

IEA Heat Pump Centre

NEWSLETTER

Industrial
Heat Pumps



IEA
OECD

heat pump
centre

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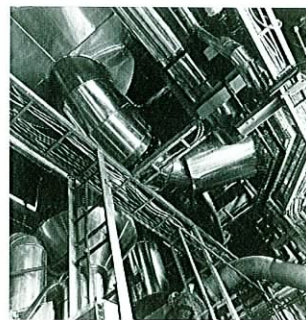
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Front Cover: These intertwining pipes form part of a 4 MW_{th} heat transformer which uses waste heat to supply steam to a steel plant. Further details are given in the article on page 17.

International Energy Agency

The International Energy Agency (IEA) was established in 1974 within the framework of the Organisation for Economic Cooperation and Development (OECD) to implement an International Energy Programme.

A basic aim of the IEA is to foster cooperation among the 23 IEA participating countries to increase energy security through energy conservation, development of alternative energy sources, new energy technology, and research and development (R&D). This is achieved, in part, through a programme of energy technology and R&D collaboration currently within the framework of 35 Implementing Agreements, containing a total of more than 60 separate collaboration projects. This publication forms one element of this programme.

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Editorial

As the Newsletter enters its 11th volume, it seems appropriate to reflect on its early days. The first issue published in June 1983 contained just seven pages of information and introduced a 'Readers' Column', starting with a call for contributions, and stressing that 'the Newsletter is designed to become an international information forum for whoever is concerned with heat pumps'. The second issue saw the launch of a news section.

Although the Readers Column didn't survive, the Newsletter has continued to provide informative articles and news items on heat pump developments with a focus on the technology. Ten years since its conception, I believe the time is right for the Newsletter to broaden its horizons and to inform its readers on the full range of factors that influence the implementation of heat pump technology. Not only the technical factors, but also the human factors as manifested by market forces, politics and public opinion.

The new layout introduced in this issue marks a significant step in the evolution of the HPC Newsletter. To mark an increased emphasis on 'news' information, the 'News and Views' section has been expanded and moved to the blue pages at the front. The white pages contain articles, beginning with the featured topic 'Industrial Heat Pumps.'

Through the HPC's network of heat pump experts, we've taken the temperature of the industrial heat pump situation around the world. Our findings are presented in an 'International Overview Paper' - something we plan to feature regularly. Although recent estimates indicate that only 5% of the technical market potential has been realized, the signs are that industrial heat pumps are finding increasing application in utilizing waste heat sources. Annex 21 of the IEA Heat Pump Programme has set out to help industrial heat pumps reach their potential by generating much needed information on technology, applications, energy efficiency and economics. Of particular importance is the determination of the CO₂ emissions reduction potential of industrial heat pumps.

Finally, with our new approach to the Newsletter, I hope we will not only reach 'whoever is concerned with heat pumps' but will also encourage wider interest in this valuable technology.



Jos W.J. Bouma
General Manager.

News & Views

Steimle: 'Europe is moving to natural refrigerants'

International Trade Fair, Germany, Puts Emphasis on Ammonia

At the annual IKK (International Trade Fair for Refrigeration and Air Conditioning), held this year in Nuremberg, Germany, it became clear that current CFC replacements such as HCFC-22 and even HFC-134a meet severe reservations in Europe. Although these fluorocarbon refrigerants were definitely still prominently present, there was an obvious emphasis on ammonia at the show, which attracted 16,000 visitors from 21 countries.

Not impressed

Professor Steimle, president of the Scientific Council of the IIR and member of the Advisory Board to the IEA Heat Pump Centre, stated in a talk with 17 U.S. firms attending the fair that "Europe is not impressed with the mixtures being proposed by refrigerant producers, because most of them have a high global warming potential". He argued that risks of toxicity and flammability associated with some natural refrigerants will have to be controlled and taken for the sake of the environment.

Confirming the strong European interest in natural refrigerants DKK of Dortmund, a producer of household refrigerators which use butane and propane as refrigerant, reports advance orders for more than 70,000 units. The units have been endorsed by the German Ministry of the Environment.

Reunification

An interesting aside is that the reunification of Germany may have a significant effect on the ammonia market. West German manufacturers interested in the application of ammonia long

struggled with a shortage of design professionals and plant operators experienced in ammonia. At the same time ammonia systems were widespread in the former East Germany. Reunification has brought ready access to a wealth of ammonia expertise.

(Source: *The News*, January 25, 1993.)

North American Experts Discuss Performance Standards

In a move towards an international standards agreement for heat pumps, experts from USA and Canada got together on December 7 and 8, 1992, to discuss standards for unitary heat pumps under 19 kW_e; air-to-water, water-to-air and air-to-water. They looked at how existing heat pump performance test methods and ratings should evolve to meet tomorrow's needs, and considered the requirement for new tests and ratings to cater for emerging heat pump products. Issues presented and discussed included:

- Differences in existing North American, European and Japanese standards;
- Uniform testing and rating methods for competing heat pump equipment;
- Standard/performance rating needs for new or emerging heat pump technologies;

- Standards in relation to utility DSM (Demand Side Management) programmes;
- Environmental rating for heat pump equipment.

The results of the workshop will form the basis for a North American action plan for heat pump standards development over the next five to ten years. There was general agreement that ISO (the International Organization for Standardization) will give the direction for future performance test methods and ratings for electric heat pumps, likely to be adopted in North America, Japan and Europe. Country deviations will probably complement future ISO standards of use. The proceedings of this joint workshop, an initiative of the US and Canadian National Teams, were published in February. For more information contact Mr. Doug Cane of the Canadian National Team.

Switzerland Opens Heat Pump Test and Training Centre

The growing trend in Switzerland towards using renewable energy means that the number of electrically driven heat pumps is expected to increase dramatically. The perfect operation of thousands of new installations on the electric network is of critical importance to electric utilities. To meet this need, the Swiss Heat Pump Promotion Group (FW - Fördergemeinschaft Wärmepumpen) has built a Test and Training Centre dedicated to heat pumps which opened on January 26, 1993 at Töss.

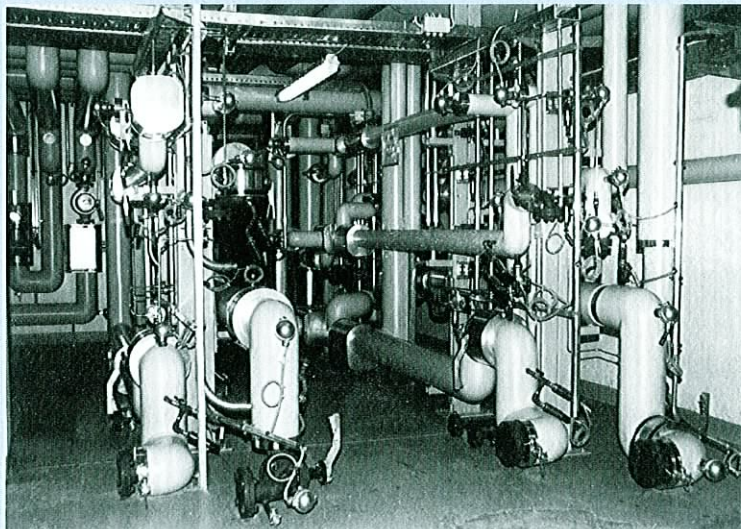
At the facility, tests can be made on air-to-water (up to 50 kW), air-to-air (up to 20 kW) and water-to-water (up to 100 kW) heat pumps. These tests will play a major role in implementing a subsidy scheme for small heating-only heat pumps, introduced by the Swiss Federal Office of Energy on January 22, 1993. To qualify for the CHF 300/kW_{he} (USD 200) subsidy, a heat pump must meet stringent

performance levels including COP ratings. By January 1994, all heat pumps must be tested at the Test and Training Centre to qualify.

The Centre also offers training for engineering consultants, architects

and electricians. At a cost of around CHF 2.5 million (USD 1.65 million) the Centre is financed by electric utilities NOK, EKZ and EWZ, the Canton of Zürich and the Federal Authority for Energy Economy.

Heat pump test equipment at the new Swiss Centre.



(Source: Swiss National Team.)

Austrian Heat Pump Day Attracts Two Hundred

The second Austrian heat pump day was held on October 1, 1992, in St. Pölten, the capital of Lower Austria. The meeting was organized by "Leistungsgemeinschaft Wärmepumpe" (The Austrian Association for the Promotion and Support of Heat Pumps) and the "Österreichisches Heizungs-museum" (The Austrian Heating Museum). More than 200 people including heat pump manufacturers and distributors, planners, installers and consumers attended the meeting. The head of the Austrian Heat Pump Manufacturers' and Distributors' Organization, Mr. Oberhumer, opened the meeting with remarks on how heat pumps can be used to help meet demands for energy conservation and CO₂ emission reduction.

Presentations covered markets (Kunesch), emissions reductions (Gilli) and new refrigerants and CFC-free heat pump systems (Halozan). The results of several heat pump projects were presented:

- a recreation centre where heat pumps achieve SPFs of 3.7 and 4.0 (Atzgerstorfer) (see Newsletter Vol.10, No.3);
- a cooling water heat recovery system of a factory for plastic materials (Wiesmeier);
- a school building heated by a ground-coupled system with a heating capacity of 326 kW (Ochsner);
- two heat pump systems installed in single-family homes

New regulations affecting the installation of ground-source heat pumps were presented by Mr. Meissel and provoked intensive discussion. The concept of an Austrian quality certification for heat pumps was presented by Mr. Friedl and new strategies for marketing heat pumps by Mr. Linsberger.

The 2nd Austrian Heat Pump Day was a great success. It showed the interest in heat pumps and also the uncertainties concerning the development of new refrigerants and regulations which sometimes are a barrier for heat pump installations. The conclusion was that with close cooperation, wider use of this clean heating technology can be achieved. A third Heat Pump Day will be held on March 11, 1993.

(Source: Austrian National Team.)

Goldberg: Phase-out of HCFCs is 'foolishness of the highest order'

Science and Industry Express Divergent Views on CFC issue

Hard on the heels of the Montreal Protocol revision in Copenhagen, David Goldberg, former chairman of ARI (the U.S. Air Conditioning and Refrigeration Institute), voiced severe reservations about the environmental concern which underlies the Protocol, and about the necessity to phase out HCFCs.

of the debate. In a carefully argued article he addresses many of the scientific or pseudo-scientific statements which deny or belittle the role CFCs play in ozone depletion. Such statements include the alleged role volcanoes play, the natural variability of ozone abundance, the chlorine which escapes from oceans through evaporation

or tidal waves, and the relative rarity of CFC molecules. The statements are refuted by Dr. Rowland, who maintains that the scientific evidence indicates that "as the CFC concentration increases and the rate of chlorine removal of ozone increases, the globally averaged ozone concentration is maintained at a lower level".

Insignificant

Speaking to the Refrigeration Service Engineers Society at their annual conference he said that "frankly, I have come to believe that the environmental threat which is driving all these changes, is relatively insignificant". He classified the now agreed phase-out of HCFCs as "foolishness of the highest order". He argued that HCFCs are the best refrigerants currently available, of which the chlorine contribution will have no significant effect on either the environment or human well-being on this planet.

Shortages

In a separate contribution to the argument, Mr. A. Ishida, chief editor of JARN (Japan's English language HVAC&R trade journal), also expressed concern about quick implementation of CFC and HCFC restrictions. Since exports are totally controlled from 1993, he warns of refrigerant shortages in countries which depend on imports. He also argues that while it is important to recognize the foresightedness of ecologists in some areas, we should be careful not to swallow ungrounded assertions.

Lower level

In the ASHRAE Journal of December 1992, Dr. F. Sherwood Rowland, president of the American Association for the Advancement of Science, presents the scientific side

(Sources: *The News*, December 28 1992; *JARN*, December 25, 1992; *ASHRAE Journal*, Volume 34, No. 12, December 1992.)

US Energy Bill Mandates Efficiency Standards

The energy bill passed by the U.S. Congress in November 1992 will affect every part of the heating and cooling industry: contractors, distributors, manufacturers, utilities, and equipment owners. The bill includes the first statutory provision for establishment of efficiency standards at the 1992 levels in ASHRAE/IES Standard 90.1. The law covers a wide range of air conditioning and heating products including air and water-source heat pumps. Standards for products below 39.6 kWe go into effect January 1, 1994, and for products up to 70.3 kWe on January 1, 1995. Future revisions by ASHRAE

will be adopted by the Department of Energy (DOE) as revised federal standards.

Higher CFC Taxes

The bill also includes provisions for raising the CFC excise tax. The new tax base amount will be USD 7.39/kg (USD 3.35/lb) in 1993, USD 9.59/kg (USD 4.35/lb) in 1994, and USD 11.79/kg (USD 5.35/lb) in 1995. After 1995, the base tax amount will increase by USD 0.99/kg (USD 0.45/lb) every year, as under present law. The bill does not tax HCFCs.

(Source: *Air Conditioning and Refrigeration News*, October 19, 1992.)

Training Reduces GSHP Installation Costs

U.S. electric utility Pennsylvania Power and Light (PP&L) is now seeing the benefit of its comprehensive training programme for well drillers and HVAC contractors. Developed together with the International Ground-Source Heat Pump Association, the programme has led to increased competition for

GSHP installation jobs leading to lower costs. To further encourage GSHP installation the utility offers USD 1000 grants for customers using qualified contractors. For more information contact: Frank Mayberry, Pennsylvania Power and Light, Tel.: +1-215-774-5270.

(Source: *EPRI News Exchange*, Fall 1992.)

Parties Agree on HCFC Levels

A report by Dr. Lambert Kuijpers of the United Nations Environment Programme (UNEP)

The Fourth Meeting of the Signatory Parties to the Montreal Protocol took place in Copenhagen, from 23 to 25 November 1992. Within a 31-point package, decisions were taken on adjustments and amendments to the Montreal Protocol. CFCs, carbon tetrachloride and methyl chloroform will now be phased out by the end of 1995. HCFCs and methyl bromide (a widely used agricultural chemical) have become controlled substances.

For HCFCs, a reduction scheme has been decided that implies a virtual phaseout by 2020. The phase-out of HCFCs begins 1 January 1996. At that time, the amount of HCFCs that is allowed to be consumed will be capped at a level of:

- 3.1% of the CFCs consumed in 1989, weighted by their ozone depletion potential (ODP), plus
- the total, ODP weighted HCFC consumption in 1989.

Reduction steps have been decided for the years 2004 (35% reduction), 2010 (65%), 2015 (90%), 2020 (95%), followed by a complete phase-out in 2030.

No consequence

For developing countries, these decisions have no consequence. Measures on HCFCs for these countries will be evaluated at the 1995 Meeting of the Parties. The financial mechanism for the assistance of developing countries has become a very important issue in the Protocol negotiations. The Parties have now decided to extend the Multilateral Fund for technology transfer agreed in 1990 at least until 1996.

The phase-out decided for many chemicals implies that a large number of specific issues will have to be investigated by two UNEP assessment panels, in particular by

the Technology and Economic Assessment Panel. These relate to e.g. essential uses, the halon bank, recycling and recovery, the use of and the substitutes for methyl bromide, the application of HCFCs.

The Parties also decided on an update of the 1991 assessment,

which implies that the "Refrigeration, Air Conditioning and Heat Pumps" committee will again be activated. This committee is chaired by Dr. Lambert Kuijpers, who also co-chairs the entire Technology and Economics Assessment Panel, following a nomination by the Parties in Copenhagen.

Canada's Most Advanced Houses are using Heat Pumps

In Canada, eleven advanced houses have been selected in a national competition to find the most energy-efficient and environmentally responsible homes. Many of these use a ground-source heat pump. One uses a natural-gas-engine heat pump. Each advanced house will be open to the public for one year allowing consumers and the building industry to learn about new and innovative ideas and products.

The performance of the houses will be monitored to assess the commercial potential of the innovative technologies and products. The results will be shared with members of the building industry across Canada and around the world. Advanced houses will also be featured at Advanced Housing '93, an international conference in Vancouver in June 1993.

Japan's Superior Heat Pump Systems

As a way of promoting heat pump systems which offer major energy-saving and environmental benefits, the Heat Pump Technology Center of Japan (HPTCJ) awards "Superior Status" to 10 heat pump systems every year. For 1992, the following systems were selected:

- "Crystal liquid ice storage system" for Crystal Tower (Takenaka Corp.);
- "Harvest type ice storage HP system" for Osaka Cement Co. (Ohbayashi Corp.);
- "Air-to-air multi air-conditioning HP system" for Kajima Corporation (Kajima Corp.);

- "Casting-mould-drying HP system" for Kimura Castlong Iron Co. (Mayekawa Mfg. Co.);
- "Heat Recovery HP system with ice storage" for Sumida River Hall (Mayekawa Mfg. Co.);
- "Cold water storage type HP system" for Makuhari Heat Supply Centre (TEPCO);
- "WIP system" for Matsmoto Building (Simizu Corp.);
- "River water source absorption HP system" (Tokyo Gas Co.);
- "Road snow melting HP system" for Tohoku Electric Co. (Mayekawa Mfg. Co.).

(Source: Japanese National Team.)

Europe Takes Concerted Action on Heat Pumps

A report by Mr. Onno Kleefkens - the Dutch delegate to the European Commission's Concerted Action Group on Heat Pumps.

In their November 1992 meeting, the members of the European Commission's Concerted Action Group on Heat Pumps (CAG) agreed to develop a European Strategy on Heat Pumps. This strategy will coordinate European Community (EC) activities on heat pumps within current EC programmes such as Joule, Thermie, SAVE and BRITE.

The CAG grew in 1991 from within the Directorate XII of the EC, based upon the belief that heat pump technologies need special attention as they can contribute to a significant reduction in primary energy use and thereby in the reduction of CO₂-emissions. The group is composed of experts from the United Kingdom, Italy, Ireland, Germany, France and the Netherlands, and supports the Commission on activities relevant to heat pump technology, including development, promotion and application.

It is envisaged by the CAG that increasing the implementation of heat pump technology must not be a goal in itself, as the amount of energy saved and thus the reduction in CO₂-emissions is dependent on the way in which the heat pump is applied and used. Experiences in all member countries have shown that, although heat pump technology is well established, its operating efficiency is very sensitive to the way in which it is applied and therefore very much dependent on the engineering skills of the designer and builder of the heating system. Thus there is a strong need for a better understanding of how and where to apply heat pumps so that benefits to the environment and to the efficiency of the energy system are maximized.

Amongst EC countries, the barriers for a wider application of heat pumps differ, while on the other hand there is a common need for

heat pumping technologies to achieve the goals for the further reduction in primary energy use and CO₂ emissions set by the EC and its member countries. While it is difficult to formulate a specific type of heat pump technology which is applicable in all countries in the same way, it should be mentioned that the knowledge on how to apply heat pumps and on how to overcome barriers for their implementation have characteristics which are generally applicable to most EC countries. The CAG therefore considers that there is a strong need for

integration and coordination of activities on a European level in order to work effectively on heat pumps.

The strategy agreed at the November meeting should give added value to the activities of member countries. This meeting was also attended by delegates from the EFTA-countries (Norway, Sweden and Switzerland) who supported these ideas. The CAG will propose a draft Strategy to the directorates of the Commission in the first quarter of 1993.

Canadian Research Laboratory Now Open

The first phase of Canada's Energy Diversification Research Laboratory (EDRL) at Varennes, Quebec is now complete. With a complement of 32 person-years and an annual budget of CAD 7.4 million this CANMET (Canada Centre for Mineral and Energy Technology) laboratory has a national scope dealing with the development of energy technologies as well as increased energy efficiency for the industrial and commercial sectors. Work will include research on ground-source

and advanced heat pumps. Other areas of interest are: thermal energy storage, heat transfer phenomena and heat exchangers. The laboratory is expected to grow to 44 person-years and a budget of CAD 7.8 million in 1994-95. EDRL is also assuming national responsibility for the IEA Centre for the Analysis and Dissemination of Demonstrated Energy Technologies (CADET).

(Source: Canadian National Team.)

IEC Standard Sets Heat Pump Safety Requirements

International Electrotechnical Commission (IEC) has recently published Standard 335-2-40, "Safety of Household and Similar Electrical Appliances; Part 2: Particular Requirements for Electrical Heat Pumps, Air-Conditioners and Dehumidifiers".

This international standard establishes electrical safety performance requirements and test methods that will be adopted and used worldwide.

(Source: Koldfax from the Air Conditioning and Refrigeration Institute, November 1992.)

Technology & Applications

Results Show Promise for CFC Alternatives

The Air-Conditioning and Refrigeration Technology Institute (ARTI) has released preliminary results from the Materials Compatibility and Lubricants Research programme. This programme is evaluating the properties and compatibilities of non-CFC refrigerants and various lubricants. These preliminary results indicate that the fluids evaluated continue to be viable candidates for further space conditioning and refrigeration systems.

Miscibility results for HFC-32, -125, -134a and -143a are presented in Table 1. The initial results of the miscibility project is good news in that all of the new refrigerants tested, with the possible exception of HFC-143a, have a high degree of miscibility with a number of synthetic lubricants. Although further research is needed to examine more refrigerant-lubricant concentrations, the results to date indicate that HCFCs and HFCs with

Temperature Range: -50 to +60 °C				
Lubricant	HFC 32	HFC-125	HFC-134a	HFC-143a
AB	I	I	I	I
MPAG	<10	<0	<0	<-10, >20
MO	I	I	I	I
PE-branched	<-40	M	<10	I
PE-mixed	<-20	M	M	I
PPG-butyl	<-30, >60	M	M	I
PPG-diol	M	M	M	I

M -- miscible over the complete test temperature range
 I -- immiscible over the complete test temperature range
 < -- the mixture became immiscible below this temperature (°C)
 > -- the mixture became immiscible above this temperature (°C)

Table 1: Miscibility of lubricants with refrigerants at 50/50 concentration.

synthetic lubricants are viable mixtures for use in air-conditioning and refrigeration systems.

The programme has also examined stability. Results clearly indicate that the 10 alternative refrigerants tested are more stable than the CFC refrigerants they are designed

to replace. Furthermore, the non-ozone depleting HFCs were among the most stable of the refrigerants tested. For more information contact Mr. James M. Calm, Engineering Consultant, 10887 Woodleaf Lane, Great Falls, VA 22066, USA.

(Source: Tech Update from the Air Conditioning and Refrigeration Institute, November 1992.)

HydroTech 2000™ Proves its Efficiency

As was reported in a previous Newsletter issue (Vol. 9, No.4), a U.S. collaboration of EPRI (the Electric Power Research Institute) and Carrier Corporation has resulted in a variable-speed heat pump for combined heating, cooling and hot water supply known as HydroTech 2000™. Recently released results of a two-

year field-monitoring programme show that the advanced heat pump attained average COPs of 4.1 and 2.6 for cooling and heating respectively. The water heating COP was 2.4.

The heat pump features a variable-speed compressor and indoor fan,

"smart" microprocessor-based controls, and advanced refrigeration and heat transfer technology. For more information contact John Kesselring, EPRI Residential Program, Tel.: +1-415-855-2902, or Kevin Dunshee, Carrier Corporation, Tel.: +1-315-432-6247.

(Source: EPRI News Exchange, Fall 1992.)

Heat Pump Recycles Printing Ink Solvents

A small print shop in Elst, the Netherlands, has recently installed a 3 kW_e electric heat pump for recycling the solvent used in printing ink. The condenser (T_{cond} = 80°C) heats the used liquid and the evaporator (T_{evap} = 20°C) is used as

the cold spiral of the distillation column, where the clean solvent is condensed.

The print shop has also been using two electric heat pumps in its printing machine for nine years.

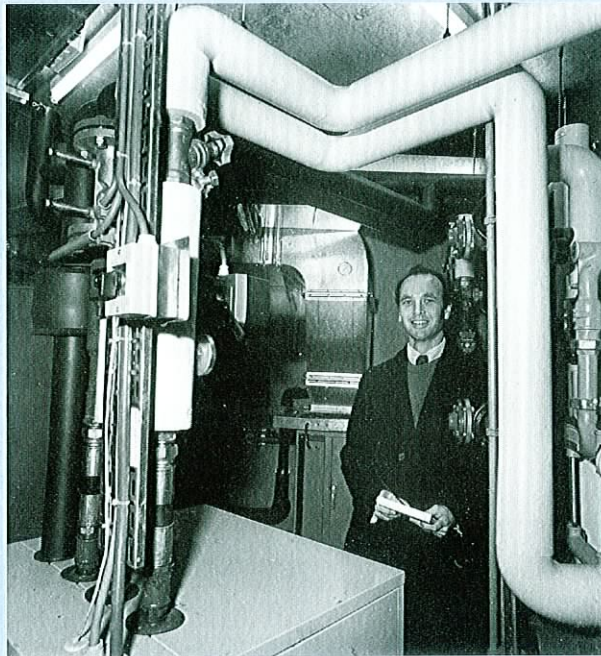
These heat pumps serve the dual function of cooling the machine cylinders and providing hot air for paper drying.

(Source: The Dutch National Team.)

Heat Pumps Join the Underworld

The Dutch National Park, the Hoge Veluwe, is the site of a museum known as "the Museonder" - the "museum under the ground" to be opened this Spring. Whilst learning about the natural world under our feet, visitors will be warmed by a 40 kW_{he} electric heat pump which uses heat from a nearby aquifer. In operation, water at 10°C is pumped from 20 m below and used to supply 55°C water to a central heating (hydronic) system. A COP of 3 or more is expected and the heat pump will save an estimated 2000 m³ of gas per annum. In summer, water from the aquifer is used directly to cool the air supply to a space conditioning system.

The system was installed by PGEM, the regional electric utility, and was supported by a 25% government subsidy. The HPC was present as the heat pump system was officially handed over to the museum operators who will benefit from



Mike Steadman of the HPC at the Museonder heat pump.

lower fuel bills after five years. PGEM will provide full maintenance cover. The utility hopes that this "high-profile" application will

stimulate interest in heat pumps. A display in the museum will inform visitors on the operation of the heat pump.

Water Source Heat Pump uses HFC-134a

The IEA Heat Pump Centre was present when on October 28th 1992, a 280 kW electric heat pump was inaugurated in Wesseling, Germany. The heat pump will serve an office building on the banks of the Rhine using the river water as heat

source. The heat pump is operated by the area's utility RWE Energie AG, which now manages 15 bi-valent heat pumps. The main technical hurdle was the development of a compatible lubricant for use with the HFC-134a working fluid.

Interestingly the new heat pump replaces the very first one commissioned by RWE, built in 1980, which used CFC-12 as working fluid.

Absorption Systems User's Club Meets with Manufacturers

The 1992 annual meeting of the User's Club was the first at which manufacturers were invited to report on new developments in absorption technology and to discuss practical problems of mutual interest. Hosted by Houe & Olsen Consulting Engineers in Thisted, Denmark, the November meeting was attended by Swedish, Danish and Dutch users plus Hitachi Zosen and Sanyo Electric. A visit was made to a 3.2 MW absorption heat pump at Thisted

which uses 42°C geothermal water and is driven by steam from a refuse incineration plant. Other geothermal plants are planned for Germany and Poland.

Hitachi Zosen reported on a heat transformer under construction in Japan which supplies 81°C hot water to a district heating network and swimming pool using 59°C water vapour from a refuse incineration plant. They also presented a high-temperature

(200-260°C) corrosion resistant absorbent, and inhibitor (130-200°C) for water/lithium bromide systems along with a new heat exchanger design.

The 1993 meeting is scheduled to be held in the autumn in Germany. Interested manufacturers and users of large capacity systems (>1MW thermal) may contact the Heat Pump Centre.

Markets

Spanish Warm to Heat Pumps

The share of heat pumps in Spain's room and packaged space conditioner market has now risen to between 60 and 65% in value according to Mr. Ishida of Japan's JARN magazine. This shows an increasing recognition that these simple heat pump units are well suited to Spain's climate where winters are relatively mild. Overall, sales of space conditioning equipment have been hit by the

slowdown in Spain's economy with 1992 results expected to be well below the 1991 sales figures of about USD 600 million. Hitachi hopes to make significant inroads into this market when its new plants begins production of packaged air conditioners and heat pumps in March 1993. 8,000 units will be produced in the first year, eventually increasing to 20,000.

(Source: JARN, January 25, 1993.)

Sharp Growth in Japanese Exports

The number of packaged heat pump space conditioners exported from Japan rose by 80% to 13,000 units in Reference Year '92/'91 (September-September). Such a sharp rise is attributed to the rapid decline in Japan's home market compared to the previous Reference Year. This meant that sales shifted to exports in order to off-load output. Another factor has been an increase in the number of heat pump imports.

(Source: JARN, January 25, 1993.)

French Market Stagnates

A survey of around 1000 contractors in the French HVAC industry makes clear that some 110,000 unitary air-conditioners were installed in France in 1991, of which 25,000 (23%) were reversible heat pumps. Sales have stabilized compared to 1990,

breaking the strong upward trend of previous years. The stagnating market is confirmed by preliminary data for 1992, which indicate an actual reduction of sales.

In spite of this, the number of market players (dealers, importers,

etc.) shows a continued increase. This may indicate confidence of the industry in the long-term prospects of the technology for France. It certainly already means that the French manufacturers are losing ground to foreign competitors.

(Source: CCI, 1/1993.)

IEA Heat Pump Programme

Two IEA Heat Pump Centre Workshops for 1993

As part of our strategy to enhance the exchange of knowledge on heat pump technology, the IEA HPC will hold workshops in May and July this year. A workshop entitled "Combined Systems of Heat Pumps and Thermal Energy Storage Units" will be held in Fukuoka, Japan on May 24 and 25. Speakers will report on

developments from around the world with particular emphasis on the soon-to-be-completed Japanese Super Heat Pump Energy Accumulation System Project.

Denver, USA will be the venue for a workshop on Heat Pump Water Heaters, following up the results of the HPC's analysis of the same title.

The workshop is tentatively scheduled for June 30 to July 1 and will be held in conjunction with the ASHRAE summer meeting.

Applications to attend or present a paper at these workshops are welcome although numbers may have to be limited.

Workshop Finalizes Working Fluid Safety Annex

Annex 20 will be drawn to a close at an International Workshop on Working Fluid Safety in Leuven, Belgium in April 1993. The Final Report on this Annex will give an

overview of safety experience with refrigeration machines and heat pumps. Based upon a quantitative risk analysis approach, a comparison between conventional

and alternative working fluids is made. The report will also review safety regulations.

HPC Completes its Hot Water Heat Pump Analysis

Although hot water heat demand is in general somewhat less than for space conditioning, hot water heat pumps can offer major energy savings. To find out the state-of-the-art of this technology and to ascertain market trends, the HPC has conducted an analysis entitled "Domestic Hot Water Heat Pumps for Residential and Commercial

Buildings." The Analysis Report HPC-AR2 will be published this Spring.

With information from North America, Europe and Japan, the report includes surveys on technology, applications, field performance, marketing studies and marketing programmes. A

methodology is given for evaluating costs and benefits according to fuel and electricity prices. The analysis was prepared by Caneta Research Inc., Canada and will be available to HPC member countries from the IEA Heat Pump Centre, price NLG 80.

Annex 12 Reports on Variable-Speed Compression Heat Pumps

The Italian Operating Agent of Annex 12 has recently published the "Final Report" on "Modelling Techniques for Simulation and Design of Compression Heat Pumps". This summarizes the findings of the concluding stage of this task-shared Annex which focused on variable-speed heat pump systems. The tasks included the development of computer simulation models to determine a heat pump's SPF

(Seasonal Performance Factor) under different operating conditions. These models showed the potential for improved efficiency with a variable speed system and highlighted the design criteria needed to achieve optimized performance. Other tasks conducted included experimental analysis and performance evaluation of variable-speed heat pumps.

Erratum

HPC Newsletter Vol.10, No.4, gave an incorrect figure for Switzerland's objectives in hydroelectricity generation. Page 18, line 12 should read: "5% increase in average hydroelectricity generation from 1990 to 2000" and not 10%.

Summary of the Annexes - IEA Programme on Heat Pumping Technologies*

No.	Annex	Operating Agent	Participants	Began	Scheduled Completion	Completed
12	Modelling techniques for simulation and design of compression HPs	US ¹ , IT	AT, BE, DE, IT, JP ¹ , CH, US	1986 1989	Phase 1 Phase 2	1989 Sept. 1992
13	State and transport properties of high-temp. working fluids and non-azeotropic mixtures	SE	CA, DE, JP, NO, SE, US	1987	1989	May 1992
15	HP systems with direct expansion ground coils	CA	AT, CA, JP, US	1989	1990	Apr. 1993
16	Heat Pump Centre	NL	AT, CA, IT, JP, NL, NO, SE, CH, US	Jan. 1990		
17	Experiences with new refrigerants in evaporators	SE	CA, NL, NO, SE, CH	Nov. 1990	Nov. 1992	
18	Thermophysical properties of environmentally acceptable refrigerants	US	AT, CA, DE, JP, NO, SE, UK, US	Dec. 1989 ¹ Jan. 1993	Dec. 1992 ¹ Dec. 1996	
20	Working fluid safety	BE	BE, JP, NL, NO, CH	Apr. 1991	Jan. 1992	Apr. 1992 ²
21	Global environmental benefits of industrial HPs	US	CA, JP, NL, NO, SE, UK, US	Jan. 1992	Apr. 1994	

* Participating countries: Austria (AT), Belgium (BE), Canada (CA), Denmark (DK), Finland (FI), Germany (DE), Italy (IT), Japan (JP), the Netherlands (NL), Norway (NO), Spain (SP), Sweden (SE), Switzerland (CH), United Kingdom (UK), United States (US).

¹ Phase one only

² Predicted completion date

Industrial Heat Pumps - an International Overview

Bert Stuij, IEA Heat Pump Centre

The potential of heat pumps to reduce energy consumption in industry has long been postulated and indeed dates back to the first ever industrial heat pump which was installed in Austria in 1856. The environmental benefits from using industrial heat pumps to lower energy consumption and reduce thermal pollution are clear. But just how far has heat pump technology progressed towards realizing its full potential? This article summarizes the results of a survey amongst the member countries of the IEA Heat Pump Centre (HPC) to give an insight into the status of industrial heat pump technology around the globe.

* * *

The signs are that the penetration of heat pumps in industry will continue to increase. As environmental regulations become stricter in all countries, industrial heat pumps will be used to deliver process heat whilst significantly reducing associated emissions. They are also able to reduce the amount of cooling water required and reduce thermal pollution.

In a separate development, Pinch Technology to integrate and optimize total processes is rapidly gaining popularity. It is estimated that process integration on the basis of pinch technology may save up to 25% of primary energy use. The technology is proving an excellent instrument to identify economic heat pump opportunities.

Applications

In all HPC countries heat pumps are extensively used in de-humidification or drying systems. A heat pump is particularly suitable for this, because it can first dry air by cooling it, and then return the withdrawn heat to the dried air. The application of heat pumps in, for instance, timber, lumber and pulp drying is very energy efficient, and in general economically attractive.

A second important application area is the process industry. Figure 1 gives an indication of the potential for heat pumps in this area (based on U.S. data). Typical for process industries is the availability of waste heat streams and a number of heat demands at various temperature levels. Heat pumps are a particularly significant component of integrated

systems where both a cooling and heating demand exists.

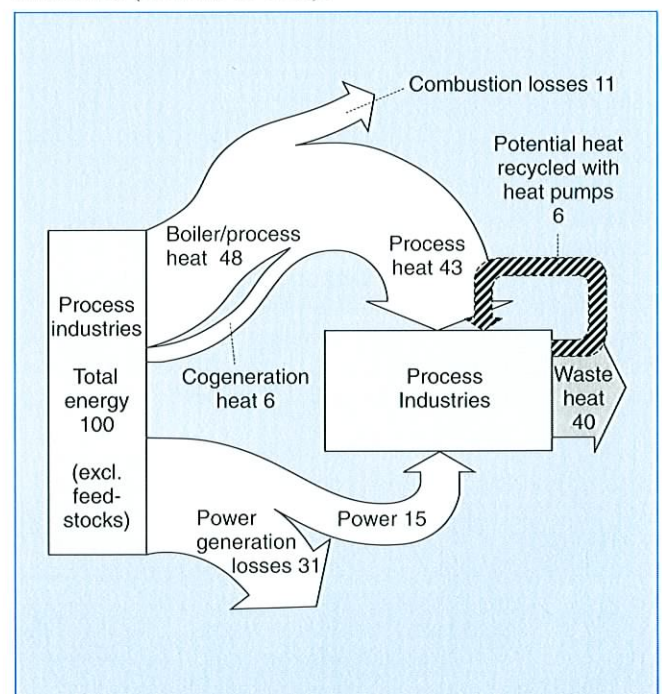
One application of heat pumps in the food industry is the recovery of condenser heat from refrigeration plants. A significant number of installations has been realized in Scandinavia.

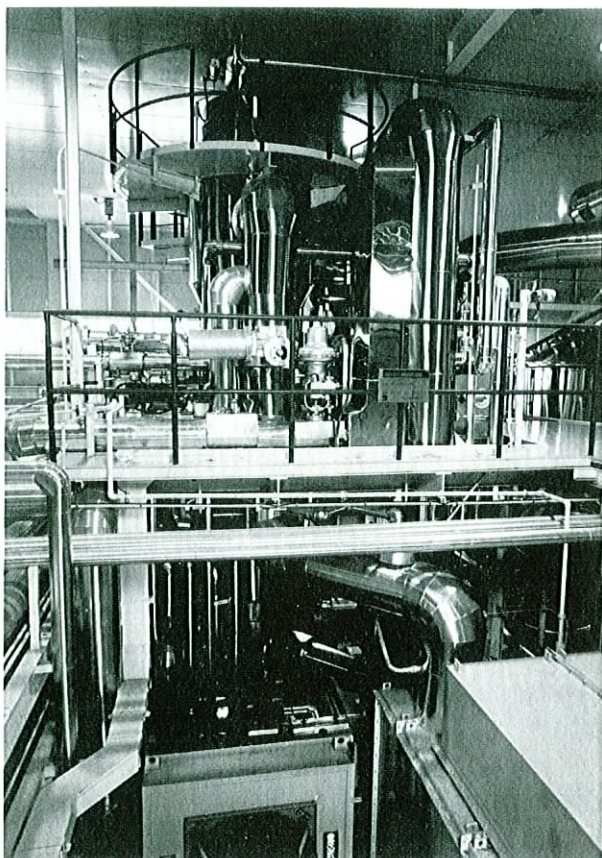
More in general the installation of a heat pump is attractive if there is an obvious heat source available, and if the required temperature lift is not too high. An interesting example of an area where these conditions are met are fish farms in Norway: water is used as heat source, and the required output temperature is relatively low.

Technology

Most countries report a variety of applied technologies, depending on the nature of the industry, the availability and form of waste heat and temperature levels. Most common is the 'conventional' electric closed cycle compression heat pump, which can be tailored to many situations.

Figure 1: Estimated potential of heat pumps in process industries (data as in USA).





MVR system at Kirin Beer brewery in Japan.

Mechanical Vapour Recompression (MVR) systems are extensively used in the process industries and drying processes. In fact in distillation processes a large number of MVR systems may be in operation that are not explicitly referred to as heat pumps, since the idea of re-compressing vapour to regain heat is rather obvious and not always recognized as heat pump technology. Thermal vapour recompression is used when there is an abundance of low grade available steam as heat source. It is, however, not as efficient as MVR.

Absorption heat pumps are relatively rare. In some countries, heat transformers are used to upgrade heat of medium temperature without the requirement of fuel or electricity. Corrosion problems have affected some of these installations which all use lithium bromide as working fluid, but these problems are now largely resolved (see the article on pages 17-19).

A few countries mention the similarity between district heating heat pumps and industrial heat pumps with regard to size and technology. In some cases industrial waste heat is used in district heating heat pumps. A mutual benefit is expected from developments in both these areas.

Important technological developments are expected to widen the applicability of industrial heat pumps,

and increase their economic attractiveness. Such developments are likely to result in, for instance:

- environmentally sound working fluids for closed cycle compression systems;
- corrosion resistant high temperature working fluids for absorption heat pumps (e.g. Alkilate);
- technical improvements in system components such as compressors, motors and heat exchangers.

Major progress has been made in Japan under the National SHPEAS programme (Super Heat Pump Energy Accumulation System), which will be concluded this spring.

Policies

Few countries have policies specifically directed at industrial heat pumps, but the importance of the technology for the industry is generally recognized. In Japan the government supports the development of heat pumps for the industry through a series of national programmes. When the development work is complete it is up to the industry to put the technology to good use.

Environmental legislation is getting more stringent in most countries, and by nature the industrial heat pump should benefit from this development. Apart from emission reduction, heat pumps can also play a role as concerns about 'thermal pollution' grow, or when the use of natural cooling water is restricted. In some countries legislation obliges industries to re-use waste heat.

Some industrial policies appear to be detrimental to heat pumps. Italy mentions the very low energy tariffs for industry which reduce the economic incentive to install a heat pump. In the Netherlands, Combined Heat and Power (CHP) is actively stimulated and subsidized. As a consequence the price of heat for some industries reduces significantly and with it the amount of heat that could be delivered by heat pumps. The result is again a reduced economic attractiveness of the heat pump option.

Moderate Penetration

Penetration of heat pumps in industry is still very moderate. It is estimated that worldwide less than 2000 MW of thermal capacity has been installed. Data from some countries suggest that this represents no more than 5 to 10% of the economic potential of industrial heat pumps.

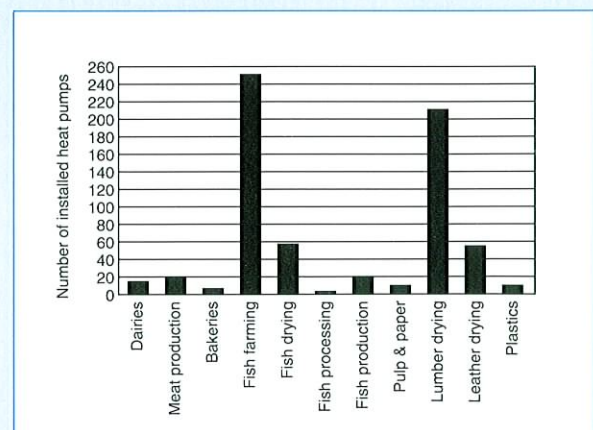
Significant barriers to a greater penetration remain. Factors include the lack of knowledge exchange between the 'heat pump community' and industry, the risk perception in industry, where the first priority

Country Highlights

- Austria** Most significant are either high-temperature heat pumps, or installations where the process heat is used to cool other processes and condition the work environment. Data on actual numbers installed are scarce.
- Canada** The prevailing application is industrial de-humidification, in particular drying lumber. Due to the economic recession very few industrial heat pumps were sold in 1992, but the demand is expected to pick up as the economy revives. The structural fact of low gas prices versus high electricity prices means, however, that the incentive to install a heat pump will be product quality and/or environment, rather than economy.
- Italy** Relatively few heat pumps are reportedly installed in Italy. The low energy tariffs to the industry are cited as a major dis-incentive.
- Japan** Heat pumps diffused into the Japanese society mainly as air-conditioning devices, without government involvement. For the industry, however, the Japanese government explicitly stimulated the use of heat pumps, first of all as energy saving devices after the oil crises, later as an environmentally beneficial technology.
- Development of heat pumps was stimulated through the organization of a number of national programmes, in particular the 'Super Heat Pump Programme', completed early 1993. It is estimated that up to 500 industrial heat pumps are currently installed. At the same time the diffusion of heat pumps into district heating systems is progressing, and the development of the technology for this application area is expected to result in further diffusion of heat pumps into industry.
- The Netherlands** In the Netherlands, 17 MVR systems were traced (10 in the food industry, and 7 in the chemical industry). An additional number of MVR systems may exist that are not 'recognized' as heat pumps. Positive results are reported on most MVR systems. All are coupled to vaporization processes. Low temperature lifts result in high COPs, 6.5 to 30.
- Some 10 compression heat pumps are installed, most of them electrically driven. Drying is an important application area. Two absorption heat transformers have been realized in the Netherlands. The extensive corrosion problems with the first one are overcome with the second. It is estimated that less than 5% of the market potential for industrial heat pumps, up to 600 units, is realized today.
- Government policy in The Netherlands is aimed at improving energy efficiencies with 2% per year. With respect to heat pumps the policy is to promote implementation of proven technology in market niches where they are attractive under present conditions. More explicitly a number of activities to promote the heat pump option are underway: the definition of demonstration projects, the preparation of a handbook, promotion of the concept of process-integration, participation in Annex 21, and general publicity and promotion activities.
- Norway** Some 650 heat pumps are installed. A breakdown per application area is provided in the figure.

Very high COPs are reached in fish farms, because of the low temperature lift. Some 50 heat pumps, mainly in the fish industry, use condenser heat from refrigeration plants.

Several plants for evaporation purposes use thermocompression, with water as working fluids. CFCs are now phased out, and for drying purposes, plants with ammonia at 40 bar as working fluid are becoming popular - well in line with the Norwegian aim to move to natural refrigerants such as water, CO₂, ammonia and hydrocarbons.



Country Highlights

- Sweden** Of the estimated 70 industrial heat pumps, 20 are MVR systems. Furthermore 200 MW of district heating heat pump capacity is installed which uses industrial waste heat as heat source.
- Switzerland** Data on industrial heat pumps in Switzerland are scarce. It is known that more than 1500 electric heat pumps are used for space conditioning in industry, but it is not clear how many of those are linked to industrial processes and can thus be qualified as 'industrial heat pumps'.
- U.S.A.** Industrial heat pumps are often referred to as 'heat recovery systems', and data on actual numbers installed are scarce. The total process heat demand in the U.S. has been estimated at some 7500 PJ, of which over 1000 PJ could be delivered by heat pumps. It is certain that only a very small amount of this heat pump potential is currently realized. The federal government is encouraging further penetration of heat pumps, for instance through direct sponsorship of research and demonstration projects. Process integration and pinch technology are rapidly gaining popularity, identifying optimized heat recovery opportunities involving heat pumps. Some niche markets already show significant heat pump penetration: there are for instance 2000 lumber drying heat pumps in operation.
- Specific developments in the U.S. include the market introduction of the reverse Brayton cycle solvent recovery heat pump, and the development of Alkitate, a high temperature, corrosion resistant working fluid for absorption systems.

remains an un-interrupted operation, the low energy prices of recent years, and the required system integration to fully benefit from a heat pump which may involve significant (re-)design work and high costs.

For closed-cycle compression systems the working fluid issue also remains. For high temperature applications, replacements for CFCs are still immature. In Norway the use of ammonia (at 40 bar) is gaining popularity.

Realizing the Potential

More details of the HPC's survey on industrial heat pumps are described in the blue sections of this article. The survey shows that the application of heat pumps in industry is a long way from reaching its full potential. Although the number of applications is low, a range of heat pump technologies have been successfully applied in many important industrial sectors. This experience should be used as a stepping stone towards realizing the heat pump's full potential.

An important factor is to increase the exchange of knowledge on industrial heat pump technology. The IEA will make a significant contribution towards this through a newly commenced project "Global Environmental Impact of Industrial Heat Pumps" (Annex 21 of the IEA Heat Pump Programme) which will look closely at current application trends and work towards increasing industrial heat pump penetration.

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Heat Transformer finds Success in the Steel Industry

Ronald Krom and Peter Oostendorp, the Netherlands

In many industrial situations, the use of waste heat is an important way to save energy. If the temperature of this waste heat is lower than the temperature level at which heat is required, heat recovery cannot be accomplished with simple heat exchangers. In such cases, a heat transformer may be a useful option. Dutch steel producers Hoogovens found a suitable application in their hot strip mill where 600 TJ of heat was lost annually in its cooling water system. A 4 MWth heat transformer was applied to use some of this low temperature heat to supplement its steam requirements. It has now been operating successfully since July 1991.

* * *

When planning the heat transformer at Hoogovens, the designers were able to draw on experiences from the Netherlands' first heat transformer at a chemical plant of AKZO-Delamine (this has been extensively reported in an earlier issue of this Newsletter [1]). In particular, attention was focused on overcoming the corrosion problems that occurred through the use of a lithium bromide/water working fluid at high temperatures. Extensive research was carried out in a cooperative effort by AKZO, Hoogovens and the

Table 1: Predicted economic figures for similar future heat transformers.

Total investment cost (USD)	3 500 000
Running hours (h/yr)	8000
Costs (in USD)	
* Capital (8% for 10 yr)	525 986
* Operation and maintenance	120 000
* Electricity (2,77 million kWh at USD 0.0471/kWh)	130 470
* Total yearly costs	776 456
Production/Savings	
* Steam (tonne/year)	52 000
(GJ/year)	142 000
* Natural gas savings (GJ/year)	131 700
(M ³ /year)	4 174 600

Dutch research organization TNO, and finally resulted in the heat transformer design by Rinheat-Ahlstrom of Finland that is now being used at Hoogovens.

Design

In the design and application of the heat transformer, several measures were taken to improve reliability:

Low Temperature Output

Heat is delivered at a temperature of 130°C which is 15°C lower than the heat produced by the Delamine heat transformer.

Careful Choice of Materials

A minimal number of different materials are used and are selected to prevent corrosion. The basic materials used are cupro-nickel - CuNi90/10, carbon steel, titanium for plate heat exchangers and Hastelloy C in pumps.

Airtight Design

In order to prevent the infiltration of air (oxygen) and a subsequent increase of corrosion, measures are taken to maximize air-tightness to less than 50 cc/hour. These measures include the use of welded joints wherever possible and hermetic fluid pumps.

Monitoring System

A special measurement instrument has been developed to monitor leakage rates down to the low level required by the system. The following other parameters are measured:

- corrosion speed (two probes);
- corrosion inhibitor quality and concentrations;
- dissolved oxygen concentration in condensate (maximum allowable 5 p.p.b.; normally observed: 1 p.p.b.)

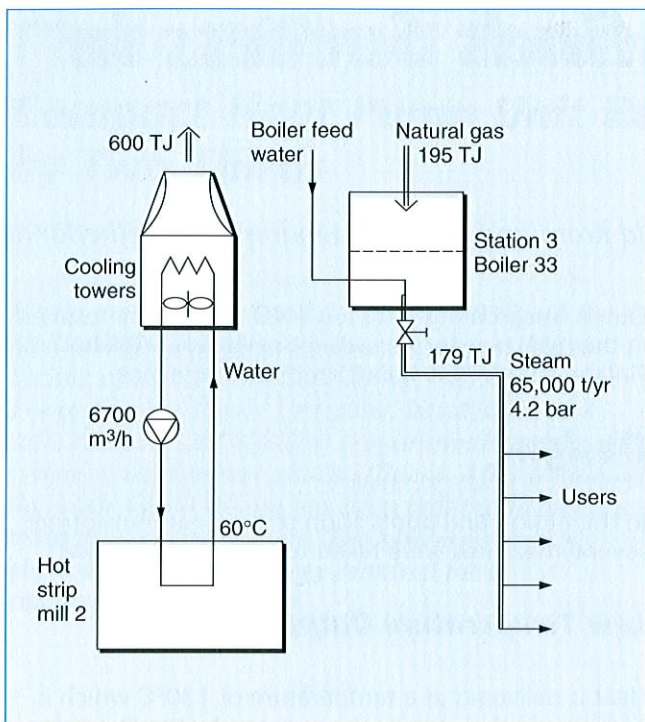


Figure 1: Yearly energy flows without heat transformer.

Operator Training

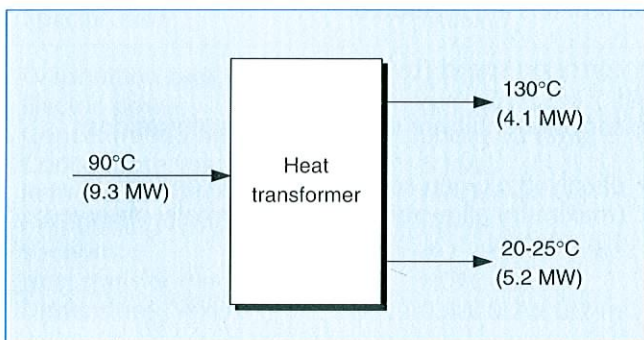
Much attention has been paid to the education of the operators of the system.

Application

Figure 1 indicates the flow of energy in the original situation at the hot strip mill before the heat transformer was installed. As shown, a huge quantity of waste heat is carried by the cooling water from the steel strip mills and emitted into the environment through cooling towers. At the same time there is a substantial need for steam (at 4.2 bar and 145°C).

To allow application of the heat transformer, the process conditions had to be changed. First the cooling water temperature was increased from 60 to

Figure 2: Net heat flows of heat transformer.



90°C; secondly the steam pressure and temperature in the existing network was decreased to 2.7 bar and 136°C.

Figure 2 shows the principle of the heat transformer. In operation, 268 TJ of heat at a temperature of 90°C is transformed into 119 TJ of heat at a temperature of 130°C. The energy transfer process is given in more detail in Figure 3. The numbers shown are annual figures based on heat transformer operation at 6.5 tonnes of steam per hour for 8000 hours per year.

The heat transformer produces saturated steam. In order to prevent condensation in the distribution system, this steam is superheated to 136 °C. The heat for the superheater is delivered by the existing steam boiler.

Financing

The heat transformer is owned in an agreement between Hoogovens and the local electric utility (PEN), while additional funding was obtained from NOVEM (The Netherlands Agency for Energy and the Environment) and the European Economic Community.

Energy and Economics

From Figures 1 and 3, a natural gas saving of 132 TJ (195 minus 63) can be derived. Electricity consumption is considered to be higher than optimum, especially by the hot and cold water pumps. It is expected however, that the present consumption of 2,77 GWh/yr can be reduced in future systems by using shorter transport distances and by reducing external pressure losses in evaporator, regenerator and condenser.

Based on current experiences with the system, Table 1 shows the estimated economics for the system when operating for 8000 hours per year. The figures indicate costs for similar systems when full use is made of the experiences with the Hoogovens heat transformer such that all "learning-curve" costs are omitted. Tables 2a and 2b give the steam and gas prices that are required in order to balance the total yearly system costs by the value of the steam production or the natural gas savings.

It should be stressed, that the energy savings can be directly translated into a reduction of the same magnitude of the cooling load of the overall system. The profit of this reduction is not included in the economic analysis.

Taking Lessons

Several conclusions can be drawn from the Hoogovens project:

Operating period (yrs)	interest rate			
	4%	6%	8%	10%
4	23.6	24.5	25.4	26.3
6	17.8	18.7	19.6	20.5
8	14.9	15.8	16.7	17.6
10	13.2	14.1	15.0*	15.9

* denotes correspondence with the capital costs in Table 1.

Operating period (yrs)	interest rate			
	4%	6%	8%	10%
4	29.4	30.5	31.6	32.8
6	22.2	23.3	24.4	25.5
8	18.6	19.7	20.8	21.9
10	16.5	17.6	18.7*	19.8

* denotes correspondence with the capital costs in Table 1.

Table 2a: Minimum required steam price (USD/tonne) as a function of the operating period and interest rate.

Table 2b: Minimum required price of natural gas (US cent/m³) as a function of the operating period and interest rate.

- The lessons learned from experiences with the Netherland's first heat transformer at AKZO Delamine, contributed considerably to a first year of successful operation of this project;
- The project shows that corrosion problems associated with lithium bromide are manageable;
- Although heat transformers are in principle driven by waste heat, in future applications the auxiliary power requirements should receive more attention;
- Finally, the project emphasizes the volatility of the economic climate: In the period '81 to '85, when the system was conceived, the system would have been an economic success. At present, an increase in energy prices by 50 % (or similar measures such as taxes on the use of energy or environmental

cooling water) would be required to make the system attractive.

Reference

[1] Bouma, J.W.J., "Experience with a Heat Transformer in the Chemical Industry", IEA HPC Newsletter, Vol.8, No.4, December 1990, pp 12-15.

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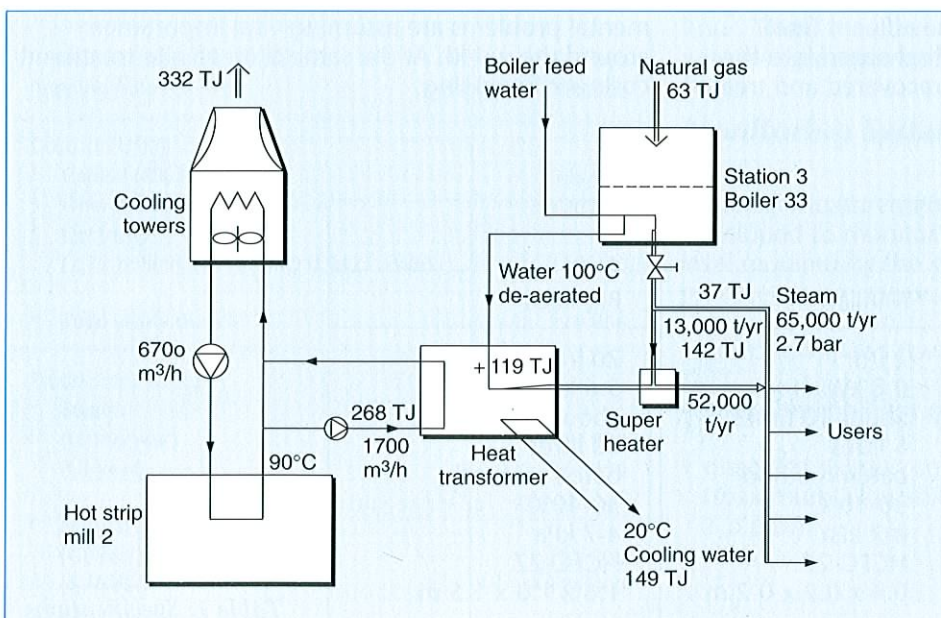


Figure 3: Yearly energy flows with heat transformer.

Photo-Effluent Treatment Technology - Compact Heat Pump Unit Reduces Energy Consumption by Two Thirds

Shoichi Kuroda, Japan

A heat pump can be used to concentrate liquid waste, facilitating subsequent treatment and possible re-cycling of a much smaller volume. TEPCO, the Tokyo Electric Power Company, has developed a safe, compact and efficient evaporation/condensation system to concentrate photo-effluent. After treatment the waste liquid stream has been reduced to about a tenth of its initial volume. The system uses only about a third of the energy required for a conventional evaporator.

* * *

Worldwide the concern about the environmental impact of industrial waste products is growing, while at the same time economic pressures stress the importance of conserving resources. In this context intensive research is advancing into the re-cycling and environmentally sound disposal of liquid waste. In a significant new development for the treatment of photo-effluent heat pumps are used as compact and highly energy efficient concentrating devices.

Conscientious

Much of today's photographic processing is carried out in small laboratories known as minilabs. The processors in most of these minilabs use the 'washless' process which eliminates the conventional washing of the image after development. The effluent from washless minilabs can either be discharged into the urban sewer system, or must be recovered and treated

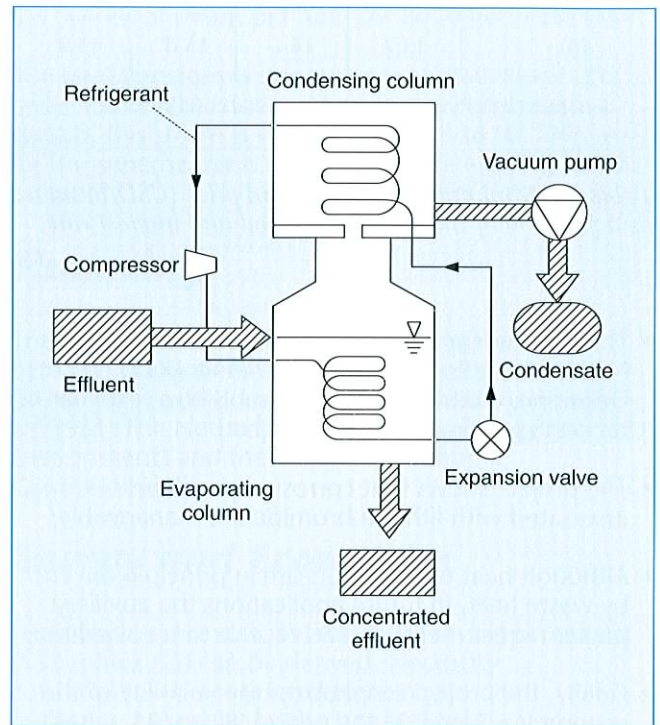


Figure 1: The heat pump effluent treatment.

off-site, depending on local regulations. Recently, however, sewer codes and regulations have become stricter. Also, many municipalities are now more conscientiously enforcing the local law, as environmental problems are assuming vital importance around the world. At the same time off-site treatment costs are increasing.

Model	Minilab	Big-Labs
Evaporation rate	2 l/hr	20 l/hr
Electric power	0.8 kW	5.6 kW
Concentration ratio	about 10 times	about 10 times
Concentrate volume	5 litres	30 litres
Removal of concentrate	batch method	batch method
Evaporating temperature	30-40°C	30-40°C
Vacuum	4-7 kPa	4-7 kPa
Heat transfer medium	HCFC-22	HCFC-22
Dimensions (WxDxH)	0.4 x 0.7 x 0.2 m	1.6 x 1.0 x 1.5 m

Table 1: Specifications.

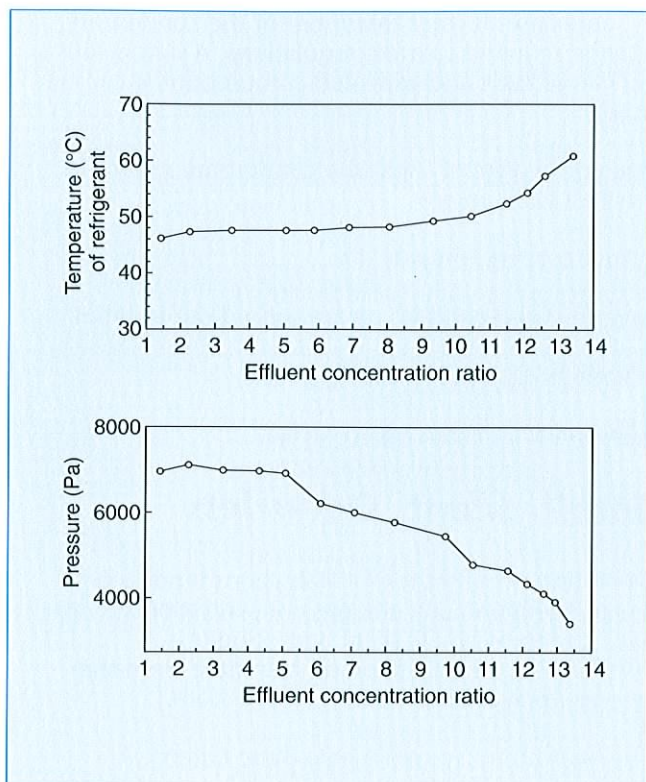


Fig. 2: The relationship between pressure, temperature and effluent concentration.

As one aspect of its support for environmental preservation TEPCO and KONICA Co. have been studying photo-effluent treatment technology, and a heat pump evaporation/condensation system was developed.

Advantages

Compared to conventional systems the heat pump type evaporator has the following advantages and characteristics:

- A high concentration can be achieved without any danger;
- The system is very compact;
- Electric power consumption is far less than conventional evaporating systems - about one third;
- Initial investment and running costs are modest;
- The operation is odourless because of its low evaporating temperature. There are no reactions such as synthesis of hydrogen sulphide, sulphur dioxide or other toxic materials.

The heat pump system is illustrated in Figure 1. In essence it is comparable to systems used for home air-

conditioners. Photo-effluent is boiled and steam is condensed on the surfaces of heat exchangers, installed in a vacuum column of 4 - 7 kPa.

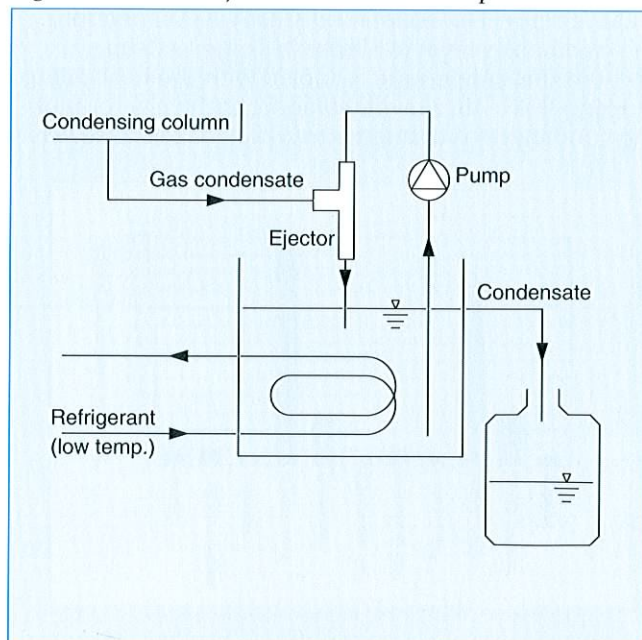
The working fluid used is HCFC-22, which is not restricted under current regulations intended to prevent ozone layer decomposition. After compression the working fluid enters a heat exchanger which is immersed in the effluent. Here it condenses at 60 °C, high enough to achieve a rapid evaporation of the water in the effluent. The working fluid is then expanded, and subsequently evaporates at 30 °C - picking up heat from the steam which condenses on the outside of the evaporator heat exchanger.

Two systems were developed, one with an evaporating capacity of 2 litres per hour, mainly for minilabs, and another with a capacity of 20 litres per hour, for bigger labs. Specifications of the two systems are shown in Table 1. For both systems the electric power consumption is significantly smaller than for conventional systems, but the larger system is most energy efficient, with smaller heat radiation.

Balance

The heat balance of the complete system is virtually neutral - the heat used to evaporate the effluent is recovered from the condensing steam, and essentially the only heat loss is the heat emitted by the compressor. Effluent can easily and continuously be fed into the system by maintaining the vacuum in the evaporation column. This vacuum is achieved with a water ejector, through which the steam condensate is pumped. Continuous effluent evaporation requires a vacuum of 4 to 7 kPa, where the vacuum will need to get deeper

Figure 3: A water ejector maintains a deep vacuum.



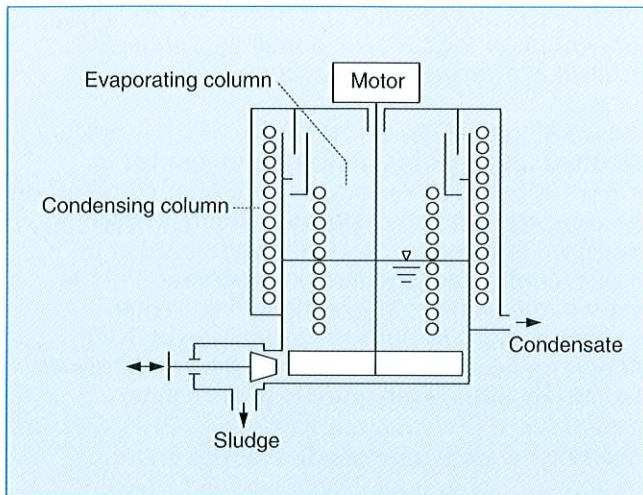


Figure 4: Cross-section of the effluent treatment unit.

as the process progresses and the effluent gets more concentrated. The evaporation temperature will also rise with increasing effluent concentration. The relationship between pressure, temperature and effluent concentration is shown in Figure 2. Depending on the kind of effluent these curves will vary somewhat.

The relationship between temperature and concentration allows the installation of a thermal switch to detect the completion of the process. This switch can thus control the so called 'concentration ratio', the ratio between the final volume of concentrated effluent and the initial volume of raw effluent. This ratio is set to allow easy removal of the concentrate, and is normally between one tenth and one fifteenth.

Deep Vacuum

The vacuum in the evaporator is maintained with a water ejector. The condensed steam is pumped into the ejector as shown in Figure 3. To get a deep vacuum this condensate is cooled with the heat pump working fluid. After overflowing from the ejector tank the condensate is drained into a tank or to the sewer.

In some cases further treatment of the condensate may be required to meet regulations. A simple ion exchange resin and activated carbon purifier can be used.

The advantages of using the condensate ejector to create a vacuum are:

- Low-cost equipment
- Vapour and condensate are sucked out together
- Vapour dissolves in condensate
- Deep vacuum can be achieved

Small, Silent, Odourless

Operating premises for minilab shops tend to be small. Therefore, any effluent concentration system will have to be small, silent and odourless. Furthermore no heat should be emitted from the system, to avoid overheating of the store.

The heat pump system meets these criteria. A compact unit (Figure 4) is achieved by positioning the evaporating column inside the condensing column. Inherent to the heat pump system is a very small heat loss. Heat pumps appear well placed for a role in the treatment of photo-effluent, and more in general the technology used could play a significant role in the treatment of other liquid industrial waste.

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Factory Combines Process Cooling with Space Conditioning

Otto Oberhumer and Hermann Halozan, Austria

For many factories and production processes, both space conditioning and process cooling are required. In Austria, a grinding materials factory combines both functions with waste heat recovery to reduce energy consumption as well as pollution of the environment. By using a multi-zone system, the factory benefits from flexible space conditioning control and can easily extend the system if the factory expands.

* * *

With respect to new materials like ceramics, titanium and silicon, which have an increasing share in industrial production processes, new grinding materials and grinding tools are required by the market. This was the reason for one of the largest manufacturers of such equipment to construct a new factory in Stans, Tyrol, Austria. In this factory, not only products and manufacturing techniques are "high-

tech" developments, but also the process cooling and space conditioning system fulfils the most recent requirements on energy efficiency and protection of the environment.

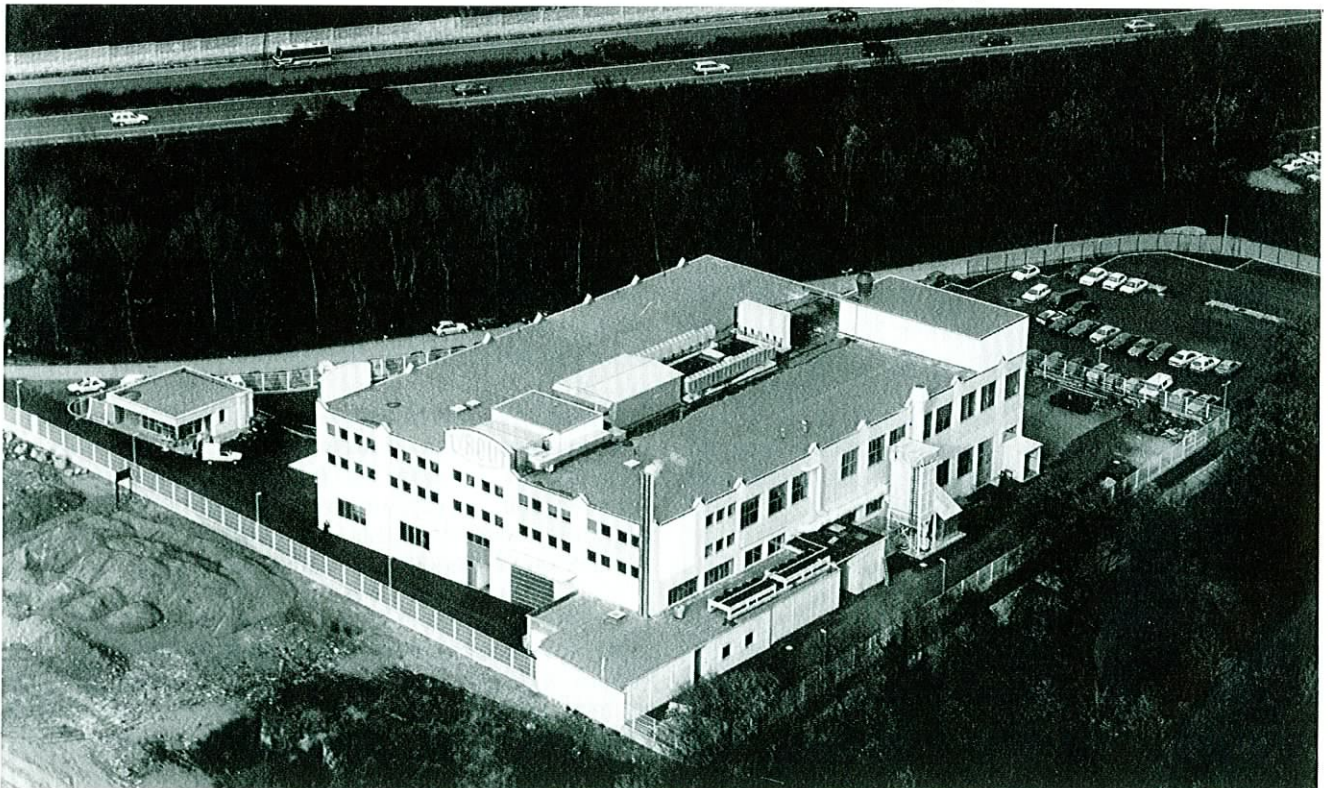
In the new factory, where 110 people are working in an area of 6000 m², high internal temperature gains are caused by the production process. To keep the temperature at a comfortable level, two systems are available:

- a direct cooling system for the machinery installed in the factory;
- a space conditioning system.

Keeping the Machinery Cool

The primary means of avoiding high internal temperature gains is by directly cooling the machinery using a water-based cooling system. Cold water is

Figure 1: View of the factory with roof-mounted outdoor units and cooling tower equipment.



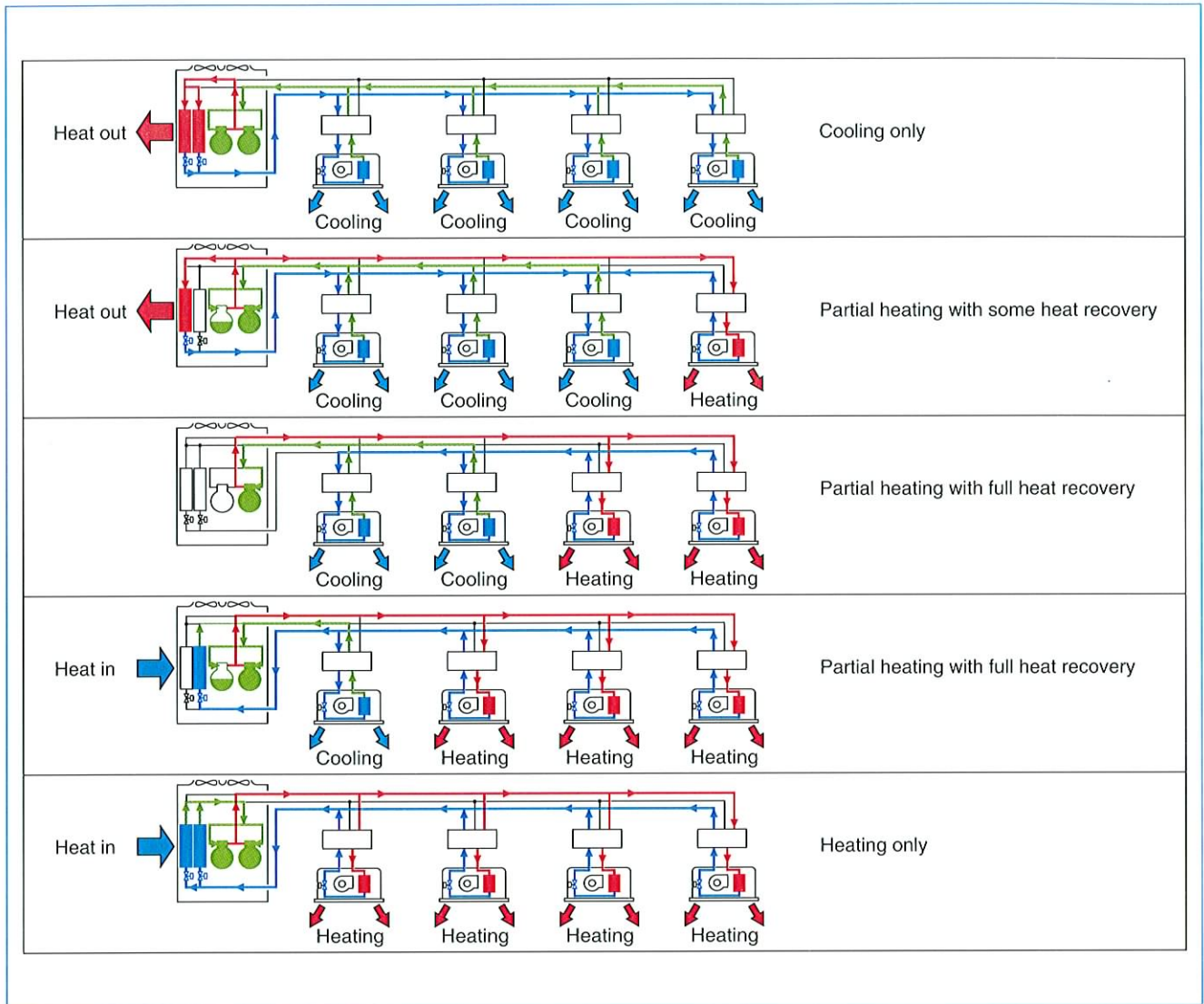


Figure 2: A three-pipe system allows individual selection of indoor units to heating or cooling mode at the same time.

provided by a heat pump chiller equipped with two condensers arranged in series.

Operation of the chiller is controlled principally by the cooling requirement of the production machinery. Cooling water with a temperature of 30°C is taken from the cold tank and cooled down to a temperature of 15°C. A condenser recovers heat from the cooling water to supply a hot water tank for sanitary water and water for cleaning purposes. The utilization of the condensing heat depends on the heat demand of the consumers connected to the hot tank.

A secondary task of this chiller is to cool and dehumidify the outside air for supplying the ventilation system with fresh air. When heating is needed, heat from the condenser may be used to preheat ventilation air. A second dry split air-cooled condenser is mounted on the roof of the factory and is used to protect the groundwater. The condensing temperature varies between 40°C and 25°C

depending on the load and the outside air temperature.

Choosing the Space Conditioning System

In deciding on the best system for this factory, three technologies were considered:

An air distribution system was rejected because the high internal gains in this factory mean that the duct system would need to be extremely large.

A second possibility is to use a water distribution system, where space conditioning is carried out by means of fan-coil units connected to the hydronic system. The cooling demand is met with a heat pump chiller, which can also be used for heating purposes at low outside temperatures.

The chosen technology is the VRV-multi-split system, which uses separately controlled indoor units to provide a high degree of flexibility. Multi-split systems require a network of pipes to transport refrigerant between indoor and outdoor units. But, in comparison to a water distribution system, cost savings are made since the pipes have a much smaller diameter. Also, no circulation pump is required.

The VRV-Multi-Split System

At the factory, twenty outdoor units are directly connected to 51 indoor units via a refrigerant piping system. The indoor units have a total power requirement of 134 kW and a total cooling capacity of 500 kW. Figure 1 shows the outdoor units mounted on the roof of the factory.

Up to eight indoor units are connected to each outdoor unit requiring a total of three kilometres of copper piping.

In the past, multi-split systems were limited in pipe-length and height differences between indoor and outdoor units. With this new VRV-system, pipe lengths of 100 m and height differences of 50 m are possible.

Each indoor unit is controlled separately. When several indoor units are installed in one room they may also be controlled as a group. To match the capacity of the outdoor unit with the demand of the indoor units, inverter-driven compressors are used.

In this factory two different VRV-multi-split systems are in operation:

- the two-pipe system only operates in zoning mode which restricts each outdoor unit to either cooling or heating operation. This type is installed in larger production facilities.
- the three-pipe system allows each indoor unit to be used independently for heating or cooling. When some of the indoor units connected to an outdoor unit are in cooling mode and others are in heating mode, heat recovery takes place: surplus heat is released by the outdoor unit, missing heat is taken up by the outdoor unit (see Fig. 2). This feature is useful for controlling rooms with different internal gains.

A further advantage of multi-split is the possibility of extending the system. In a centralized system the only choice is to oversize the equipment if additional heating or cooling requirements are expected. With multi-split systems, more units can be added without changing the existing system or system operation.

Successful First Operating Year

The operation mode of the space conditioning system depends on the outdoor temperature. Although the cooling season is prolonged by the internal gains, heating is also required when the outside temperature is low. During the first year of operation, the space conditioning system met all the heating requirements even when outside temperatures became extremely low. No operational difficulties were experienced.

With this concept a cost-effective and highly-efficient system has been realized. Furthermore, the space conditioning system can be extended very easily by adding additional outdoor and indoor units. The general cooling system provides waste heat utilization with no effect on ground water. The utilization of heat pumps offers both efficient operation as well as the reduction of emissions to the environment.

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Absorption Cooling Practice in Japan - Dutch Experts get a Close Look

Jos Bouma, IEA Heat Pump Centre

In the densely populated areas of the Netherlands, district heating with cogeneration is seen as an important way to reduce the country's high energy demand in winter. A significant drawback with these systems however is that the heat cannot be fully utilized in the summer. In Japan, the need to reduce the sharp growth in electrical demand for air conditioning has led to increased interest in district cooling systems using absorption chillers. Dutch experts felt that the lessons learned from this technology could be applied in their own country. In particular they were interested to see if low-temperature cogeneration heat could be used to supply cooling to large buildings in summer. Last October, a Dutch delegation had the opportunity to get a close look at Japanese absorption cooling practice.

* * *

A group of 24 experts set out to Japan in October 1992 with a mission to find out the state-of-the-art of Japanese absorption cooling technology, to learn from Japan's experiences and to identify new developments. Of particular interest was the use of low-temperature waste heat from cogeneration for producing cooling via absorption. It is hoped that this will open up new opportunities for absorption system applications in district heating networks in the Netherlands.

The group was organized by Novem (the Netherlands Agency for Energy and the Environment) and included representatives from utilities (electric, gas, heat), equipment suppliers, ministries, consulting firms and Novem. To get a good impression of Japan's technology, visits were made to Tokyo Gas, Osaka Gas, Tokyo Electric Power Company (TEPCO), Ebara Carrier, Hitachi and NEDO (New Energy and Industrial Development Organization).

DHC in Japan

In 1992, the number of DHC (District Heating and Cooling) systems in Japan rose to 84, with 48 of these located in the Tokyo area. Figure 1 shows the distribution of DHC in Japan. Some of these systems include cogeneration, usually using gas turbines, although growth in this area is limited due to regulations which prevent operators from feeding their excess electricity onto the grid.

In Japanese DHC systems, the demand for cooling is much greater than that of heating. Absorption cooling systems provide an excellent means to reduce the electricity peak load in summer.

Gas Utilities Play a Major Role

Of Japan's DHC systems, the largest is the 208 MW cooling capacity (absorption/compression chillers) installation in Shinjuku developed by Tokyo Gas. More recently, Tokyo Gas developed four large capacity DHC/cogeneration installations, one of them in their Tokyo head office. This so-called Shibaura system also serves two other building complexes. The total generating capacity is 4 x 1.1 MWe. The overall cooling capacity is 36 MW supplied by steam-driven

Figure 1: Spread of DHC systems in Japan.



two-stage absorption chillers with cooling COPs of between 1.23 and 1.27.

Osaka Gas has installed nine DHC systems and three more are planned. The largest is the new Osaka airport project which will have 90 MW cooling capacity and a 40 MWe cogeneration system (gas turbines). The total floor area is 750,000 m².

Combining Heat Storage and Waste Heat Utilization

TEPCO (Tokyo Electric Power Company) is quite active in DHC. In many of their projects, heat pumps and heat storage play a role and, where possible, waste heat is used as a heat source (heat from rivers, sewage water, refrigeration equipment, electric cables, subways and waste heat from industry and incineration plants). TEPCO sees the use of urban waste heat as an important part of its energy strategy.

TEPCO's interest in DHC originates from the need to reduce the summer electricity peak. Cold storage in buildings and DHC stations is an important way to tackle this problem. In winter the electricity load is improved by storing heat with heat pumps. By applying electric heat pumps, a significant contribution to CO₂ emissions reduction is achieved since Japanese electricity is becoming increasingly cleaner in terms of CO₂ emissions (electricity is increasingly generated from nuclear and hydro power; nuclear energy will probably double from 8.9% in 1990 to 16.9% in 2010).

A highly interesting advanced DHC system has been realized in the Makuhari project outside Tokyo. Eight buildings are heated and cooled with reversible sewage water heat pumps combined with heat and cold storage. Cold storage techniques include the production of ice during the night. For details reference is made to HPC Newsletter Vol. 10 No.1.

Trends in Chiller Technology

On its visit, the Dutch team had the opportunity to look at the latest work on chiller technology by Osaka Gas, Ebara Carrier, Hitachi and NEDO.

Osaka Gas to Enter Small-Capacity Market

Since the early 1970s, Osaka Gas has installed 4300 MW cooling with gas-fired absorption systems - 75% of these installations are larger than 350 kW. The share of the air conditioning (A/C) market by gas absorption cooling equipment continues to fall (falling from a peak of 70% to the current 40%) as preference is given to cheaper decentralized electric systems. However, gas engine-driven heat pumps (sales representing 5% of the A/C market in 1991) are finding increasing application in the Osaka area.

In an effort to compete with small electric units, Osaka Gas is now developing a small-capacity compact absorption heat pump for the residential market. The proposed double-effect split system will provide 7 kW cooling and 9.3 kW heating with a target cooling COP of 1.0 (the current prototype has a COP of 0.88). The working fluid is water/lithium bromide and the unit's weight will be less than 100 kg. The system is expected to become commercially available in two years.

Ebara Carrier Introduces Low-Temperature-Driven Chiller

Ebara Carrier produces screw and centrifugal compression (using HCFC-123), as well as absorption cooling systems. About 1000 absorption units are produced annually, mainly for the A/C market. This represents 80% of total production. All use a water/lithium bromide working pair and most are directly fired. Interest from some European countries for absorption cooling equipment has risen to about 35 units annually.

A new product is an absorption chiller for low driving temperatures featuring spray-type heat exchangers. This unit can operate on low-temperature (88/83°C) driving heat with a COP (cooling) of 0.7. Operation with a driving heat as low as 75°C is possible at the expense of considerably reduced capacity. Interestingly, it is claimed that the cost of the low-temperature chiller will be 25 to 30% lower than a conventional absorption chiller. This development was of great interest to the Dutch team since it suggests an improved competitive position for providing absorption cooling in combination with district heating systems or other systems producing low-temperature waste heat.

Hitachi Holds Back on Low-Temperature Chiller Development

The main products of the Hitachi, Tsuchiura Works, which played host to the Dutch team, are compression and absorption chillers. All new centrifugal chillers will be filled with HFC-134a by April 1993.

Over 1000 absorption chillers are produced annually, one third of which are large capacity (> 350 kW cooling) for applications in commercial buildings and industry. Both single and double-stage absorption chillers, gas or heat-driven are manufactured. All are water/lithium bromide machines. Hitachi has not yet commercialized low-temperature absorption machines because "demand is limited and costs are relatively high". Instead, their two-stage chiller will be further improved - a cooling COP of 1.23 is projected when steam driven. However, partner York/USA is developing an absorption machine for drive temperatures of 80°C and higher.

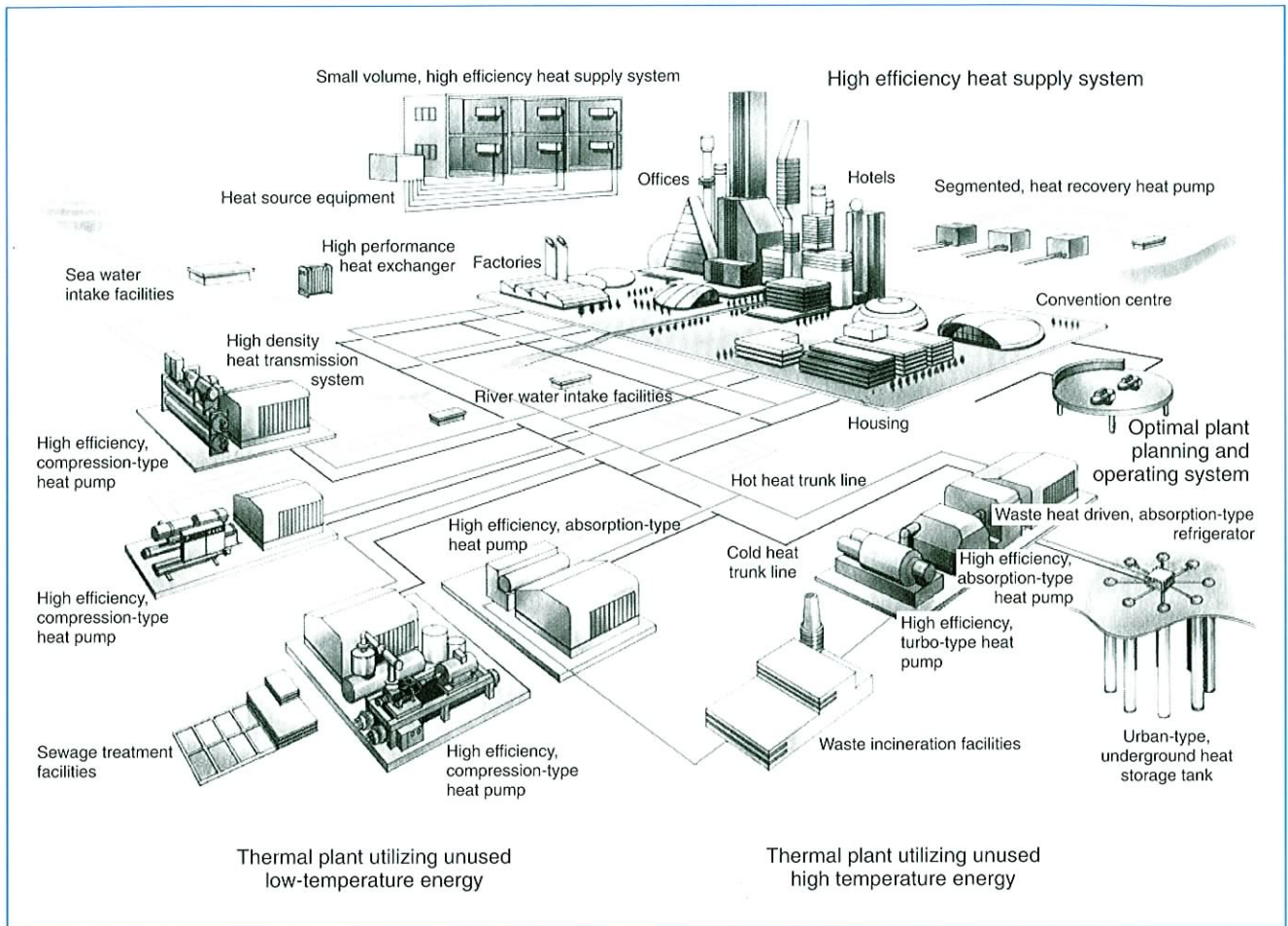


Figure 2: Projected energy distribution system utilizing unused energy.

Research Ambitions Set New Goals for DHC

In an ambitious national project run by NEDO, Japan will develop technology for utilizing so-called unused energy for promotion of energy conservation and load levelling to cope with summer electricity peaks. Heat pumps are a key technology in this project and HPTCJ (the Heat Pump Technology Centre of Japan) is playing a crucial coordinating role in this. The overall goal of the project is to shave electricity peaks by developing and applying highly-efficient large-scale DHC systems. The project started in 1991 with a study and is scheduled for completion in 1997 with demonstration installations. The R&D budget of the project is USD 120 million, of which MITI (Japan's Ministry of International Trade and Industry) sponsors 50%. The rest is financed by 22 industrial participants in the project. The participants include electric and gas utilities, manufacturers and the HPTCJ. Key R&D themes are:

- High-performance heat exchange technology;
- High-efficiency heat production (high/low temperature) technology;
- High-density heat transfer technology;
- Urban-type large-scale heat storage technology;
- High-efficiency heat supply technology;
- Optimized plant planning and operating system.

The use of natural and man-made (high/low temperature) waste heat streams in combination with highly-efficient equipment, including that developed in the Super Heat Pump Energy Accumulation System Project (see box), are the main themes in this project. Figure 2 is an artist's impression of how the various technology concepts could be applied in a futuristic living environment.

Building on Japan's Experience

The commitment of Japanese industry and government to the development of large-scale DHC systems demonstrates their belief in the value of these systems for energy saving. Clearly, absorption cooling systems will play a major role. The Dutch delegation

returned home with the impression that Japan now has commercially available absorption systems that could have applications in the Netherlands. Of particular interest are absorption chillers driven by low-temperature heat. Surely the day is not far off when this technology will be used to make better use of district heating systems in countries with moderate climates such as the Netherlands.

Super Heat Pump Energy Accumulation System Project

The Super Heat Pump Energy Accumulation System Project is due for completion in the spring of this year. Set up as part of Japan's "Moonlight Project", the project aims at developing high-efficiency heat pumps and advanced thermal storage systems. The Heat Pump Centre plans to help disseminate the lessons learned from this project by holding a workshop in Japan in 1993 with the assistance of the Heat Pump Technology Centre of Japan (HPTCJ).

All the tasks of this project will be completed early in 1993 apart from the development of a high-temperature (200°C) heat storage system based on ab/desorption of complex ammonia salts. Unfortunately this task was stopped due to high cost. The details of the Project can be found in HPC Newsletter Vol. 7, No.4.

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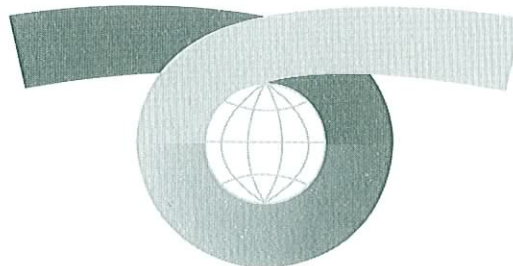
The 4th IEA Heat Pump Conference

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The Italian National Team - Collaboration in a Growing Market

Laura Manduzio, Italy

The Italian National Team was first set up in March 1991. Now, some two years on, a mature team plays a significant role as promoter of heat pump technology for energy efficiency and environmental benefit. The National Team, with representatives from government agencies, the scientific community and utilities, operates in a growing heat pump market, and is set to intensify international collaboration to accelerate the diffusion of heat pumps in the Italian society.

* * *

In March 1991 the Italian Agency for Energy, New Technology and the Environment (ENEA), took over from the National Research Council (CNR) as the Italian representative in the IEA Heat Pump Centre. It organized a new National Team, with the general aim of stimulating the development and diffusion of heat pumps as an energy-efficient and environmentally benign technology. The aim is mainly pursued through information dissemination and intensive collaboration with national and international organizations

Experts

Members of Italian National Team are heat pump experts from government agencies (ENEA, CNR, ISES), utilities (ENEL, ITALGAS, SNAM), associations (ANIMA, ASSISTAL, ASSOCALOR) and research centres (Universities of Padua and Palermo, the Polytechnic of Milan, and TECNARS). The constitution of the National Team ensures that all the main organizations dealing with heat pumps are represented. Furthermore the team members come from different regions in Italy, so that input is received from a variety of climatic conditions (Figure 1).

One of the first activities of the National Team, in March 1991, was to present itself to the main Italian manufacturers. This was realized through letters, and through an announcement in the ENEA monthly journal "Risparmio Energetico", which reaches most Italian industries (fifteen thousand copies).

To further enhance the information diffusion the publication of an Italian National Team Bulletin was started in June 1992. This bulletin contains a summary of articles from the most recent HPC Newsletter, references to papers on heat pumps published in the

Bulletin of International Institute of Refrigeration, a summary of National Team meetings, and some heat pump news. The bulletin is issued in the Italian technical magazine "Il Condizionamento dell'Aria" which is the organ of the Association of Air Conditioning, Heating and Refrigeration, AICARR. This magazine is issued in fifty thousand copies and sent to the major Italian industrial companies and research centres.

Government

In 1991, the Italian Government passed a law which made subsidies available for the installation of energy-saving devices. Heat pumps can qualify for this subsidy, as long as they replace a conventional heating system. The law requires that the request for

Figure 1: National Team members in Italy.



this subsidy is accompanied by a technical data sheet on the adopted energy-saving device. The Italian National Team helps to simplify subsidy requests by preparing these sheets for heat pump installations.

For the coming year, the National Team is planning a study on heat pump regulations, to assist the government in formulating national codes. At this stage regulations on heat pumps are virtually absent. The Italian Government shows a keen interest in this activity, since the heat pump market is recognized as significant and growing, and it is felt that adequate regulation should be in place in this area.

Enhanced value

The National Team is also planning to enhance the value of its bulletin. Considered is an overview of Italian and international organizations which are involved in heat pump RD&D. International organizations to be discussed would include the IEA and the IIR.

The National Team operates in close cooperation with the Heat Pump Centre, aiming to answer all requests for information or activities which comes from the

centre, or from other national teams. The Italian team contributed three articles to the HPC Newsletter in 1992.

Growing Interest

Italian interest in the IEA Heat Pump Centre is on the increase. This is exemplified by a steady growth in Newsletter subscribers and through inquiries by people wishing to participate in National Team activities.

The Italian National Team hopes to further intensify its collaboration with national and international bodies. It expects that this collaboration will provide vital support in its efforts to accelerate the diffusion of heat pumps, for economic, energy-efficiency and environmental benefits.

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Bibliography

Technology

Ground-Coupled Heat Pumps

"Erdgekoppelte Wärmepumpen", Burkhard Sanner, IZW (Informations Zentrum Wärmepumpen+Kältetechnik), Fachinformationszentrum, Karlsruhe, Germany. 284 pp, ISSN 0940-3442 (German).

This book gives a comprehensive overview of the history, systems, design and installation of ground-coupled heat pumps (GCHPs). In a lucid and highly readable style, the author details all possible theoretical and technical aspects of ground coupling. He discusses direct evaporation systems, geological considerations, and presents example calculations. The economy of heat pumps is briefly discussed, and the impact of the German legislative environment on heat pumps is shown.

The author also addresses the possibility of heat and/or cold storage in the ground, and even a listing is given of a BASIC computer program to roughly design a GCHP system and estimate its economics. A worthwhile book, which concludes that "a suitable GCHP can be applied in every climatic condition, from sub-polar to sub-tropical". Its only drawback is that it is only available in German - at this stage.

Ground-Coupled Heat Pumps for Commercial Buildings

Steve Kavanaugh. ASHRAE Journal, September 1992, 30-37 pp (English).

Recent improvements in heat pump units and installation procedures have expanded the market for ground-coupled heat pumps (GCHPs) from residential to commercial applications. Compared to more conventional water-loop heat pump systems, GCHPs require fewer components and provide more versatile heating and cooling of large buildings with reduced maintenance costs. This article discusses the installation costs and operating efficiencies of GCHPs and outlines a design method.

Heat Pumps in Japan

The Japanese report "Heat Pumps in Japan - Third Edition" (March 1992) has been translated and used to produce two English-language publications: "Heat Pump R&D in Japan" (HPTC-80, December 1992, 78 pp) includes details on Japan's Super Heat Pump Programme, the Advanced Unused Energy Utilization System and the programme on Stirling Engine Heat Pumps. A separate volume "Heat Storage Type Heat Pumps in Japan" (HPTC-81, December 1992, 45 pp) is

dedicated to advances in heat pumps using storage media such as water, ice or clathrate.

Research on Advanced Heat Pumps

"Untersuchung fortgeschrittener Absorptionswärmepumpen", G. Alefeld et al, IZW (Informations Zentrum Wärmepumpen+Kältetechnik), Fachinformationszentrum, Karlsruhe, Germany. 250 pp, ISSN 0940-3442 (German).

The report summarizes the results of eight years of work on advanced absorption heat pumps, carried out under Prof. Alefeld of the University of Munich. Both theoretical and practical work was performed, and the report extensively discusses the building and running of a test installation which can be switched between 'double effect' (moderate lift, high COP) and 'double lift' (high lift, moderate COP).

The book contains extensive data on the working pair water/lithium bromide, and concludes with a description of a demonstration plant at the German Centre for the History of Air and Space Travel. This plant can be used for heating in winter, and space conditioning in summer.

Working Fluids

Tables and Diagrams for the Refrigerants Industry - R134a

IIR, 177, boulevard Malesherbes - F 75017, Paris, France (English) - price FRF 60.

The latest in a series of IIR booklets contains tables and equations on the thermal and physical properties of HFC-134a providing sufficient information for the development of data-processing programs. The booklet compares HFC-134a with the major refrigerants and includes a 70 cm x 50 cm pressure/enthalpy diagram.

Performance Evaluation of Environmentally Benign Refrigerants in Heat Pumps

Bansal, Dutto and Hivet; International Journal of Refrigeration Vol. 15, No. 6 1992 - International Institute of Refrigeration (English)

In a special issue on HFC-134a, the IIR published two articles under the above title. The first presents results from computer simulation of a number of heat pump systems, including combined compression-absorption cycles, using different refrigerants. The second studies the behaviour of HFC-134a in an experimental industrial heat pump with twin-screw compressor.

Markets

ARI 1993 International Trade Directory

This booklet lists contact information on all member companies of ARI (The U.S. Air-conditioning and Refrigeration Institute) and gives an overview of their products and international business interests.

Contact: International Trade Dept. ARI, 4301 North Fairfax Drive, Suite 425, Arlington, VA 22203-1627, USA.

Software

Residential Energy-Use Program

U.S. research group EPRI (Electric Power Research Institute) has released a new version of its ESPRE computer program for estimating residential energy use. The new release, ESPRE 2.1, allows users to more easily evaluate alternative space-conditioning and water heating technologies, including for the first time ground-source, dual-fuel, and variable-speed integrated heat pumps. The new release models the characteristics of the most advanced heat pump technologies. As a result, ESPRE can be used to forecast the impact of these technologies on utility loads and energy costs, and thus help in calculating customer rebates or other incentives in demand-side management programmes. ESPRE can also be used as a marketing tool to show customers what their energy bills would look like with an advanced heat pump in place of a conventional heating and cooling system.

The program will operate on an MS-DOS PC. For more information contact John Kesselring, EPRI Residential Program, Tel.: +1-415-855-2902. (Source: EPRI Heat Pump News Exchange, Fall 1992)

EASY - Analyzing Vapour Compression Systems on a Personal Computer

Software developed by F. de Rossi, R. Mastullo, P. Mazzei, M. Sasso.

EASY stands for Exergetic Analysis of SYstems and is the name of a computer program developed at the University of Naples in Italy for evaluating the thermodynamic properties of working fluids and analyzing vapour compression systems. The program will run on an MS-DOS PC and covers twenty working fluids and nine vapour compression systems for cooling and/or heating purposes. As well as the basic single-stage cycle, the software will also study more complex arrangements with compound compression, separation by flashtank, and subcooling and/or desuperheating by intermediate heat exchangers.

The program is available (price ITL 500,000) from CUEN, Piazzale Tecchio 80, 80125 Naples, Italy.
Tel.: +39-81-610426/7682337; Fax: +39-81-5936667.
(Source: Italian National Team)

Proceedings

Thermochemical Technologies Workshop

This workshop was held in Canada in October 1992 to discuss the potential of thermochemical technology for space conditioning and refrigeration. With thermochemical technology, the strong exothermic and endothermic reactions between a salt and a gas are used to store, pump and transport heat. The heat storage function of thermochemical technologies provides energy densities that are three to four times higher than phase-change materials. Further advantages are heat storage without loss, noise-free operation and no damaging emissions.

Papers presented included developments such as solid adsorption systems, the STELF process and SWEAT technology (as featured in HPC Newsletter Vol.10, No.1). The workshop was attended by about 60 people including representatives from utilities, and users and manufacturers of HVAC&R equipment. Discussions identified promising research niches and the factors determining market success. Proceedings of the workshop findings are available from Mr Robin Majumdar, Energy Diversification Research Laboratory, Canada; Tel. +1-514-652-3210; Fax: +1-514-652-5177.

Innovative Cooling Systems

IEA, UK, Oscar Faber Applied Research Ltd, 1992, ISBN 0 946075 69 7 (English)

This workshop was held in Solihull, UK, on 12-14 May 1992 by the IEA Programme for Energy Conservation in Buildings and Community Systems. It was the first to be held under the auspices of the Future Buildings Forum. Its aim was to review the potential for low-energy cooling concepts, and to identify the research priorities which would enable the most promising systems to be applied in practice.

Several papers examine the trends which impact upon the needs of cooling systems for future buildings. Other papers present a variety of cooling technologies including desiccant cooling, advanced classical air-conditioning systems, and a presentation on heat pumps by Mr. Jos Bouma of the IEA Heat Pump Centre. The proceedings include a detailed summary of the discussion sessions and outline proposed areas for future work including new projects within the IEA framework.

Conferences

*Call for Papers

The 4th IEA Heat Pump Conference

April 26-29, 1993 / Maastricht (The Netherlands)
Conference Secretariat: Van Namen & Westerlaken Congress Organization Services, P.O. Box 1558, 6501 BN Nijmegen, the Netherlands.
Tel.: +31-80-234-471; Fax: +31-80-601-159.

Energy Efficiency in Refrigeration and Global Warming Impact

May 12 - 14, 1993 / Ghent (Belgium)
Organized by the International Institute of Refrigeration
Contact Prof. P. Moerman, Rug, Rozier 44, B-9000 Gent, Belgium.

Sixth International Stirling Engine Conference and Exhibition

May 26 to 28, 1993 / Rotterdam (The Netherlands)
Contact: The Organizing Secretary, P.O. Box 16350, 2500 BJ The Hague, The Netherlands.
Tel.: +31-70-3819394; Fax: +31-70-3824321

6th Nordic Heat Pump Meeting

June 9-12, 1993 / Nådendal (Finland)
Contact: Prof. Antero Aittomäki, Tammerfors Tekniska Högskola, Box 589, SF-33 101 Tammerfors, Finland.
Fax: +358-31-162-034.

China Refrigeration '93

June 10-15, 1993 / Beijing (China)
The 4th International Exhibition for Refrigeration, Heating, Ventilation and Air-Conditioning, Frozen Food Processing, Packaging and Storage.
Contact: M. Lu Lei, China Council for the Promotion of International Trade (CCPIT), Beijing 100006, China.
Tel.: +86-512-5185; Fax: +86-512-5183.

Annual Conference of the International District Heating and Cooling Association (IDHCA)

June 19-23, 1993 / Harrisburg, Pennsylvania (USA).
Contact: IDHCA, 1101 Connecticut Ave. N.W., Suite 700, Washington D.C., 20036, United States of America.

1993 ASHRAE Annual Meeting

June 26-30 1993, Denver, Colorado (USA)
Contact ASHRAE Meetings Department, 1791 Tullie Circle NE, Atlanta, GA 30329, United States of America.
Tel.: +1-404-636-8400 Fax: +1-404-321-5478

Indoor Air '93 - International Conference on Indoor Air Quality and Climate

July 4-8, 1993 / Helsinki (Finland)
Sponsors include: IEA, ASHRAE, World Health Organisation.
Contact: Prof. Olli Seppänen, Helsinki University of Technology, SF-02150 Espoo, Finland.
Tel.: +358-0-451-3600; Fax: +358-0-451-3611.

Chinese International Compressor Technique Conference and Exhibition

August 15 - 18, 1993 / Xi'an (China)
Contact: Danqing Wu, Associate Professor, Room 227, Chemical Engineering Building, Xi'an Jiatong University, 28 Xian Ning Road, Xi'an, 710049, P.R. China.
Tel.: +86-29-335011 Ext. 3980; Fax: +86-29-337910

* 2nd International Conference on Heat Pumps in Cold Climates

August 16-17, 1993 / Moncton, New Brunswick (Canada)
Abstracts of proposed papers due on March 30th 1993.
Contact: Mr. D. Cane, CANETA Research Inc., 6981 Millcreek Dr., Unit 28, Mississauga, Ontario, L5N 6B8, Canada.

4th International Workshop on Heat Pump Research and Applications: Energy, Economy and Environment

August 29-31, 1993 / Prague (Czech Republic)
Organized by the European Federation of Chemical Engineering.
Contact: CHISA '93, P.O. Box 857, 111 21 Prague, The Czech Republic.
Tel.: +422-311-61-38; Fax: +422-311-55-29.

14th AIVC Conference - Energy Impact of Ventilation and Infiltration

September 21-24, 1993 / Copenhagen (Denmark)
Contact: IEA Air Infiltration and Ventilation Centre, Barclays Venture Centre, Sir William Lyons Road, Coventry CV4 7EZ, United Kingdom.
Tel.: +44-203-692-050; Fax: +44-203-416-306.

Clima 2000

November 1-3, 1993 / London (UK).
Organized on behalf of the Federation of European Heating and Ventilation Associates
Contact Anne Gibbins, CIBSE headquarters, 222, Balham High Road, London SW12 9BS, United Kingdom.
Tel.: +44-1-81-6755211; Fax: +44-1-81-6755449.

Symposium on Heat Pump Design, Analysis and Application (1993 ASME Winter Annual Meeting).

November 28 - December 3, 1993 / New Orleans, Louisiana (USA).
Contact: Karen R. DenBraven.
Tel.: +1-208-885-7655; Fax: +1-208-885-9031.

International Absorption Heat Pump Conference '94

January 19-21, 1994 / New Orleans, Louisiana (USA).
Contact IAHP '94 Conference Secretary, Mechanical Engineering Dep't, University of Maryland, College Park, Maryland 20742-3035, United States of America.
Fax: +1-301-314-9477.

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Future Issues

<i>Vol./No.</i>	<i>Topic</i>	<i>Deadlines</i>
11/2	Special Issue on the 4th IEA Heat Pump Conference	-
11/3	Heat Pumps and the Environment	1 June 1993
11/4	Trends in Heat Pump Technology & Applications	1 September 1993
12/1	Heat Pump Working Fluids (including Alternative Refrigerants)	1 December 1993

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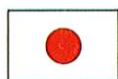
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