Solar cooling: The way forward

The use of solar energy for cooling purposes has existed for a long time but has so far hardly exceeded the stage of experimentation.

However, the possibility of using solar energy has attracted more and more countries. It is a plentiful source of energy, especially in developing countries where electricity infrastructure is lacking. Since solar is a renewable energy that does not emit greenhouse gases, at least directly, significant investments are being made in this sector and therefore its cost is falling. It will certainly be part of the energies of the future.

Already in 1999, the IIR had published a guide to solar refrigerators. The IIR has just issued a much more synthetic Informatory Note on solar cooling - prepared by R. Lazzarin - which updates decision-makers with the information needed to understand technologies for generating cold from solar energy. Only IIR members have access to this note at this time. We hope that they will help contribute to the development of these systems and ensure the sustainable development of refrigeration all over the world.

This Informatory Note comes on top of all the other notes we have published for the past three years regarding fluorinated and natural fluids used in vapour compression systems and other technologies, such as evaporative cooling in buildings or direct expansion systems. We have increased the use of refrigeration while reducing its impact on the environment. These notes are available online: http://bit.ly/IIRNotes

I wish members an interesting read and look forward to welcoming others as members!

Didier Coulomb
Director General of the IIR

Le froid solaire : une voie d’avenir

L’utilisation de l’énergie solaire pour faire du froid existe depuis longtemps mais n’a jusqu’à présent guère dépassé le stade de l’expérimentation. Toutefois, de plus en plus de pays en sont arrivés à cette possibilité d’utilisation de l’énergie solaire. C’est une énergie abondante, particulièrement dans les pays en développement où les infrastructures électriques manquent. Son coût baisse, à cause du développement croissant des investissements dans l’énergie solaire, énergie renouvelable qui n’émets pas, de façon directe tout au moins, de gaz à effet de serre. Elle fera certainement partie des énergies d’avenir.


Cette note d’information s’ajoute à toutes celles que nous avons publiées depuis trois ans, concernant les fluides fluorés et naturels utilisés dans les systèmes à compression de vapeur et d’autres technologies, telles que le froid évaporatif, afin de continuer à accréditer l’utilisation du froid tout en diminuant ses impacts sur l’environnement. Ces notes sont consultables ici : http://bit.ly/IIRNotes

Bonne lecture pour nos membres et bonne adhésion pour ceux qui ne le sont pas encore !

Didier Coulomb
Directeur Général de l’IIF

Activities of IIR’s Commission B2 on “Refrigerating Equipment”

Overall, Commission B2 Refrigerating Equipment includes 69 experts from 25 IIR member countries. The activities of Commission B2 are aimed to promoting knowledge of refrigeration technologies and their applications in the field worldwide. This includes not only components and systems related to the widely used vapor compression cycle, but also sorption technologies, gas cycles, and alternate technologies such as magneto caloric, thermoplastic, thermoelectric, thermoacoustic, and chemical looping technologies. Due to its focus on this great variety of refrigeration equipment, Commission B2 is a key commission for many IIR activities and it provides synergy with most of the other commissions.

In an effort to operate the commission more effectively, Commission B2 generated a certain set of internal goals. This includes increasing the number of regular and junior commission members and make sure that all commission members are actively involved. Furthermore, the commission encourages increased activities by vice-presidents and close cooperation with Commissions B1, E1 and E2.

In the framework of the 2005 IIR Strategic Plan, Commission B2 generated a list of research priorities with several of them still relevant today. For instance, one of these topics was “assessment of conventional concepts of TEWI and/or LCCP” (Life Cycle Climate Performance), which has very recently (January 2016) resulted in the Guideline for Life Cycle Climate Performance and a related Informatory Note. This guideline has been developed by a working group under leadership of Prof. Yunho Hwang from the University of Maryland, USA, who is also a vice-president of Commission B1. Recently, new research priorities have shown up as a result of the Paris agreement of December 2015 related to yet another change in refrigerants to be used in the future. As Commission B2 members of industry and academia, it is our task to find solutions to the given challenges related to replacing refrigerants in refrigeration equipment.

Since the last IIR International Congress of Refrigeration, Commission B2 has participated in 9 IIR conferences and 12 IIR-co-sponsored conferences.

One of the latest conferences was the very successful 12th IIR-Gustav Lorentzen Conference on Natural Refrigerants, which took place in Cambridge, United Kingdom, August 21-24, 2016, and was attended by 264 delegates. A total of 147 papers have been presented during this event dealing with diverse topics including many Commission B1 topics. A joint Commissions B1-B2-E1-E2 business meeting was organized during this conference, allowing commission members to review ongoing projects.

In addition, Commission B2 co-sponsored the 5th IIR Conference on Thermodynamic Properties and Transfer Processes of Refrigerants, which will be held in Seoul, South Korea, from April 23 to 26, 2017, at the 7th International Conference on Ammonia and CO2 Refrigeration Technologies, which will be held in Ohrid, Macedonia, from May 11 to 13, 2017. Furthermore, the 9th International Conference on Compressors and Coolants will be organized in Bratislava, Slovakia, in September 2017, and the 13th IIR-Gustav Lorentzen Conference on Natural Refrigerants will be held in Valencia, Spain, in June 2018. These upcoming conferences will provide vast opportunities for Commission B2 members to exchange ideas and discuss technologies.

Commission B2 is also very active in several IIR Working Groups, namely Magnetic Cooling, Mitigation of Direct Emissions of Greenhouse Gases in Refrigeration, Refrigerant-Charge Reduction in Refrigerating Systems, Refrigerant-System Safety and the aforementioned LCCP Evaluation.
The IIR Working Group “Phase-Change Materials and Slurries for Refrigeration and Air Conditioning” (chaired by Dr. Laurence Fournaison) has been active for a long time. It has organized the PCM 2016 conference in Karlsruhe (Germany) last May and it will organize the upcoming PCM 2018 conference in Oxford (Canada) in May 2018. Based on the activities associated with the IIR Working Group “Magnetic Cooling”, the Thermag VII conference was held in Turin, Italy, in September 2016. An IIR Informatory Note on Solar Cooling has been prepared by Prof. Renato Lazzarin and will soon be published. An IIR Informatory Note on Cogeneration Trigeneration, prepared by Prof. Michel Feindt, has just been published.

It is my intention to consult the Commission B2 members on several topics during this spring in order to gauge their interest in the various ongoing commission activities. Furthermore, I would like to take this opportunity to thank all IIR members who have taken part in Commission B2 activities and the IIR staff, who facilitates these activities. Your contributions are greatly appreciated.

Dr.-Ing. Eckhard A. Groll
Reilly Professor of Mechanical Engineering
President of the IIR’s Commission B2

Dresden (Germany), will address key issues involving equipment and technology problems where temperatures reach below 120K (-153°C), whilst also including other related devices and technologies. There’s still time to register.

The 9th International Conference on Compressors and Coolants - Compressors 2017, on September 6-8, 2017, in Bratislava (Slovakia), will provide an international meeting place for knowledge exchange. Registration now open.

New! Following on from the success of the 2016 event in Auckland (New Zealand), the 5th IIR Conference on Sustainability and the Cold Chain (IIRCS) (PCM2018) will take place in Beijing (China) on April 6-8, 2018. This prestigious biennial conference attracts international audiences and provides an opportunity to showcase cutting edge developments in sustainability, retail refrigeration and the cold chain. Call for abstracts open.

New! Now! The twelfth in the series, the 12th IIR Conference on Phase-change Materials and Slurries for Refrigeration and Air Conditioning (PCM2018) moves to Quebec (Canada) on May 21-23, 2018 and will bring together scientists, researchers and key stakeholders from industry to exchange on the latest developments in the field. Call for abstracts open.

New! The 13th IIR-Gustav Lorentzen Conference on Natural Refrigerants (GL2018), to take place on June 18-20, 2018 in Valencia (Spain), invites experts to address critical issues on the future of the phase down of HCFCs and to present and discuss their research on the quest for new and more sustainable solutions with natural fluids. Call for abstracts ends July 17.

Discounts on IIR conference registration fees

IIR Members receive a discount on IIR conference registration fees of up to a one-year IIR private membership from a paid-up Member Country.

IIR co-sponsored conferences

Focused on the retrofit of historical buildings in the Mediterranean region, Climmed 2017 - Mediterranean Congress of Climatisation will re-ignite key stakeholders on May 12-13, 2017, in Matera (Italy). There’s still time to register.


The 8th International Conference on Compressors and Refrigeration (ICCR) (ICCR) will take place in Xi’an (China) on July 20-22, 2017. Registration open.

A quarter of a century later, the international Sorption Heat Pump Conference 2017 (SHP2017) will again be held in Tokyo (Japan) on August 07-10, 2017. Registration open.

The 10th International Conference on Compressors and their Systems to take place on September 11-13, 2017, in London (United Kingdom), will include a full day dedicated exclusively to topics of high importance to industry. Registration open. Please consult our Conference Calendar on the last page for details on upcoming IIR events.

European projects

SuperSmart offers free trainings

Under the SuperSmart EU project, food retailers and suppliers of HVAC&R system solutions are eligible for dedicated training sessions on selected aspects or comprehensive overviews on how to build new energy efficient food retail stores or refurbish existing ones. These trainings are free of charge and are provided by the SuperSmart team members.

If you want to join a dedicated training session or organise a training session with the SuperSmart team, please contact us: www.supersmart-supermarket.info/training-interest

Call for industrial partners to finance joint industry cryogenics project linked to LNG production

The objective of this Joint Industry Project (JIP) of MINES ParisTech - ARMINES on the “Evaluation of the crystallization risk in LNG production” is to combine experimental and modelling activities, and to obtain a precise model to identify the limits of the solubility of impurities in natural gas at low temperatures in order to allow an optimized process design. The IIR will act as a key contributor, in charge to promote and disseminate the research outcomes through its worldwide network, activities and services. The JIP is scheduled to begin in January 2018 for an expiration in three years. For information on how to become a partner of this JIP, please read: http://bit.ly/IIJPartner

Or if you would like to receive the technical program, please contact Dr. Paolo Stringari (paolo.stringari@mines-paristech.fr)

IIR member news

Landmark district heating and cooling system

At the last ASHRAE winter meeting in Las Vegas, Andy Pearson, Director of Star Refrigeration (IIR corporate member) and involved in many IIR publications, received the Comfort Cooling Award for Project Excellence for leading the design of the world’s largest ammonia water source heat pump. Installed in Drammen, a Norwegian city of 64,000 people, this virtually zero carbon heat pump – which electricity consumed is supplied by hydropower – provides district heating and cooling by extracting warmth from the cold waters of a local river and boosting it up to 80°C for heating on a mass scale, thus providing 85% of the city’s demand. The system has been working uninterrupted for over five years and has delivered savings of EUR 10m and 75,000 tonnes of CO₂ emissions to date.

http://bit.ly/PearsonAward

The IIR is delighted to welcome the following members:

Corporate members:
CTCPA - Centre Technique de la Conservation des Produits Agricoles, France; Kaeser Kompressoren SE, Germany.

Private members:
Cristoforo Livio Calabrese, Italy; Young-Soo Chang, South Korea; Cecilia Gabrielli, Sweden; Joseph Grealy, Ireland; Fridolin Holderer, Switzerland; Robin Heinfled, USA; Young Ae Kang, South Korea; Jean Luc Lefebvre, France; Jacques Millerioux, France.

Junior members:
Marine Andrich, France; Sébastien Baudin, France; Petter Koseng, France; Arijanth Rachakonda, India; Nicoli Scalon Franceschi, Brazil; Anh Thao Thiue, France; Ganna Valiakina, Russia.

Markets and figures

World air conditioner market

According to JARN, the 2016 global air conditioner market saw a 5.5% year-on-year growth, increasing to 114 million units.
The Asian market remained attractive. The Southeast Asian market increased to 8.7 million units (+11.2%). India (5.1 million units, +21.2%) benefitted from a booming summer – Vietnam (2.0 million units, +14.7%) – where the average penetration in urban areas has exceeded 10% – and Philippines (1.8 million units, +21.9%). Europe had the highest growth rates. China (47.1 million units, +7.6%) and Japan (9.6 million units, +2.4%) also experienced growth. The Middle Eastern market reached 2.5 million units (-3.4%), while Saudi Arabia, the largest market in this region (1.7 million units), experienced a decrease of 5.4%. In America, the US market, pulled up by a hot summer and economy recovery, increased to 14.9 million units (+9.8%). The Latin American market decreased by 18.7% in 2016, mainly due to economic recession. Brazil, the largest Latin American market contracted 34.2%. The European market increased to 6.2 million units (+11.7%). Italy (1.1 million units, +16.5%), Germany (0.8 million units, +13.8%), Spain (0.6 million units, +9.8%), with respective penetration rates of 30%, 5% and 40%, experienced the highest growths in 2016. In Oceania, no big fluctuations were seen in the Australian market (0.9 million units, +2%). The African market surpassed 2.8 million units (+5.8%). The main markets are Nigeria, Egypt, South Africa and Algeria (+15.2%). JARN, January 25, 2017

According to Marketandsmands, the global natural refrigerants market is projected to reach USD 1,419 million by 2020 at a compound annual growth rate (CAGR) of 11.12% and 2020. Europe will be the largest market for natural refrigerants followed by Asia-Pacific. Ammonia accounted for 60% of the market share for natural refrigerants in 2014. http://bit.ly/NaturalRefrigantsMarket

Technavio analysts forecast the global refrigerated transportation market to grow to USD 19.6 billion by 2021 at a CAGR of more than 26% during the period 2017-2021, with almost 50% of the incremental growth originating from Asia. http://bit.ly/TechnavioRefriginatedRoad

According to Technavio, the global refrigerated warehousing market should grow at a CAGR of 14.3% during the period 2016-2020. http://bit.ly/TechnavioWarehousing

Refrigerant news

Kigali amendment on HFC phase-down: first steps

The Kigali amendment will enter into force on January 1, 2019, provided that it is ratified by at least 20 countries. The process is therefore under way:

Africa: On March 31, 2017, Malta became the first country to ratify the Kigali amendment: the West African country executed the instrument of ratification and deposited it with the UN Treaty Section in New York.

Oceania: On February 28, 2017, Marshall Islands became the second country to ratify the Amendment, starting the process of ratification. To formally complete the process, the instrument of ratification has to be deposited in New York.

European Union: For the European Union to ratify a treaty, the European Commission has to be informed, which is then followed by a decision by the Council of the European Union and the Parliament. On February 2, 2017, a first step to ratify the Kigali Amendment to the Montreal Protocol was taken, since the European Commission adopted a proposal for the Council to endorse the Kigali deal. The proposal is available on http://bit.ly/Kigali_Commission.

The list of countries that have ratified the amendment can be found here: http://bit.ly/1UN7Kigali.

Final results of the NIST study about HFC alternatives in AC

On February 17, 2017, the journal Nature Communications published the final results of the multiyear study conducted by the American National Institute of Standards and Technology (NIST) about HFC alternatives to R410A in air conditioning systems. The database PubChem was methodically screened and according to the authors of this study, the most promising choices are the combination “of chemical, environmental, thermodynamic and safety properties necessary for a refrigerant and […] these fluids are at least slightly flammable.”

The document is available in Fridoc: http://bit.ly/FridocNist2017

Cold chain news

One-third of all food produced is lost or wasted along the food chain

In its 2017 report The future of food and agriculture - the 2017 state of the world agriculture and food system, the FAO stresses that despite undeniable progress in reducing rates of undernourishment and improving levels of nutrition and health, almost 800 million people are chronically hungry and 2 billion suffer micronutrient deficiencies. Under a ‘business-as-usual’ scenario, without additional efforts to promote pro-poor development and improve food systems, some 653 million people will still be undernourished in 2030. According to FAO, every year, about 670 million tons of food is lost or wasted in high-income countries. 100 million tons in low- and middle-income countries – a total of 1.3 billion tons, or one-third of the edible part of food originally intended for human consumption in low-income countries, significant levels of food losses occur upstream, at harvest and during post-harvest handling, owing to poor infrastructure, low levels of technology, a limited knowledge base and lack of investment in production. The extent of losses and waste along the food supply chain differs across regions. In North America, Europe, Japan and China, around 15% of food is lost or wasted in the distribution and consumption stages. This percentage is lower in North Africa and Central Asia (11%) and much lower in Latin America, South and Southeast Asia and sub-Saharan Africa (5.9 to 7.8%). In contrast, North America, Europe, Japan and China lose or waste only around 15% of food in the harvest and post-harvest stages. In sub-Saharan Africa, some 653 million tons of food losses and waste are particularly high at 36%, more than 30% occurs in the harvest, post-harvest and processing stages. In this regard, the Informative Note “The role of refrigeration in worldwide nutrition” the IIR had determined that refrigeration can make a significant contribution to addressing the issue of undernourishment, especially in the least developed countries. The setting up of cold chains for perishable foodstuffs that are as extensive and reliable as those in industrialized countries would greatly enable countries to raise food supply by about 15%. To consult it: http://bit.ly/5thIIRNote

Food losses and waste are also an increasingly concerning environmental issue. According to FAO, most food losses and waste are the result of energy consumption for refrigeration. Food losses and waste generate every year more than 3.3 gigatons of CO2, equivalent, equal to the combined annual CO2 emissions of Japan and the Russian Federation. http://www.fao.org/publications/ftora/en/

China cold chain figures

Over 1 billion of perishable food is consumed in China every year. Of this over 50% needs to be transported. But China is a cold chain laggard, according to JARN. However, the integrated cold chain circulation rate now comes to only 19%, and agricultural goods are seeing a high rate of loss. The loss rate of fresh foods, which are particularly valuable reaches RMB 100 billion (USD 14.5 billion) every year. In 2015, the operational number of refrigerated car broke 90,000 units, showing 18.4% year-on-year increase. While substantial, this growth is still too low to address market demands. JARN, February 25, 2017

Cold connection

The Dominican Republic (DR) is one of the fastest growing economies in the Caribbean and one of the largest Central American markets for U.S. food and agricultural products. In 2016, the U.S. imports of agricultural products from DR totaled USD 413 million in 2015. Agriculture is the country’s second largest sector and has the potential to drive significant economic growth. Unfortunately, a high percentage of the country’s agricultural products are rejected due to food safety and quality concerns. The United States Department of Agriculture is currently working to strengthen the DR’s ability to export high quality and safe fruit and vegetable products through the Exporting Quality and Safety (EQS) project. The new program, which is funded by the U.S. Department of Agriculture Foreign Agriculture Service, provides technical assistance to increase the quality, productivity and sales of four key agricultural products: avocado, cocoa, pineapple, greenhouse vegetables (tomatoes, sweet peppers, cucumbers, and a wide range of exotic vegetables. One of the main cargo companies in the DR, Cool Connect Cargo, is working at the request of United Parcel Service (UPS), to open a receiving terminal for fresh produce in the city of Since November 2016, Cool Rail, a rail link between Spain and North West Europe, has been shipping fruits and vegetables in reefer trains on a weekly basis. Every week, 12 trains are transporting goods across the continent via Spain, with Cologne, Germany. The cargo is then loaded onto trucks and transported to distribution centres. Cool Rail trains reach Rotterdam with 40 containers per train. The goal is to eventually have the train riding five times a week. This new service to Rotterdam, promoters expect to further reduce CO2 emissions. The train to Cologne has been calculated to save 180.000 tonnes of CO2 emissions, which is equivalent to the annual fuel consumption of 7200 cars. Even though today the transport with Cool Rail trains hasn’t manage to reduce shipping times the containers must be reloaded when crossing the Spanish border because of a different rail width - in the long run, this new train connection will be quicker than road transport, thus allowing a higher supply of fresher and better quality products. http://bit.ly/FreshPlazaOranges

At the other end of the continent, KTZ Express, a division of Kazakhstan Railways, recently transported fruit and vegetables grown in Uzbekistan through a container train through Kazakhstan to Russia. The pilot train travelled from Samarkand (Uzbekistan) to Lokot (Russia) through the Kazakh cities of Almaty and Semei and reached its destination in five days. Bearing in mind that it takes 45 days to deliver goods by the sea in this area, this new service could not only reduce delivery time, but it could give strong impetus to the development of refrigerated transport, strengthen the economy, increase the transit capacity of Kazakhstan, as well as the volume of transit traffic from China to Europe via Kazakhstan. http://bit.ly/KazakhstanTrain

Reefers might redefine the refrigerated transport industry

Spain is a key fruit and vegetable supplier for supermarkets in North West Europe. However, the road transecting this route overly exposes perishable goods to heat waves, ripening, and rotten vegetables, tomatoes, cucumbers, peppers or lettuce, depending on the season. According to estimations, around 1.5 million lorry movements are needed every year.
of La Vega for a daily Miami-Santo Domingo-Miami air freight route. They plan on installing pristine-cooling units of 5,000 ft², of cold rooms, and refrigerated transport to the airport.


**Bundled**

- **Data centres electricity consumption expected to soar by 2030** In their study on the global electricity usage of communication technology, Swedish researchers have estimated the evolution of electricity consumption of data centres until 2030. Data Centres are expected to improve their electricity intensity. This seems, however, not enough to cope with about 25% annual growth rate, given the IP Traffic. According to the authors, data centres will use around 3-13% of global electricity in 2030 compared with 1% in 2010. In the intermediate scenario, due to growing cooling requirements, they expect to consume 2,967 TWh in 2030, representing 7.5% of the estimated global electricity consumption. Since, according to the IIR*, cooling of data centre environment represents about 50% of this consumption, it could account for almost 4% of the global electricity consumption by 2030. http://bit.ly/Challenges2015-6

- **Solar cooling implemented in Jordan** Under the umbrella of the Projads program funded by the German international cooperation agency (GIZ) to introduce solar cooling technology to Jordan and the region, four sites in Jordan are now equipped with air absorption chillers: the German Jordanian University and the Royal Cultural Centre in Amman, Petra Guest House and Irib Chamber of Commerce. The Jordan Minister of Environment Yaseen Khayyat stressed that these “state-of-the-art systems” will not only reduce power costs but also encourage the use of renewable energy resources, but will also serve as a reference for researchers and experts in the field, as it is the first of its kind to be implemented among developing countries”. Ministry officials underscored that solar thermal energy is not only a great option for grid-connected systems but also a viable option for net metering solutions for the Kingdom, especially since 98% of its energy demand is imported at high costs. Jordan, which has 330 days of sunshine per year, has one of the highest annual daily averages of solar irradiance in the world, according to official figures.


- **US: LNG exports expected to drive growth in natural gas trade** The United States is expected to become a net exporter of natural gas on an average annual basis by 2018, according to a February 2017 US Energy Information Administration study. By 2030, the US is expected to become a net exporter of total energy in the 2020s, mainly because of increasing natural gas exports. In the Reference case, natural gas production is expected to grow through 2030 at about the same rate (3.6% annual average) as it has since 2005, when production of natural gas from shale formations began to accelerate. As a result, the US is expected to drive the production of liquefied natural gas, and according to the chief executive officers of Canadian energy giant Enbridge Inc. and LNG exporter Tellurian Inc. http://bit.ly/EIA2Feb2017

http://bit.ly/AmericaLGasupplier

- **World’s first rotating skyscraper unveiled in Dubai** It is in the head of David Fisher, architect at Dynamic Architecture, that this futuristic and totally hallucinating architectural project was born: an 80-story, 420-m tower with floors that can rotate 360 degrees in both directions. This “dancing tower” will continuously change shape thanks to a voice-activated technology allowing residents to spin their apartments just by speaking, and up to 79 wind turbines placed horizontally between the floors and solar panels on the roof that produce the tower’s energy. The surplus energy acquired from the turbines and solar panels is expected produce enough electricity to power five other similarly sized buildings nearby. A special elevator built inside the central concrete core will let residents transport their car to the ground floor right next to their apartment. The tower’s floors will be prefabricated units, made of steel, aluminium and carbon fibre materials. Dynamic Architecture hopes the skyscraper - dubbed the Dynamic Tower - will be gracing Dubai’s skyline by 2020. It will be one of Dubai’s tallest buildings and each apartment unit will range from USD 4 million to USD 40 million.


**The world’s first rotating skyscraper unveiled in Dubai**

- **Solar cooling implemented in Jordan**
- **Out of the ordinary**

- **Supermarkets**

- **Chile’s first CO2 system for retail application** Implemented by the Chile Ministry of Environment, funded by the Climate and Clean Air Coalition (CCAC) and supported by the United Nations Development Programme (UNDP), Chile’s first transcritical CO2 supermarket refrigeration system has been installed in a new 5,300 m² store located in Valdivia. This transcritical system produces 400 kW of cooling capacity and uses 100 kW (MT) and 100 kW at low temperature (LT) and serves 115 MT/LT display cabinets and 30 cold rooms in addition, the system has implemented efficiency applications such as LED lighting and BMS systems for the intelligent control of all building systems. http://bit.ly/ChileCO2Plant

- **A transcritical CO2 system efficient in hot countries** The Retail trade fair EuroShop 2017 took place in Düsseldorf (Germany) in early March. A transcritical CO2 refrigeration system was presented: entitled “Full Transcritical Efficiency” (FTE), it was launched by Epta Francesco Mastrapasqua, Refrigeration Systems Marketing Manager in the group, describing a transcritical CO2 system that has to be added to a traditional transcritical CO2 system, (global since the system is supposed to be efficient in any climate), industrialized (the system is produced on a large scale) and reliable. Two years of tests have been conducted by Epta in Italy and Australia. In Italy, the machine outside the building was located in the summer was 36 °C. In Australia, the outside temperature reached 47 °C. According to Epta, this system is the unique option that reduces countries since the tests showed an annual efficiency gain of around 10% compared with traditional CO2 systems in Italy and Australia.

- **Retrofit from R404A to R449A** The existing R404A supermarket refrigeration system in a Waitrose supermarket located in Holsworthy (UK) has been retrofitted with R449A refrigerant (HFC/HFO blend of R32, R125, R134a and R1234yf), R449A has a rather high GWP (1397) but significantly lower ODP (0.0) and has PAG (phosphatehyrhosphorym, which investigates blood pulsation) when thermal conditions change from a level that is very uncomfortable to a comfortable temperature range, with full load in the cooling and heating modes in a car cabin. The experience was performed in a thermal environment created specifically for healthy men using a car driving simulator. The outside temperatures were simulated between -20 °C and 60 °C. The results showed that the vent exit temperature has a major influence on thermal comfort and concentration of the driver. In winter conditions, the vent exit temperature to reduce drivers’ stress was measured at 40 °C (which maintains the cabin at 22.5 °C). In summer conditions, with a vent exit temperature of 30 °C (ambient cabin temperature at 27.5 °C), the activity of the autonomic nervous system is increased and the driver’s stress decreases.

http://dx.doi.org/10.1016/j.applthermaleng.2016.10.193*

**Technologies**

- **Performance comparison of R1234yf and R134a** In a recent study*, S. Daviran et al have simulated an automotive air conditioning system and compared the performance of HFC-134a and HFO-1234yf as drop-in alternatives to HFC-134a. The simulated air conditioning system consists of a multi-louvered fin and flat-plate type evaporator, a wobble-plate type compressor, a micro-channel parallel-flow type condenser and a thermostatic expansion valve. Two different conditions have been considered in this program for the cycle analysis: for the first state, the refrigerating capacity is taken as constant, and for the second state the refrigerant mass flow rate is considered fixed. The refrigerant-side thermodynamics of system including COP and cooling capacity have been studied with changing different parameters. The results show that the refrigerant-side overall heat transfer coefficient of HFO-1234yf is 18-21% lower than that of HFC-134a, and the pressure drop is 24% and 20% smaller than HFC-134a during condensing and evaporating processes, respectively. Also, at constant cooling capacity, the COP of HFO-1234yf is lower than that of HFC-134a by 1.3-5%, and at constant pressure drop, the COP of HFO-1234yf is about 18% higher than that of HFC-134a.


- **Impact of automotive HVAC systems on drivers’ attention and comfort** A Korean expert Dr. Junchun Shin et al focuses on the thermal comfort provided by automotive HVAC systems in cooling or heating modes.

The authors focus on the notion of homeostasis, which is the ability of a system to maintain internal stability even when it is confronted to external changes. A typical example of homeostasis is human body temperature regulation. The authors assume that humans try to control their physiological reactions to maintain homeostasis when they are exposed to the outside environment, and that it is more difficult in extreme environment, such as cold or hot temperatures, due to the system’s impact on concentration. HVAC systems are supposed to provide a comfortable environment and help humans adapt easily and thus better concentrate. This assumption was tested by measuring people’s thermal comfort thanks to EEG (electroencephalography, which detects changes in brain functioning) and PPG (photoplethysmography, which investigates blood pulsation) when thermal conditions change from a level that is very uncomfortable to a comfortable temperature range, with full load in the cooling and heating modes in a car cabin. The experience was performed in a thermal environment created specifically for healthy men using a car driving simulator. The outside temperatures were simulated between -20 °C and 60 °C. The results showed that the vent exit temperature has a major influence on thermal comfort and concentration of the driver. In winter conditions, the vent exit temperature to reduce drivers’ stress was measured at 40 °C (which maintains the cabin at 22.5 °C). In summer conditions, with a vent exit temperature of 30 °C (ambient cabin temperature at 27.5 °C), the activity of the autonomic nervous system is increased and the driver’s stress decreases.


**Automotive**

- **Supermarkets**

- **Chile’s first CO2 system for retail application**

- **Retrofit from R404A to R449A**

- **The world’s first rotating skyscraper unveiled in Dubai**

- **Data centres electricity consumption expected to soar by 2030**

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Frozen food

Comparison of the nutritional values of fresh and frozen fruits and vegetables

Prior studies showed that fresh fruits or vegetables are frequently picked before peak ripeness and their nutrient qualities are affected during harvest/handling as opposed to period of storage and transportation at temperatures above freezing. Storage, packaging and production techniques were therefore improved over time. Nevertheless, the degradation continues at the customers’ home, when modified atmosphere packages are opened, for example. Freezing fruits and vegetables could be a solution to this problem. But recent studies show that public opinion still associate freezing with diminishing nutritional qualities. A team of researchers from the University of Georgia, USA, recently published in the Journal of Agricultural and Food Chemistry a study comparing nutritional values between frozen, fresh and fresh-stored fruits and vegetables, considering the period between purchase and consumption. The authors assumed that “the nutritional quality of fresh produce specifically after a period of refrigerated storage has not received proper investigation.”

Broccoli, cauliflower, corn, green beans, green peas, spinach, blue berries and strawberries were studied, over the span of three and seven months, depending on the season, for example from summer to fall. The products were purchased in different supermarkets around Athens (Georgia) to account for variables such as growing conditions or retail chain management. The results examined were l-ascorbic acid contents (vitamin C), trans-β-carotene content (provitamin A), and total folate concentration. There were no significant differences in the levels of these nutrients between fresh, fresh-stored and frozen food right after purchasing. But after five days of refrigerated storage, significant differences were observed: refrigerated storage showed a negative association with nutrient concentration. Frozen produce samples had higher nutrient contents than the fresh-stored produce, which was frequently the inverse. It suggests that the time a consumer stores their fresh products prior to consumption is an important factor in determining comparative nutritional quality. A common belief of consumers that fresh food has significantly greater nutritional value than its frozen counterpart is then refuted.

The study is available on Frozen Food Facts website: http://bit.ly/frozenvegetables

Dehydrofreezing of apples

Freezing foodstuffs preserves the taste and nutrients with characteristics similar to those of fresh products. But it often results in a soft texture and lack of retention of finished products after baking - especially in the case of fruits and vegetables, due to the process.a

R & D

A Norwegian project: Snow for the future

In Norway, skiing is not only a sport, it is a long-term work. And the industry is hoping the results will boost ski business in the future. Sawdust is currently used but it is not efficient enough in a few years because it does not be efficient enough in a few years because of the global warming: if temperatures are above freezing, this traditional system will no longer work.

The SINTEF and NTNU project, entitled Snow for the future, relies on heat pumps. The cold side of the heat pump would be used to produce snow, while the hot side would be useful to heat indoor facilities nearby the slopes at a very low cost, according to Petter Nekså, chief scientist in SINTEF. This “virtually cost-free” approach is the key to reversing the decline in snowfall and the heat pump technology. The researchers will also have to develop new ways of storing artificial snow. Sawdust is currently used but it is not efficient enough over time.

The Norwegian Ski Federation also collaborates on the project, hoping the results will boost ski sports. http://bit.ly/snowforthefuture

Impact of air conditioning velocity airflow on human sleep

The Energy and Buildings journal published an article1 studying the effects of varying air conditioning airflow on human sleep and thermoregulation.

The hypothesis was that a higher air velocity of airflow disturbed human sleep more than a lower one. The experimentation was carried out on ten healthy young men as subjects. Two rooms were prepared: one as usual, the other as a high velocity air flow. A group of subjects were studied in the rooms at each of two high air velocities. The results showed that there was no big difference in the total amount of time during each sleep stage between the two groups. The comfort sensation did not differ significantly either. Nevertheless, the first group felt more of the airflow than the second group. A further analysis was then conducted, and physiological responses to the airflow were measured, such as body movements or heartbeat. With a higher velocity airflow, sleep stages were affected, sometimes to the stage of wakefulness. The researchers then concluded that a higher velocity airflow has a negative influence on sleep.

The bibliographical note of the article is available in Fridoc: http://bit.ly/FridocACsleep


Always closer to absolute zero

The rules of physics say it’s impossible to cool an object to absolute zero, to remove all thermal energy until its atoms come to a standstill. But in a paper recently published in the journal Nature2, researchers at the National Institute of Standards and Technology (NIST) in the USA claim their new technique finally makes it possible to cool stuff colder than previously thought possible.

Scientists have been cooling atoms with lasers for several decades, but there was a limit to how cold could be - according to the laws of quantum mechanics. They had a hunch that colder was possible, if they could eliminate the “kicks” from the particles of light. To do this, they “squeezed” their lasers, using a special kind of superconducting circuit to produce a light beam in which the quanta were forced to follow one another in orderly fashion. This didn’t eliminate all of the “kicks” from the lasers, but it got rid of a lot. When the scientists tried again to cool their drum with squeezed light, they got it so that the drum was one-fifth the magnitude of quantum motion.

Now that it’s proven to work, Teufel says the technology can be refined to get objects even colder. It opens the door to building instruments of unprecedented sensitivity - for example for measuring the deformations induced by the passage of gravity waves. Not only that, but also for understanding quantum mechanics - one of physics’s most mysterious branches - better than ever before.


Briefs

Medical: A scalp cooling device could prevent alopecia caused by chemotherapy in breast cancer treatment

Two studies were presented at a meeting in February 2017 in the American Journal of the American Medical Association (JAMA). They both deal with the hypothesis that using a scalp cooling device could prevent hair loss during chemotherapy for breast cancer. These studies were conducted between 2013 and 2016 and concerned respectively 182 and 59 patients.

In the first study1, scalp cooling began 30 minutes before each chemotherapy infusion and lasted 90 minutes after it. Hair preservation was assessed, at the end of the chemotherapy. The results show that women who underwent scalp cooling were significantly more likely to have less than 50% hair loss compared with no hair loss. In the second study2, the researchers tried to evaluate whether use of a scalp cooling system could reduce the rate of alopecia and hair loss among women receiving specific chemotherapy regimens for early-stage breast cancer and to assess related changes in quality of life. Scalp cooling was initiated 30 minutes prior to each chemotherapy cycle, with scalp temperature maintained at 3 °C throughout chemotherapy and for 90 minutes to 125 minutes afterwards, in an at least 50% of patients.
less was seen in 66% of patients evaluable for alopecia in the scalp cooling group, versus 0% of patients in the control group. Three of five quality-of-life measures were significantly better one month after the end of chemotherapy in the scalp cooling group.1 (Nangia, Julie et al. “Association between use of a scalp cooling device and alopecia after chemotherapy for breast cancer.” JAMA volume 317, number 6 (2017): 606-614. DOI: 10.1001/jama.2016.20939) (2) (Hope, S. Rugo et al. “Recent advances in non-halogenated and low-GWP refrigerants.” This amended directive extends the world’s first regulation to require environmental-conscious product design during the entire life cycle from acquiring raw materials to product disposal. It has been adopted by the regions surrounding the EU. Concerning developing countries, CSFP adoption has accelerated in Asian countries. In Hong Kong, Taiwan, Vietnam, the Philippines, Malaysia, and India, there has either been a shift from energy efficiency ratio (EER) to CSPF or a commitment to shift. In Japan, SEER was adopted for inverter performance. Japan adopted the annual performance factor (APF); the United States, the seasonal energy efficiency ratio (SEER); and straight cooling regions, such as Southeast Asia, the cooling seasonal performance factor (CSFP), respectively. In the European Union, the Ecodesign Directive is the world’s first regulation that requires environmental-conscious product design during the entire life cycle from acquiring raw materials to product disposal. It has been adopted by the regions surrounding the EU. Concerning developing countries, CSFP adoption has accelerated in Asian countries. In Hong Kong, Taiwan, Vietnam, the Philippines, Malaysia, and India, there has either been a shift from energy efficiency ratio (EER) to CSPF or a commitment to shift. In Thailand, SEER was adopted for inverter units. In Latin America, Brazil made minimum energy performance standards (MEPS) mandatory in 2008 and was soon followed by Argentina, Chile and Mexico, and by Uruguay and Colombia in 2016. In Africa, Kenya announced energy-labeling regulations in November 2016 (mandatory in May 2017). JARN, February 25, 2017)

In Rabat, Morocco, a gigantic cultural project began in 2010 in the Bouregreg valley. Four facades are being constructed and should open in 2018. Among them, the futuristic Grand Théâtre de Rabat, designed by Zaha Hadid, will accommodate 1800 spectators. Technical work packages are currently being installed. The HVAC system, provided by Climaveneta, will be equipped with two multi-stage heat pumps and one air cooled chiller using R410A. According to Climaveneta, the system could produce simultaneous cooling and heating. The system has a total cooling capacity of 2,500 kW.


IIr conferences

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IIr-co-sponsored conferences

Matera - Italy - May 12-13
Climemed 2017 Conference “Historical buildings retrofit in the Mediterranean area” info@climemed17.eu www.climemed17.eu Commissions E1 and E2
Rotterdam - Netherlands - May, 15-18
12th IEA Heat Pump Conference heatpumps@cgim globe.eu www.hpc2017.org Commission E2
Xian - China - July, 20-22
8th International Conference on Compressors and Refrigeration http://www.iccr-xian.org
Commissions B1, B2 and A2, E1, E2
Tokyo - Japan - October, 7-10
Commissions B1, B2, E1, E2
London - UK - September, 11-13
10th International Conference on Compressors and their Systems 2017 compressed@icely.co.uk www.city.ac.uk/compressors-conference
Commissions B1, B2

IIr-co-sponsored conferences

West Lafayette, Indiana - USA - July, 9-12
24th International Compressor Engineering Conference at Purdue
17th International Refrigeration and Air Conditioning Conference at Purdue
5th International High-Performance & Green Buildings Conference at Purdue

On March 30, 2017, the Australian government introduced an amendment to the existing Ozone Protection and Synthetic Greenhouse Gas Management (OPSGGM) Act. It will allow Australia to start phasing down HFC imports from 2018 to achieve its Kigali target of an 85% reduction by 2036. No HFCs are manufactured in Australia itself. Australia’s HFC phase-down plan, which will enter into force on January 1, 2018, aims to streamline licensing and reporting requirements for HFC imports, as well as the administration of existing legislation. http://bit.ly/AustraliaOzoneProtection

Singapore plans to implement a carbon tax from 2019, making it the first Southeast Asian economy to introduce such a mandatory carbon pricing scheme. While the exact tax level and implementation schedule remain to be hammered out following industry and public consultations, the government is considering a carbon tax between SGD 10 (EUR 6.6) and SGD 20 (EUR 13.2) per tonne of greenhouse gas (GHH) emissions. Six GHGs, including HFCs, will be covered. This plan, which is projected to be implemented from 2019, will apply to power stations and other large emitters producing over 25,000 tons of CO2 equivalent per year. http://bit.ly/SingaporeCarbonTax

International Institute of Refrigeration International Institute of Refrigeration 177, bd Maleaserbes - 75017 Paris, France Tel.: 33 (0)1 42 27 32 39 - Fax: 33 (0)1 47 63 17 98 E-mail: ifir@ifir.org Web site: www.ifir.org The Newsletter of the IIR is a quarterly publication of the IIR Managing Editor: Didier Coulomb Edition: Jean-Luc Dupeau Editorial assistants: Deonie Lambert, Sylviane Fournier, Aurélie Durand, Nolwen Robert-Jourdain Graphic Design: EdiConseil

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