

# THE IIR, YESTERDAY, TODAY AND TOMORROW MEETING FUTURE CHALLENGES

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**Abstract:** The second half of 19th century showed both a sharp increase in the demand for cold storage, refrigerated transport, needs of various factories and in the development of successful refrigerating machines. 1908 was the year of the creation of the International Institute of Refrigeration. The IIR had then to adapt to new challenges such as the protection of the environment, to new uses of refrigeration and scientific progress.

**Key Words:** refrigeration, 100<sup>th</sup> anniversary, environment, heat pumps

## 1 INTRODUCTION

The IIR is celebrating its hundredth anniversary. The first part of the text describes the creation the IIR, with the history of artificial cold, the 1908 event and the first years of this new international body. The second part explains what the IIR is today, the changes that have appeared regarding the challenges, especially the environmental one, the organization and the actions.

## 2 THE CREATION OF THE IIR

### 2.1 Introduction

At 3 p.m. on October 5, 1908, 3000 specialists in the field of artificial cold gathered in the Grand Amphitheatre of the Sorbonne in Paris. They had come to attend the formal opening of the First International Congress of Refrigeration. The Congress, which lasted a week and attracted a total of 5000 participants from 40 countries, was a resounding success. Representatives from the worlds of science, commerce, industry and government exchanged views on low temperatures, refrigeration technology, food, applications of artificial cold in trade and industry, and legislative issues. The Congress culminated in the founding of the International Association of Refrigeration in January 1909. It became an international organization, the International Institute of Refrigeration, in 1920.

While it was electrical engineering that had taken the world by storm in the last quarter of the 19th century, the baton passed to the cold industry in the early years of the new century. Buyers included breweries and ice-cream factories, cold storage and refrigerated transport companies, hospitals (for the conservation of dead bodies), dairy, chocolate, rubber and perfume factories, dyeworks and factories producing liquid carbonic acid, ammonia or air. Those involved in building mineshafts and subway tunnels soon saw the potential of artificial cold in their line of business: refrigerant pipes could be used to create a wall of frozen ground, after which it became far easier to dig out the space inside. In short, artificial cold was a growing market.

## 2.2 Artificial cold

The mid-19th century witnessed a sharp increase in the demand for natural ice during the summer months in Europe, North America (where ice was soon being used by the middle classes) and the colonies. The demand was perhaps greatest among breweries producing lager, which ferments at 5-8°C, unlike the 20-30°C of many English beers. The advent of railways and steamships boosted trade in natural ice from Scandinavia and Canada, but suppliers could not keep pace with the growing demand. Furthermore, rising concern about the sawing of blocks of ice from polluted rivers and lakes gave extra impetus to the development of machines that could manufacture clean artificial ice. The producers of natural ice lowered their prices in a fruitless effort to reverse the tide.

The first machine to produce a continuous output of ice was invented by the French businessman Ferdinand Carré. His idea was to release ammonia from a water solution by heating it, to condense the vapour under pressure until it was liquefied, and then to allow this liquid to evaporate and expand in a sealed space. This would extract heat from an adjoining space with water, which would immediately freeze. The vapour would be absorbed by the "aqua ammonia", after which the cycle would be repeated. A prototype was placed in a brewery in Marseille in 1859. After some adjustments made by Mignon and Rouart in Paris, the vapour absorption device was one of the best-selling refrigerators in the years 1870-1885, especially in France. After that it was superseded by the vapour-compression refrigerator, which is based on a far simpler construction.

This system, which is still applied in household refrigerators, artificial ice rinks and industrial plants today, was invented by the French engineer Charles Tellier, earning him the title "le père du froid". It uses a closed cycle. A compressor is used to compress methyl ether (which was later replaced by methyl chloride, sulphur dioxide, carbonic acid gas, and above all ammonia); a water-cooled condenser turns this into liquid, which evaporates in the space to be refrigerated (in a system of pipes – the main difference with regard to Carré's system) and thus extracts heat from it. Tellier built his first refrigerator in Paris in 1863. Four years later he installed an improved version, using methyl chloride as the coolant, in an ice factory in Marseille, France.

Commercially speaking, the most successful machines were compression refrigerators using ammonia, launched in 1875 after theoretical studies carried out by the scientifically trained Carl von Linde. *The Gesellschaft für Linde's Eismaschinen A.G.*, in Wiesbaden, supplied its first machine to a brewery in Munich and was soon the market leader. By 1890 the German company had sold about a thousand machines, and around the turn of the century the Wiesbaden factory was sending off one or two of its refrigerators every day (Dienel 2004).

A major innovation made possible by the new refrigerators was the export of frozen meat from Australia, New Zealand and South America to Europe. Cooling the meat with ice proved not to be an option; steamships were still slow in the 1870s, and clippers also took over 100 days to cross the ocean. The problem had to be solved with machines. In 1876, Tellier built a compression refrigerator on board the French ship *Le Frigorifique*. This steam-powered three-master sailed from Marseille to Buenos Aires with a cargo of frozen meat, to return to Le Havre a year later. Though not a commercial success, the voyage had demonstrated that shipping frozen meat across the oceans was technically feasible.

Bulk transportation imposed more stringent demands, and the problem with Tellier's machine was that if built on a larger scale, it sometimes broke down. Besides this, the toxicity of the coolants and the risk of explosion deterred ship owners from taking the plunge. It was another type of refrigerator that made them change their minds: the air expansion machine patented by the Scottish butchers Bell and Coleman in 1877. This cooled the produce by the rapid expansion of compressed air, and in spite of poor efficiency – large steam engines

were needed to compress the necessary quantities of air – and problems with frozen water vapour, the sailing vessel *Strathleven* transported 34 tons of frozen meat from Australia to England safely in 1879 using one of these machines. Things moved very fast after this. In 1907, Argentina exported 425 000 tons of frozen meat to England alone.

Low-temperature science, too, progressed in leaps and bounds. The last quarter of the 19th century witnessed the liquefaction of each of the “permanent gases” in turn. In 1877, the Frenchman Louis Cailletet and his Swiss colleague Raoul Pictet liquefied air. In 1883, the Polish team Zymunt von Wroblewski and Karol Olszewski went a step further, by inducing the blue liquid of oxygen to boil gently. James Dewar, working in the Royal Institution, London, became the first to produce liquid hydrogen, in 1898, after which Heike Kamerlingh Onnes won the race for liquid helium in Leiden on 10 July, 1908 (Van Delft 2007).

## 2.3 The Paris congress

In this atmosphere of up-and-coming artificial cold, of new, hitherto unsuspected applications, of changing economies in countries such as Argentina, of a proliferation of technical problems crying out for solutions, of a scientific quest for absolute zero, the idea of holding a major international Congress of refrigeration, in Paris, emerged. A Congress of this kind had been held in Vienna in 1873, to coincide with World Exposition there, but it had focused on brewers and their need for natural ice. At the beginning of the 20th century, artificial cold produced by refrigerators revolutionized agriculture all over the world and offered an immense economic potential concerning national and international food trade by using large-scale refrigerators.

The engineer J. de Loverdo was the prime mover of the Paris congress, and in May 1907 a circular was distributed calling for participants. The initiative soon attracted a wide-ranging and distinguished band of supporters including l'Institut de France, the French Parliament, the Collège de France, l'Académie de Médecine, major transport companies. No-one interested in cold could afford to miss the *Premier Congrès International des Industries Frigorifiques*, which was finally held at the Sorbonne University on October 5-10, 1908 under the more appealing and inclusive name of *Premier Congrès International du Froid*, or First International Congress of Refrigeration (Museum Boerhaave No. 190). The broad aim was to exchange ideas and discoveries in the field of cold technology.

To keep the Congress manageable, it was divided into six sections: low temperatures, refrigeration installations, applications of cold to foodstuffs, applications in other industries, applications in trade and transport, and a final section that would examine the relevant legislation. The name of the Congress made it clear that it was not to be a one-off initiative. Ideas for an international institute for cold and science, or for training courses in refrigeration technology, to be founded in Paris, soon proved overambitious. Instead, the preparatory committee offered to set up an International Association of Refrigeration. Its remit would be to perform research on scientific, technological and industrial applications, to set up a library covering all aspects of the field, to publish articles and inform its members, to provide courses, set up excursions, and organize a biennial Congress on the subject of cold, to be held in a different country each time. National committees were formed to ensure that all went smoothly. The latter coordinated the submission of reports for Paris, and once the Association of Refrigeration actually got off the ground, they were to have seats on its Executive Committee.

In the avalanche of recommendations that the Congress adopted on its final day, applied cold technology predominated, but there were also follow-up proposals to the goal that Kamerlingh Onnes had formulated at the opening session. The most striking was: “Given the crucial interest attached to pursuing and coordinating scientific and practical work in the field of low temperatures, the Congress emits the wish of the foundation of an International

Association for the promotion of scientific and other studies, with its head office in Paris, which would pursue its study of the whole field of refrigeration and at the same time continue to strengthen the already specialized work centres” (IIR 1909).

## 2.4 The International Association of Refrigeration

The International Association of Refrigeration duly materialized. It was founded on January 25, 1909 in the presence of delegates from 35 countries. Lebon was appointed President of the new association, and De Loverdo became its director. The Paris Congress led to the establishment of six international committees. Vice-president Kamerlingh Onnes was chosen to chair the “first committee”, which was to focus on scientific matters.

While the Association started life with a few dozen members, by the time of the 2nd Congress of Refrigeration, held on October 6-11 in Vienna, Austria, it had 1700. Argentina contributed most, with 1000 members – all because of its frozen meat – and the United States at 370, also had a strong contingent. For all America’s numerical preponderance, however, 92% of the financial contributions came from Europe. The second congress attracted over 3000 participants (IIR 1913).

## 2.5 Restructuring Association

After the Great War, the Association was restructured into the International Institute of Refrigeration. This was triggered by the resignation of the president, André Lebon, on December 12, 1918. Following this, the director of the Association convened a meeting of the Executive Committee on February 6, 1919. The meeting in the “Crédit Foncier [mortgage bank] d’Algérie et de Tunisie” in Paris was attended by only six of the 28 members of the executive committee.

Discussions on restructuring designed to place the Association on a solid financial basis were postponed until the end of the peace talks in Versailles. On June 21, 1920, the Association was replaced by the International Institute of Refrigeration. This had a far more tightly-knit organizational structure, based on that of the International Institute of Agriculture in Rome: instead of individual members it had participating countries in six categories, paying fixed contributions. And these rules are still valid in 2008.

# 3 THE IIR TODAY

## 3.1 Fundamentals

The IIR is 100 years old. It has changed, but some principles are still alive:

The basic reasons for the creation of the IIR are still important: the role of refrigeration in agriculture and food, the importance of science and technology in refrigeration and the need for scientists to share their research.

The IIR is still an intergovernmental organization with six member-country categories. However, it also has, as in the beginning, private and corporate members who receive its services.

The structure of the IIR, with congresses and with commissions or committees, is partially the same. The *Bulletin*, which was the first IIR publication, has been maintained.

The roots are still presents, but new branches have appeared and the world has changed. The IIR had to adapt to its environment and continues to adapt to new challenges.

### 3.2 The challenges

The most important challenges for humanity in the 21st century are health and the environment.

Diseases and mortality are still too widespread in developing countries. The aim to live as old as possible in good health is the goal of most people in developing countries. Refrigeration is one of the answers: it is necessary to guarantee sufficient quantities of food, available to everybody, and to preserve its quality, particularly in order to avoid contamination.

Refrigeration is also necessary to enable the storage and transport of health products (vaccines, certain drugs, diagnostic products...), and to preserve organ and tissue in hospitals, for cryobiology, surgery and medicine.

Refrigeration is at the core of two major threats to the environment: ozone depletion and climate change, because of the use of certain refrigerants and because of the energy it needs. We thus have to implement new refrigerants, to reduce electrical consumption and to develop new environmentally friendly technologies. Refrigeration is also an answer to global warming: air conditioning will be increasingly necessary in many cases and refrigeration is needed in several leading-edge energy sources: liquefied natural gas, liquefied hydrogen, thermonuclear fusion. Moreover, refrigeration will be needed for the capture of CO<sub>2</sub> in energy plants, the steel industry...

The IIR is not only still necessary: it is more and more necessary.

### 3.3 Members

Our members have changed but not totally. The First and Second World Wars, and decolonization had an important impact. However, the main countries present when the IIR was set up are still there.

May I mention that Switzerland was one of the founding member countries (it joined in 1920) and has always been really active in the IIR.

Originally, there were about 40 member countries; they are now 61. Fifty years ago, the number of private and corporate members was about 500, and there are currently almost 600. We certainly need to attract more countries and more private and corporate members.

The challenges we have are challenges for governments, but also for all public and private sectors.

### 3.4 The committees, commissions and working parties

The IIR is more sophisticated than at the beginning, perhaps too sophisticated. However, it reflects the various fields of actions and the broad mission we have. We have a General Conference, an Executive Committee, a Management Committee, a Science and Technology Council. The latter comprises ten commissions: each one has about 50 members from all paying IIR member countries.

Commission E2 (Heat pumps, energy recovery) is naturally in close connection with the work of the IEA-Heat Pump Programme (IEA-HPP): the partnership between the IIR and the IEA-HPP is effective and necessary for both organizations.

### 3.5 Publications

The first IIR publication was the *Bulletin*. It was first published in 1910; it still exists, but it has of course changed: it is now an electronic Bulletin (*e-Bulletin*). We have an electronic

database, Fridoc, which now comprises more than 81 000 entries. It is the most important database in refrigeration technologies. The *Bulletin* now essentially comprises the new entries of abstracts of articles and documents published all over the world and is now merging with Fridoc.

We launched two other publications:

- The *International Journal of Refrigeration* was created 30 years ago. We needed a scientific journal, with the same kind of selection and strict peer-review approach as the best ones. We have succeeded and its impact factor is the best in the refrigeration sector: it is the 26th out of 106 journals in mechanical engineering and 14th out of 42 journals in thermodynamics.
- The *Newsletter* was created 8 years ago. It comprises selected news from all over the world in addition to IIR news and it is sent to our entire network (more than 3000 people).

The IIR progressively began to publish books and guides, thanks to its network of experts, which is our main wealth. We publish technical books, brochures, diagrams, training courses and recommendations. We publish reference documents that are used and recognized all over the world. For example, we publish the *International Dictionary of Refrigeration* in 11 languages, or the Guide: *Saving Energy in Refrigeration, Air-conditioning and Heat Pump Technology*.

Thanks to our intergovernmental status, we are invited to international events and are able to deliver statements, to participate in meetings and side events, to prepare international standards and recommendations for governments, the United Nations and its various bodies, for decision-makers. For instance, we regularly deliver statements during the United Nations Conferences on the ozone layer and on climate change.

### **3.6 Conferences and congresses**

One of our main activities is now the holding of conferences. We organize about 3-4 IIR conferences per year and we co-sponsor 8 conferences per year on the average. Most of them are series of conferences, like this one, and it is important to have regular events on key subjects for scientists and engineers. I am sure that this one will be successful as usual.

We also organize The International Congress of Refrigeration every 4 years, which covers all fields of refrigeration technologies, as was the case 100 years ago. The next one will take place in Prague in 2011.

## **4 HEAT PUMPS: A PROMISING ANSWER TO THE ENVIRONMENTAL CHALLENGE**

Global warming is very probably the major challenge we will have to face during this century. Each year, new scientific reports show an increasingly uncertain future, with major consequences on our environment and our way of life.

The objective of a limited increase in the average temperature of the Earth's surface by 2°C in 2050, which would nevertheless be difficult to achieve, seems for certain people too insufficient to avoid important and dangerous changes in the climate.

All economic and scientific reports show how it is vital to act immediately if we want to meet this challenge of a maximum increase of 2°C in 2050 and even more so if we attempt to achieve a greater reduction; and it is possible to do this without halting economic growth, even if growth would be reduced and of course of a different kind.

There are three main sectors concerned by the economic and technical changes that we need: industry, transport and buildings. The first one has already made efforts and of course has to continue. The second and the third ones are just beginning.

New concepts have emerged in building construction: high quality buildings from an environmental viewpoint, and positive-energy buildings that generate more power than they consume. They imply energy savings, lower energy needs (thanks to insulation...), energy-efficient technologies and new energy sources. Heat pumps can be considered as one of them. They are now rapidly expanding in most countries.

However, we still have efforts to implement: of course to always improve their effectiveness and their reliability, and to reduce their price, but also to promote them, not only in new buildings, but also in existing buildings. Most buildings in Europe are old ones and it is always more difficult to implement new technologies in old buildings than in totally new buildings.

People tend to be aware of renewable energy sources like solar or wind energy, but not heat pumps, the concept of which is harder to understand.

Solutions for the future are integrated solutions and heat pumps are only a part of them. They are nevertheless an essential part and an effective solution in environmentally friendly buildings.

Heat pumps use refrigeration technology. Thanks to their high energy efficiency, they are an efficient tool to reduce CO<sub>2</sub> emissions; by comparing heat delivery by means of heat pumps with fossil fuels, one can easily show that with heat pumps, primary energy consumption can be at least cut in half.

Our role is to promote their application in the residential/commercial sector where their use is now substantial but could be greater in many countries. Their penetration in the industrial sector should also be raised because of their potential technical and economic benefits.

The potential for reducing CO<sub>2</sub> emissions, assuming that heat pumps secure a 30% share in the building sector with currently available technology, is about 6% of the total worldwide CO<sub>2</sub> emissions (IIR 2007). However, our role is also to make heat pumps more efficient, less energy consuming and working with fluids with low or no global warming impacts, in order to obtain totally environmentally friendly technologies at a reasonable cost.

## **5 CONCLUSION**

In conclusion, the IIR is 100 years old. However, it is still young: refrigeration preserves health and quality of life! We still have a lot of work to do throughout this century, together, for a better health, for a better environment, in a way of sustainable development.

I hope the coming generation will continue to celebrate the IIR in 2108, with many more people and many more countries and companies in a healthier and safer world for everyone.

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- N.B.: The first part of this paper is partially derived from a text by Dirk van Delft, which will form the introduction to a booklet published for the IIR Centenary in 2008.