Current environmental issues require a substantial reduction in the role fossil energies play in the worldwide energy mix despite the significantly growing need in emerging and developing countries. Nevertheless, in view of the various scenarios drawn up by public institutions such as the International Energy Agency and private companies involved in the field, natural gas should keep its primary position, in proportion to used energies and the demand should continue to grow (+1.8% per year according to BP Energy Outlook). As a matter of fact, gas produces fewer greenhouse gas emissions than oil, let alone coal. Within the gas field itself, the share of liquified natural gas (LNG) should continue to grow significantly, moving from 10% to roughly 15% of the total within 20 years. As such, despite the current energy crisis, a large number of projects related to gas liquefaction continue to be developed and technologies to evolve quickly in order to satisfy anticipated demands.

The IIR has been involved in this area, mainly by organizing a conference on LNG every three years, co-organized with the IGU (International Gas Union) and the GTI (Gas Technology Institute). This conference, featuring an exhibition where all major worldwide companies from the energy sector are represented, brings together thousands of attendees. The latest conference took place in Perth, Australia, in April 2016. The next edition will be held in Shanghai, China, in 2019 and the following session is scheduled to be programmed six years after, in Saint-Petersbourg, Russia, in 2023. The fact that these conferences are planned six years in advance, as well as the fierce competition between the countries eager to host these conferences, underline the importance of such events.

Should you be interested in these worldwide energy-oriented issues, in the new usage of LNG and in cryogenic techniques, save the date: April 1-5, 2019!

Didier Coulomb
Director General of the IIR

Les enjeux environnementaux imposent de réduire fortement la place des énergies fossiles dans le mix énergétique mondial malgré la croissance considérable des besoins dans les pays émergents et en développement.

Toutefois, selon les différents scénarios établis tant par des organismes publics tels que l’Agence Internationale de l’Energie que par des analyses privées de la section, le gaz naturel devrait maintenir sa place de premier plan, en proportion des énergies utilisées et la demande devrait continuer à croître (+1,8% par an selon BP Energy Outlook) : en effet, le gaz produit moins d’effet de serre que le pétrole et à fortiori le charbon. Et au sein même du gaz, la part du gaz naturel liquéfié (GNL) devrait continuer à croître fortement, en passant en vingt ans de 10 % à environ 15 % du total. Ainsi, malgré la crise énergétique actuelle, de nombreux projets de liquéfaction de gaz continuent à voir le jour et les technologies continuent à évoluer rapidement pour faire face aux demandes prévisibles.

L’IIF est actif dans ce domaine, principalement à travers l’organisation tous les trois ans d’une conférence sur le GNL, co-organisée avec l’Union Internationale du Gaz (IGU) et le Gas Technology Institute. Cette conférence, combinée à une exposition où toutes les grandes compagnies mondiales du secteur énergétique sont présentes, rassemble des milliers de personnes.

La dernière a eu lieu à Perth (Australie) en avril 2016. La prochaine aura lieu à Shanghai (Chine) en 2019 et la suivante à Saint-Pétersbourg (Russie) en 2023. Le fait de programmer ces conférences six ans à l’avance, ainsi que la rude compétition entre les pays souhaitant accueillir ces conférences, soulignent la portée de ces événements.

Si vous êtes intéressé(e) par ces enjeux énergétiques mondiaux, par les nouvelles utilisations faites du gaz naturel liquéfié et les techniques cryogéniques, retenez l’heure et déjà la date : 1-5 avril 2019 !

Didier Coulomb
Directeur Général de l’IIF

Fridoc, the most comprehensive refrigeration database in the world, has passed a symbolic milestone: it now comprises over 100,000 documents selected from scientific and technical publications from across the globe, in all refrigeration spheres, from cryogenics to air conditioning including refrigerating equipment, refrigerators, the food cold chain and heat pumps. Fridoc contains documents written in 36 languages by over 80,000 authors from 93 countries. Each bibliographical note comprises the full bibliographical references of the document, keywords, the fields covered, and in most cases an abstract. Many of the documents referenced in Fridoc can be directly downloaded following secured online payment. Don’t forget to login or register first! IIR members benefit from quotas of free downloads: up to 60 per year for private members and up to 1,000 per year for corporate members.

IIR members can also receive regular daily or weekly e-mail alerts informing them of the new references added to Fridoc. Moreover, IIR members can customize e-mail alerts according to their fields of interest.

Access to the papers from the latest IIR conferences!

The Fridoc database gives you access to all the articles from the International Journal of Refrigeration.

You can also access all the papers from IIR conferences, congresses and IIR co-sponsored conferences shortly after the event has taken place. Papers from recent IIR events can already be downloaded via the links below.

- 4th IIR International Conference on Sustainability and the Cold Chain in Auckland (New Zealand) on April 7-9, 2016 (64 papers): http://goo.gl/F1CZ9o
- 11th IIR Conference on Phase-Change Materials and Slurries for Refrigeration and Air Conditioning in Karlsruhe (Germany) on May 18-20, 2016 (32 papers): http://goo.gl/BJF0Yz
- 1th International IIR Conference on Cryogenics and Refrigeration Technology in Beijing (China) on June 22-25, 2016 (33 papers): http://goo.gl/TWzZsf
- 8th Ibero-American Congress of Refrigeration, Science and Technology (CYTEF2016) in Coimbra (Portugal), May 3-6 (133 papers): http://goo.gl/vHStiv

Publish your PhD thesis in Fridoc!

The IIR offers a new service to referencing and making available in open access the Fridoc database all PhD theses dedicated to refrigeration.

Now, publication of dissertations in the Fridoc database can be initiated by the author or their supervisor, provided one of them is an IIR member.

Dissertations presented for a Master’s or a Bachelor’s degree may be included also, provided the content is of broad interest and high quality.

The submittal package includes a one-page document containing the author’s name and contact information, the title of the dissertation, the name of the educational institution which granted the degree, the dissertation in PDF format, and a signed agreement by the author for inclusion of the dissertation in Fridoc.

The agreement indicates no copyright conflict. This submittal package should be sent to the IIR Scientific and Technical Information Department (STID) by e-mail: info@iiriir.org

Indexing IIR conference papers

In the near future, we expect to strengthen the visibility of Fridoc and papers from IIR conferences and congresses by implementing the indexation of these papers in renowned scientific databases such as Scopus and Web of Science.

All papers from IIR conferences and congresses will be searchable via these databases and a permanent link (DOI) will direct readers to the Fridoc web page where the paper can be downloaded.

Fridoc is evolving. So try it once and you will adopt it for sure!
Past events

- The IIR International Cold Chain Conference (ICCC2016) took place on April 7-9 in Auckland, New Zealand. 64 papers on the preservation of food products and on technologies for equipment that allow the cold chain to be maintained were presented. A workshop of the IIR Working Group “FRISBEE International” was also organized, as well as a keynote “Women in the Cold Chain Industry” linked with another IIR Working Group “Careers in Refrigeration”. This conference was linked with a national conference organized by IRHACE and the IIR New Zealand National Committee also met on that occasion.

- The LNG18 conference co-organised by the IIR with the International Gas Union and the Gas Technology Institute on Liquefied Natural Gas took place in Perth, Australia, on April 11-15. Thousands of visitors came for the conference and exhibitions, despite of the current crisis among energy providers, since LNG is clearly an energy for the future. The next one will take place in Shanghai, in April 2019. The series of conferences decided to organise the LNG conference in Saint Petersburgh, Russia, in 2022.

- The 2016 meeting of IIR Sub-Commission D2 CERTE on Test Stations (Refrigerated Transport), chaired by Eric Devín, took place in Prague, Czech Republic, on April 13-14, 2016. Discussions focused on harmonised common requirements for test stations from countries which signed the international ATP agreement on transport of perishable food, in particular test procedures resulting in the use new low-GWP refrigerants such as R452A.

- Gathering nearly 200 individuals, the 8th Ibero-American Congress and the 3rd Ibero-American Congress of Refrigeration Sciences and Technologies (CYTEF2016) took place on May 3-6, 2016, in Coimbra, Portugal. 133 papers were presented.

- The 11th Phase-Change Materials and Slurries for Refrigeration and Air Conditioning (PCM 2016) conference took place on May 18-20, 2016, in Karlsruhe, Germany. 31 high quality articles were presented in the presence of 73 attendees coming from 17 countries worldwide. During the gala dinner, the participants sung in perfect harmony the emblematic PCM song. Please check the lyrics and sing with us: http://www. iir.org.uk/userfiles/events/PCM_Song.pdf

- In the framework of the CLIMA2016 conference in Asborg, Denmark, on May 22-25, the IIR and EURAC organised a workshop with the aim of presenting and discussing tools and solutions for an effective energy-retrofit of the IIR conference held from May 26-29, 2016, in Berlin. Discussions addressed the topics of cycle analysis, thermophysical property data analysis, and heat pump systems with new refrigerants. Call for abstracts closes July 22, 2016.

Upcoming events

IIR events

- On August 21-24, 2016, the 12th IIR General Lorentzen Conference on Natural Refrigerants (GL2016) will take place at the conference centre of Heriot-Watt University (UK) coincidently during the Edinburgh International Festival. There’s still time to register. Participate in the scheduled IIR Commission and Working Group meetings: Monday 22nd: 14:00 (Commissions B1 and B2, E1 and E2, D7), Tuesday 23rd: 16:00-18:00 (IIR Careers in Refrigeration Working Group), Tuesday 23rd: 17:00-18:00 (IIR LCCP Working Group).

- The 2nd IIR Workshop on Cold Applications in Life Sciences in Dresden, Germany, on September 7-9, 2016, will provide an interdisciplinary scientific platform for discussion and exchange of experiences between R&D-institutes and industry on cell and tissue cryopreservation and storage challenges, as well as the freezing and storage of active agents for in-vitro and in-vivo applications. Register today.

- The 7th International Conference on Magnetic Refrigeration at Room Temperature (Thermag VII) to be held in Turin, Italy, is the ideal environment for the presentation of the latest developments in the field of new magnetic refrigeration technologies and novel cooling techniques such as electrocaloric and elastocaloric refrigeration. The conference will offer an exciting technical program, with invited and contributed oral presentations as well as a number of poster sessions. Register today.

- The ELIGIT consortium will hold at the same occasion the 3rd and final workshop of the EU funded ELIGIT project. The workshop will take place on Wednesday September 14 (13:30-15:30), and it is open to all THERMAG VII conference attendees. If you are interested to attend this last meeting, please register: http://elicit-project.eu/elicit-at-thermagvii.

- The IIR Working Group on Cold Chain in Warm Countries and the IIR Sub-Commission on Test Stations (Refrigerated Transport) will organize on October 25, 2016, in Tunis, Tunisia, a meeting on refrigerated transport in warm countries and under controlled temperature in hot climate countries.

- With the key theme “Low Carbon and Green Growth”, the 5th IIR International Conference on Thermophysical Properties of Refrigerants (TPTPR), on April 23-28, 2017, in Seoul, South Korea, will bring together academic and industrial experts to discuss and exchange in the areas of cycle analysis, theoretical and experimental techniques, thermophysical property data analysis, and heat pump systems with new refrigerants. Call for abstracts closes July 22, 2016.

European projects

- As a project partner, the IIR participated to the kick-off meeting of the SuperSMART project on the occasion of the 7th annual conference ATMOsphere Europe 2016 held in Barcelona, Spain, on April 19-20. During this event was launched the SuperSMART first public workshop on April 18 which was well promoted. The consortium demonstrated representative participants how to fill in the online survey on non-technological barriers for efficient heating & cooling in European food retail stores. Please feel free to fill in the online survey, available in 6 languages: http://www.surveymoz. com/3182010299/European-Ecolabel-for-the-Product-Group-Food-Retail-Stores.

- SuperSMART aims to achieve both decisive environmental benefits through a fast implementation of efficient heating and cooling solutions, as well as significant economic benefits through reduced energy use in the supermarket sector all across Europe. The SuperSMART consortium will hold the second workshop at the GL2016 conference (Edinburgh, UK) on Sunday August 21 (15:00-18:00). For more information please check the GL2016 website: http://www.ior.org.uk/GL2016

- EU CryoHub project: Inviting cold chain companies to become ‘CryoHub Champions’ The European CryoHub innovation project (www.cryohub.eu), in which the IIR is involved, investigates and extends the potential of large-scale Cryogenic Energy Storage (CES) and applies the stored energy for both cooling and power generation. By employing Renewable Energy Sources (RES) to liquefy and store cryogens, CryoHub balances the power grid, while the meeting the cooling demand of a refrigerated food warehouse and recovering the waste heat from its equipment and components. The CryoHub project consortium is pleased to invite you to become part of one of the most fascinating innovation actions in the food retail sector. Join us and apply for the status of a 'CryoHub Champion' company by completing the 5-minute CryoHub news
New IIR publication

**New IIR Publications Catalogue**

The new IIR publications catalogue is now available in two formats: print and PDF versions.

In this catalogue, you will find our latest publications (including IIR conference proceedings), reference documents, and the list of all IIR’s information services.

You can order our publications and conference proceedings online:

- **PDF version**: You can download the PDF version of this catalogue.
- **Online store**: You can find our latest publications in our online store at www.bsria.co.uk/wmi.
- **Free registered members**: You can access the PDF version of this catalogue.

You can also purchase the print version through the “Register” link in that same space to create an account or log in if you are already an IIR member.

**New IIR member news**

- **Daikin to increase sales by 50% by 2020**
  Daikin, an IIR corporate member, is looking to increase sales by nearly 50% to EUR 24 billion over the next five years (2016 to 2020). Daikin says it will especially focus on expanding its business in North America and Asia and place a particular emphasis on certain product areas. These include accelerating the growth and development of its filter business, and focusing on commercial refrigeration. The five businesses being targeted are heating, and water heaters, energy solutions, commercial refrigeration, next-generation refrigerant and fluorocarbon gas and IAQ and AE engineering.

  Daikin is expanding its business to new fields such as IoT (Internet of Things) and artificial intelligence. http://www.coolingpost.com/world-news/daikin-to-increase-sales-by-50-by-2020/

- **The IIR is delighted to welcome the following member**

**Corporate members**

- **Air Products & Chemical, USA; BSH; Electrodomesticos Espana SA, Spain; IUSTAS Benin, Benin; ProFin members**: João Garcia, Portugal; Hiroiyoshi Hosomura, Japan; Steven Kuehl, USA; Claudio Mazzari, Italy; Olivier MULLER, France; Jürg Schumann, Switzerland; Srinivas Vanapalli, Netherlands

**Junior members**

- **Adnan Ayub, USA; Konstan Filonenko, Denmark; Mckenzie Lavalle, USA; Sergiu Liote, France; Mahmood Mastani Joybari, Canada; Abin Paikayil Kurian, USA; Santosh Pal, Norway; Housseeddie Sahraoui, Tunisia; Martin Sandvik Svenoy, Norway; Deng Shuai, China

In the news

**Markets and figures**

**Global air conditioning market**

According to a report for economic data, the global packaged air conditioning (PAC) market contracted by 5% in value terms in 2015 whereas the market had shown a growth of 7% in 2014. The biggest PAC market is Asia Pacific accounting for 61% of the world market by volume declined by 5%. The top four biggest markets, China, Japan, Indonesia and South Korea all contracted and contributed to the downward trend. China’s GDP which grew at its lowest rate in 25 years, declining imports and exports have had a negative impact in the air conditioning market. The Americas region also mirrored the trend and contracted by 2% in volume terms at 27.4 million units in 2015. The previous year’s biggest contracted by 4% after 28% growth in 2014. The 4% growth in the US market, which is the biggest market in the region, minimized the negative impact in the continent. The European PAC market grew by 2% in 2015 compared to the previous year’s drop of 16% in volume terms. In addition to a hot summer, most economies in Europe are starting to show smaller economic recovery with the impact felt across air conditioning industries. The MEIA region managed to show another year of growth in 2015 increasing from 11.6 million to 12.5 million units. The biggest AC market in the region, India, continued to be the major contributor to this growth. The market grew by 4% in volume terms and reached 4 million units. Saudi Arabia, Egypt, Iran, Bangladesh and Turkey were all amongst growing markets in the region.


**World industrial refrigeration equipment market to grow to USD 36.25 billion by 2021**

The global industrial refrigeration equipment market was valued at USD 24 billion in 2015 and is expected to grow at an annual rate of slightly above 7% between 2016 and 2021. Key application segments of the industrial refrigeration equipment market include food production and processing, beverage production, chemicals and pharmaceuticals, energy (gas production), logistics (storage-production, chemicals and pharmaceuticals), food production and processing was the leading segment, accounting for over 24% market share in 2015. North America, Europe, Asia-Pacific, Latin America, the Middle East and Africa are the key regions of the market. Demand for industrial refrigeration equipment was highest in Asia-Pacific. However, Latin America and the emerging countries have also shown promising growth during the past few years. http://www.achnews.com/articles/132561-industrial-refrigeration-equipment-market-to-grow-to-3625-billion-by-2021

**US cold chain figures**

According to the USDA National Agricultural Statistics Service, there was 4.17 billion ft³ (118.08 million m³) gross refrigerated storage capacity in the US on October 1, 2015. This is a 3% increase in refrigerated warehouse capacity in the US since October 2013. Public refrigerated warehouse capacity accounts for 75.28% of gross refrigerated capacity in the US, which is a slight decrease (0.59%) from 2013. http://www.gcca.org/coldcon/2016/02/02/us-cold-storage-capacity-increases-3-since-2013/

- **According to the American Truck Association**, the American refrigerated trucking industry hauled 520.1 million tons of freight in 2015, equating 5% of all truck freight (10.35 billion tons). Also the refrigerated freight generated USD 14.3 billion in revenue, equating 1.9% of all truck revenue (USD 748.9 billion). http://www.gcca.org/coldcon/2016/05/24/1509/

**ATW Compressor Market hit RMB 2 billion in China**

Air-to-water (ATW) heat pump for heating has been widely adopted in China over the past few years, with an explosive 250% growth in 2015. Meanwhile, heat pump dryers for industrial and agricultural applications also presented robust growth, most of them being driven by China’s heat pumps driving hot water supply and heating. After one-decade of development, ATW heat pump market in China has exceeded RMB 1 billion (USD 157 million). China’s largest compressor market for ATW heat pump hit RMB 2 billion (USD 307 million). JARN, May 25, 2016

**Refrigerant news**

**G7 urges phase-down of HFCs under Montreal Protocol this year**

On the eve of the G7 meeting in Toyama, Japan, in May 2016, Ministers and high representatives recognized the importance of mitigating emissions of short-lived climate pollutants, including black carbon, methane, and hydrofluorocarbons. On measures to address fluorocarbons, they welcomed the decision in Dubai by the parties to the Montreal Protocol to address HFCs, and supported adoption of a Montreal Protocol phase-down amendment in 2016. They also recognized the importance of implementing concrete measures to minimize emissions throughout the lifecycle of HFCs and other fluorocarbons, including through the management of equipment and appliances that use these substances and their operations and at the time of their disposal. https://www.env.go.jp/earth/g7toyama_emm/english_img/meeting_overview/Commissaire_en.pdf

**TEAP report findings**

The UNEP Report of the Technology and Economic Assessment Panel (TEAP) presented during the OEWG37 meeting of the Parties to the Montreal Protocol in Geneva in April 2016 (see IIR Newsletter No. 66) stresses that low-GWP fluids are under development, but alternatives to high-GWP refrigerants. They have either been proposed or are being tested in industry programmes, or are pending publication, or have been codified in ASHRAE 34 refrigerant standards since 2014. The majority of these (69) are new mixtures, but traditional fluids and two new mixtures are also identified. The TEAP report concludes that the prospects of discovering new refrigerants that would offer better performance than the fluids currently known are minimal. The TEAP report also expresses suitability of alternative refrigerants under high ambient temperature (HAT) conditions. It underlines that the commercialization process of refrigerants can take years. It states that commercialization of products using these alternatives will take longer. In HAT conditions, the cooling load of a conditioned space can be three times that in moderate climates. Therefore larger capacity refrigeration systems may be needed which implies a larger refrigerant charge. Due to the requirements for large limitation and high-GWP refrigerants, the possible product portfolio suitable for HAT conditions is more limited than for average climate conditions when using the same safety standards. The TEAP report says that there is a need for a comprehensive risk assessment for AZL (lower flammability) and A3 (“higher flammability”) alternatives at installation, servicing and decommissioning at HAT conditions. http://ozone.unep.org/en/assessment-panels/technology-and-economic-assessment-panel

**Briefs**

**CEM Launches Advanced Cooling Challenge**

The Clean Energy Ministerial (CEM) is a forum of the world’s major economies and leading clean energy investors working together to accelerate the deployment of clean energy. In June 2016, the CEM launched the Advanced Cooling Challenge (AC Challenge) at CEM7 in San Francisco, California. The AC...
China: online sales account for 10% of total AC sales in 2015

The Chinese air conditioner (AC) market in 2015 has shown some changes in channel and price. Total retail sales of air conditioners came to 41.7 million units last year, indicating 1.1% year-on-year decline. Among them, offline sales came to RMB 123.5 billion (USD 19 billion), indicating 8.2% year-on-year decline, while online sales came to RMB 13.9 billion (USD 2 billion), showing 41.2% growth and accounting for about 10% of total sales. JARN, May 25, 2016

France: the cold chain interruption is a fully fledged damage

The French Supreme Court confirmed that the cold chain was interrupted. The road haulage operator. The French Toulouse Court of Appeal, in July 2014, confirmed Road Froid's liability however for the following reason. The cold chain was interrupted. The required temperature was not maintained. The independent expert laboratory for a food commission. The samples collected on the JARN, May 25, 2016

Technology

I CCC2016 highlights

The two following summaries refer to three papers presented during the IIR International Cold Chain Conference (ICCC2016) which took place in Auckland, New Zealand. They can all be downloaded from IIR Fridoc database by using the direct link provided at the end of each article. Don’t forget to login or register first.

Low charge ammonia systems for the cold chain

In its presentation*, R. Lamb stresses that the refrigerant charge of the cold chain interruption was successfully avoided. Road Froid opposed that request for the following reason. The cold chain was interrupted. The independent expert laboratory for a food commission. The samples collected on the JARN, May 25, 2016

PCM2016 highlights

The two following summaries refer to three papers presented during the 11th Phase Change Materials and Slurries for Refrigeration and Air Conditioning (PCM2016) conference which took place on May 18-20 in Karlsruhe, Germany.

The supercooled water method: a promising technique for ice slurry generation

To store cold energy in the field of refrigeration, ice slurry is a technology with great potential. The cold energy can be obtained in the form of a suspension consisting of ice particles and a carrier fluid, using either water or an aqueous solution. For retrofit slurry generation, the supercooled water method is a promising technique. Contrary to ordinary ice slurry generators, this method does not need auxiliary power to drive scrapers. Fostg K, Kaufeld M. Influence area can be designed on a large scale, resulting in a high evaporation temperature and a high coefficient of performance of the refrigeration unit. However, the stability of the process depends on successful avoidance of ice blockage. At first, the flowing fluid is refrigerated in a heat exchanger below freezing temperature but still remains in a metastable, liquid state. In a second step, nucleation is initialized to create the ice slurry. This method does not require water and chemical usage. For chill and food processing applications, improvements in compressor and fan efficiency. The use of variable speed compressors and refrigeration systems enable further reductions in charge. At the end of the process, the best option was to select the best refrigeration system. The samples collected on the JARN, May 25, 2016

Out of the ordinary

7th-9th century interior cooling system uncovered in Kuwait

Slovak archaeologists discovered one of the most ancient air conditioning systems in known history during excavation works at the al-Kusur settlement on the Failaka Island in the Persian Gulf. Archaeologists, technicians and restorers of the Slovak Academy of Sciences’ (SAV) Archaeological, technologists and restorers of the Slovak Academy of Sciences’ (SAV) Archaeological, technologists and restorers of the Slovak Academy of Sciences’. This ancient system used in the region is called “windcatcher” or “takhliat” and was used to cool buildings in hot climates. The excavated well-preserved palace dating from the 7th-8th century included a stone tower with a comprehensive system of canals. The unique so-called windcatcher, utilizing an ingenius interior cooling system based on the flow of air, caught by openings in the tower superstructure, in The excavation system used to be prevalent mostly in Iran and the Middle East, later in North Africa. http://spectator.sme.sk/c/20153276/slovaks-discover-ancient-air-conditioning-in-kuwait.html

Carbon reduction opportunities for supermarkets

In their presentation*, J. Evans et al stress that refrigeration is the largest load in a supermarket, accounting for 50-60% of the electricity consumption and that 56% of all food cold chain CO2 emissions emanated from supermarkets. They have examined 81 technologies that can save direct and indirect emissions in a typical baseline UK supermarket and calculated the application timescales and cost per tonne of CO2 abated using a model of the supermarket. Considerable carbon savings (over 300 tonnes CO2e p.a.) could be achieved in the baseline supermarket with a single technology. This was related to both direct and indirect savings. The levels of CO2e savings are greater for new cabinets and refrigeration systems than for retrofitting. Cabinet technologies tended to save indirect emissions whereas the largest savings in refrigeration systems was in direct emissions. For retrofitting to current cabinets the greatest savings could be achieved by fitting doors (between 103.3 and 140.7 tonnes CO2e/year). Savings were further reduced to reduce emissions but were unlikely to be acceptable to the supermarket. Air deflectors were estimated to be a good option if doors were not acceptable to the supermarket. For new cabinets, the best option was to select the best cabinets available currently. The greatest savings in emissions for the current refrigeration system were related to alternative refrigerants and refrigeration systems that did not contain HFC. CO2e savings could save up to 142.8 CO2e/year and the use of HFO 208.4 CO2e/year. A large proportion of these savings were from reductions in direct emissions. For new refrigeration systems, the use of refrigerant charge. The cold chain was interrupted. The independent expert laboratory for a food commission. The samples collected on the JARN, May 25, 2016
Benefits of PCMs in a cold room

B. Copetora et al. presented the results of an experimental study on the performance of a cold room with a novel air heat exchanger containing PCM (Phase Change Material) which was experimentally investigated. Specifically, an air heat exchanger consisting of aluminium containers with finned surface filled with PCM (5°C melting temperature), was located in a channel near the evaporator of a cold room. The aims are to reduce cooling energy consumption and to improve the maintenance thermal conditions of stored products. For this purpose, an experimental campaign was carried out and a monitoring system was developed. The cold room thermal behavior, with and without PCM, was studied under steady state operating conditions. As expected, the introduced number of chill compressor cycles (6 cycles instead 13 cycles) in the PCM added cold room was observed. Test results showed that by storing PCM in the air conditioning systems as 16% of energy savings can be achieved.

Copetora B, Fioretti R, Principi P. Experimental Analysis on a Novel Air Heat Exchanger Containing PCM for a Cold Room. Direct link to download this article via Fridoc: http://goo.gl/TTW61

Case studies

Singapore Sports hub: ice balls for air conditioning

The multi-purpose Singapore Sports Hub complex in Kallang, Singapore, includes the only stadium in the world custom designed to host football, rugby, cricket and athletics events. A retractable roof is made of polycarbonate which is very resistant and blocks the sun's heat giving shade and protecting spectators from the hot and humid Singapore weather during the day and potential torrential rain at any point of time. An energy efficient cooling system is also designed to deliver cooled air to every seat in the stadium. In the basement of the stadium, storage tanks are filled with ice balls, which are plastic spheres made of high density polyethylene, with dimples at the surface, and filled with a special liquid avoiding supercooling. During freezing, the dimples turn in-out progressively, allowing the freezing water to expand easily and a glycol plus water mixture. For charging the storage, the chillers deliver water glycol at -5°C, and the water inside the ice balls freezes. The heat transfer medium is pumped to the upper pipes of the tank and flows by gravity from the top to the bottom. During the discharge, the medium flows from the bottom of the tank to cool the users and comes back warm at the top of the tank where it is cooled again by contact with the ice balls, maintenance inside. This ice storage technology is designed in France and named Cryogel.

http://www.airclima-research.com/ice-ball
http://www.mouv.fr/diffusion-a-singapour-un-stade-high-performance-was-opened-in-singapore-the-most-

UK Battersea district heating and cooling scheme

Carrier Rental Systems has supplied 40 chillers and 20 electric boilers for a major district cooling and heating scheme in Battersea, London, UK, to provide temporary heating, domestic hot water and cooling for 312 residential apartments. The project is part of a redevelopment of the iconic Battersea site located alongside the River Thames in central London.

Carrier AquaSnap Metallised solutions were used, each rated at 160 kW and operating on R407C refrigerant, along with new electric boilers, each rated at 300 kW. The equipment is housed in a basement area alongside the site’s permanent plant rooms and connected to the piped services mains for the district heating and cooling scheme. Two deep water wells are linked to the chillers and heat pumps. The chillers operate in heating, cooling and mixed modes. In cooling mode, the system produces chilled water at -5°C, using ground water as a condensing medium and transferring energy via compact brazed plate heat exchangers. The final phases of the Riverlight project were recently completed, and all apartments have now been successfully let or sold. http://www.racplus.com/news/carrier-chillers-battersea-district-heating-and-cooling/click/news/20100519.018.600053916
http://www.coolingpost.com/features/carrier-in-london-ground-source-project/

France: successful renovation of the Pompidou Centre air-conditioning system

Dalkia carried out renovations on the air-conditioning systems of an international art et de culture Georges Pompidou, commonly known as the Pompidou Centre based in Paris. The project is claimed to help the building reduce its energy consumption by more than 20% and prevent 500 tonnes of CO\(_2\) per year. Starting in 2012, 13 air-handling units on the roof of the building were replaced with new air-to-air ASHP (air source heat pump) systems. The new systems improve electrical and thermal efficiency and deliver the heating, cooling and humidity needed throughout the building's 100,000 m\(^2\). In line with changing weather conditions, these ASHPs can keep the temperature of a building between 19°C and 21°C, which not only makes things more comfortable for the nearby five million people who visit the Pompidou Centre every year but also ensures optimal conditions to preserve the works of art in the building, maintaining humidity at a constant level. This is the first time the technology has been used on such a large-scale project.

http://www.astruction.com/projects/pompes-a-
achaleur-air-pour-les-100-000-m2-du-centre-
georges-pompidou/66013

R&D

Miniaturized air-to-refrigerant heat exchangers

The University of Maryland, US, have used direct metal printing, a 3D printing technology, to manufacture a unique miniaturized refrigerant heat exchanger as a single, continuous piece. This project aims at developing the next generation of air-to-refrigerant heat exchangers that would improve the efficiency and decrease pressure drop, increase robustness, and improve competitiveness. The heat exchanger will feature at least 20% less volume, material volume, and approach temperature compared to current multiport flat tube designs, and it could be commercially produced within five years.

The heat exchanger, which acts as both an evaporator and a condenser, can be applied to commercial heat pumps, EERV, or heat pump systems. Prototype 1 kW and 10 kW designs will be tested and then improved as necessary for final tests and demonstration in a 10.5 kW heat pump.


New thermal sensing technology to allow individualized air conditioning

Panasonic Corporation, in Japan, announced that it has developed a thermal sensation estimation method using the infrared array sensor Grid-EYE. Based on the results of estimations, the company has started to deliver high-precision thermal sensing solutions that recognize thermal comfort for people. This thermal sensation estimation method is a unique technology that recognizes the human sensations of hot and cold by calculating heat loss based on the difference between human surface temperature and ambient temperature. The infrared array sensor Grid-EYE measures the temperature in detail and detects objects, thereby achieving air conditioning suitable for sensitive temperature by combining the obtained data and thermal sensation estimation method. When used for air conditioning for homes, offices and vehicles, the solutions help improve both energy conservation and comfort.


Biogas recovery in wastewater treatment plants in the form of biogas

BiogNVAL, coordinated by Suez Environment in France, is an innovative system enabling the recovery of biogas. Wastewater treatment plants produce biogas primarily made up of methane and CO\(_2\). Biogas is a locally-produced renewable energy. After separating methane and CO\(_2\), this gas can be used in the following ways:

- clean liquid biofuel (biomethane) that does not release any fine particles into the air,
- liquid CO\(_2\) for the industry.

BioGNVAL is a process designed to separate methane and CO\(_2\) via cryogenics. Both molecules are separated thanks to their liquefaction temperature. Storing, transporting and distributing gases is more difficult than liquids, since the liquefaction temperature. Storing, transporting and distributing gases is more difficult than liquids, since they require 650 less space than in their gaseous form. Less polluting fuels and lower greenhouse gas emissions from industries are made possible with this new project.


Briefs

Modulating ejectors to improve the effectiveness of transcritical CO\(_2\) systems in warmer climates

Carel and Carrier Commercial Refrigeration Europe have joined forces in order to put an end to the concept of the “CO\(_2\) at the limit”. The unit-now accepted geographical limit for the cost-effective deployment of CO\(_2\) systems in stores, by developing a new a range of modulating ejectors. These modulating ejectors are claimed to increase the energy efficiency of transcritical CO\(_2\) systems in warmer climates, substantially extending the possibility to use CO\(_2\) from smallest
convenience stores to large hypermarkets. The modulating ejector moreover would reduce installation costs and complexity, as it can continuously and instantly adapt to specific operating conditions. These ejectors are known to exploit the Venturi effect, using a primary fluid flow – typically the high pressure gas cooler outlet – which is then accelerated to draw in, mix and carry a secondary and lower pressure to the suction side or liquid receiver. The use of ejectors reduces the compression ratio and the flow-rate handled by the compressor. The new modeling ejectors are said to be simple to install and to use.

http://www.brainpreservation.org/small-mammal-preservation/ASCA024201500245X

UK: Apple variety gets better ‘sleeping’ in cold storage
A new English apple variety that matures in taste like a fine wine is set to transform the UK apple industry and delight shoppers. A grower has discovered a naturally aldehydes that is then accelerated to draw in, mix and carry a secondary and lower pressure to the suction side or liquid receiver. The use of ejectors reduces the compression ratio and the flow-rate handled by the compressor. The new modeling ejectors are said to be simple to install and to use.

http://www.brainpreservation.org/small-mammal-preservation/ASCA024201500245X

Regulations—Standardization

US: new proposals for HFC alternatives
On May 23, 2016, under the Significant New Alternatives Policy (SNAP) program, the US Environmental Protection Agency (EPA) listed two new R123 alternatives and expanded the acceptable uses of R513A and CO₂ in air conditioning and refrigeration. Already listed as acceptable for a foam blowing agent, HFO1336mzz(Z) is determined to be acceptable in new centrifugal chillers, positive displacement chillers and industrial process air conditioning. It has also been extended for use in ice skating rinks, centrifugal chillers, positive displacement chillers and industrial process air conditioning.

https://www.epa.gov/snap/snap-regulations/notices

Australia: two refrigeration standards under review
Australian standards AS/NZS ISO 817 Refrigerants - Designation and Safety Classification as well as parts one to four of AS/NZS 5149 Refrigerating Systems and Heat Pumps (safety and environmental requirements) are currently under review. These standards are based on international standards published by ISO in 2014. Once published, they will supersede the current Australian and New Zealand standards for refrigerating systems which were published in 1998. The Australian Refrigeration Association (ARA) president, Tim Edwards, said the proposed standards introduce a refrigerant classification system that will impact RAC system design.