HCFC refrigerants, collecting systems and policy, storage conditions and finally destruction by thermal or chemical processes are common problems that before, were not systematically treated.

Heat Pump Applications - Geology and drilling methods for ground-source heat pump installations: an introduction for engineers
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Because of low operating and maintenance costs, ground-source heat pump systems are becoming increasingly popular for commercial HVAC systems, in offices, schools, health care facilities, stores and factories. Design and installation of ground-source and groundwater-source heat pumps are straightforward engineering exercises.
This manual is intended to help the designer understand the driller's tools, techniques and the ground they penetrate. It includes an introduction to geology, hydrogeology, soil development, and other conditions that impact the feasibility and economics of ground-source heat pump installation.

Domestic ground-source heat pumps - Design and installation of closed-loop systems
This Good Practice Guide provides a general introduction to ground-source heat pumps for installers and potential end-users. It was produced with support from a wide range of industry players.

Copies are available at no charge from the Housing Energy Efficiency Best Practice Programme website at www.housingenergy.org.uk or by request to tel.: + 44-(0)1923-664258.

Source: UK Heat Pump Network Newsletter, Issue 7, March 2003

The 2002 TOC refrigeration, air conditioning and heat pumps assessment report
From The UNEP Refrigeration, Air conditioning and Heat Pumps Technical Options Committee
The report is available on the UNEP's website www.unep.org/ozone (go to English)

This report contains the following chapters: refrigerants, domestic refrigeration, commercial refrigeration, large refrigerating systems, transport refrigeration, air conditioning & heat pumps, chillers, vehicle air conditioning and refrigerant conservation (ISBN: 92-807-2288-3).

2003

Cold Climate HVAC 2003, The 4th international Conference on Cold Climate Heating, Ventilation and Air Conditioning
15-18 June 2003 / Trondheim, Norway
Eurotherm Seminar
Contact: Conference Secretariat
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The 2nd Dubrovnik Conference on sustainable development of energy, water and environment systems
15-20 June 2003, Dubrovnik, Croatia
For more information:
www.dubrovnik2003.fsb.hr/ .

10th European Conference on Technological Innovations in Air Conditioning and Refrigeration Industry with Particular Reference to new Refrigerants, New European Regulations - New Plants - The Cold Chain
27-28 June 2003/ Milan, Italy
Contact: Centro Studi Galileo – Industria & Formazione
Tel: +39 0142 452403
Fax: +39 0142 452471
E-mail: buoni@centrogalileo.it
www.Centrogalileo.it

ASHRAE annual meeting 2003
28 June-1 July / Kansas City, USA
Contact: ASHRAE meetings section
Tel: +1 404 636 8400
E-mail: jyoung@ashrae.org
www.ashrae.org

21st IIR International Congress of Refrigeration
17-22 August 2003 / Washington DC, US
Contact: ICR 2003 Conference Manager, Nadine George
Hachero Hill, 6220 Montrose Road
Rockville, MD 20852
Tel.: +1-301-984-9450 x11
Fax: +1-301-984-9441
http://www.icr2003.org

11th International Stirling Engine Conference (ISEC)
22-25 September 2003/ Graz, Austria
Contact: Joanneum Research Forschungsgesellschaft mbH,
Elisabethstrasse 5, A-8010 Graz
Tel: +43 316 876 1338
Fax: +43 316 876 1320
E-mail: stirling@joanneum.at
http://www.joanneum.at/events/ISEC2003

3rd International conference on energy efficiency in domestic appliances and lighting (EEDAL '03)
1-3 October 2003 / Turin, Italy
Tel: +39 0332 78 9299
Fax: +39 0332 78 9992
E-mail: jrc-eedal03@cec.eu.int
www.energyefficiency.jrc.cec.eu.int/events

4th International Symposium on Heating, Ventilation and Air Conditioning
9-11 October, 2003 / Beijing, China
Tel: +86 10 6278 1339
E-mail: ishvac@tsighua.edu.cn
www.ishvac2003.org

2004

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
www.ashrae.org

Interclima
3-6 February / Paris, France
Contact: Philippe Brocart
Tel: +33 1 4756 5088
E-mail: philippe_brocart@reedexpo.fr
www.interclima.com

Mostra Convegno Expocomfort
2-6 March / Milan, Italy
Tel: +39 02 48555 01
Fax: +39 02 4800 5450
E-mail: mce@planet.it

Natural Working Fluids - 6th IIR Gustav Lorenzen Conference
29 August-1 September, 2004 / Glasgow, UK
Contact: Miriam Rodway
E-mail: oir@ior.org.uk
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, Hlavnà 325
900 41 Rovinka, Slovak Republic
Tel: +421 2 4564 6971
Fax: +421 2 4564 6971
www.isternet.sk/szchkt

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Market Strategies and Assessment of Successes and Failures

Volume 21 - No. 2/2003

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

Novem

Netherlands agency for energy and the environment

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