Background

Medal-worthy natural refrigerants

2012 is being swept by Olympic fever once again. The whole world is waiting to see which records will be broken in the individual disciplines and which new idols will emerge from the Games. But the focus is currently not just on the sporting aspects. The general public also expects the Games to show "Olympian performance" when it comes to climate protection. The environment should suffer as little as possible.

This requirement is already being heeded in the construction of stadiums and sports halls. There is scope for a sustainable approach particularly in the construction method and supply concepts for the facilities. For refrigeration and air-conditioning, natural refrigerants such as ammonia offer an environmentally compatible solution. "Ammonia is not only highly energy-efficient but also very environmentally friendly to use", explains Monika Witt, Chairwoman of eurammon, the European initiative for natural refrigerants. "In contrast to synthetic refrigerants, ammonia has no global warming potential and therefore makes no contribution to the greenhouse effect."

Ammonia will also be used as refrigerant for the Olympic Games in London. A large-scale Energy Centre is responsible for supplies to all the facilities of the Olympic Park. Necessary refrigeration is generated by combining an electric compression refrigeration system with an absorption unit that uses the waste heat from the Energy Centre.

Regardless of the Olympics, operators of sporting and leisure facilities have long since discovered the advantages of natural refrigerants.

Climbing, tennis and skating all under one roof – combined refrigeration and air-conditioning system in Kitzbühel Sport Park

The 4,500 m² Mercedes-Benz Sport Park in Kitzbühel not only offers scope for daily sport and leisure but is also a venue for school sporting events, training camps and professional contests, together with other sporting, cultural and corporate events.
The architectural planning concept for a new ice rink to be erected on the Sport Park premises entailed combining the already existing indoor tennis centre with the new skating

rink. To this end, the town of Kitzbühel called for tenders including planning the complex. The refrigeration system was to supply the refrigeration capacity for an ice hockey pitch (1,800 m²), a curling track (600 m²) and a mobile outdoor ice surface (600 m²).

In addition, the client wanted a refrigeration system to take care of the entire air-conditioning for the sport complex (skating and curling, skittles, climbing, tennis and restaurant). The curling track and the air-conditioning had to be rated for operation all year round so that the complex could be used as a National Curling Training Centre – the only one of its kind in Austria. Together with an energetically optimised, climate-neutral rating, the requirements included in particular a very low temperature spread across the whole curling track. Curling is a very sensitive sport that is also called "chess on ice" on account of the refined tactics involved, and makes highly specific temperature requirements of the refrigeration system.

Haas Anlagenbau won the tender for the whole refrigeration technology, including cooling the ice rinks. The company planned and built an ammonia refrigeration system with direct evaporation for the ice hockey and curling facility. The system has two GEA Grasso reciprocating compressor units with a refrigeration capacity of 750 kW. Around 30,000 m evaporation piping was installed for the system. Together with the energetic and climate-neutral advantages of ammonia, direct evaporation in particular warrants a low temperature spread across the entire ice surface of the curling track. A secondary glycol circuit which is also integrated in the central ammonia system is responsible for air-conditioning of the sport complex. The mobile outdoor ice surface is also connected to the circuit.

In addition, Haas Anlagenbau installed two different temperature levels to recover heat from the refrigeration process. The waste heat is used for air-conditioning tasks and for melting the snow pits. In addition, the refrigeration professionals equipped the refrigeration plant with a remote monitoring system for on-line support in addition to maintenance on site. As the whole sport complex is located right at the heart of Kitzbühel, the system engineers also worked together with the Austrian authorities and Kitzbühel fire brigade to develop a corresponding safety concept for the ammonia refrigeration plant. The refrigeration plant has now been running for 4 years to the utmost satisfaction of the operator.

Underwater worlds – cooled with environmentally friendly natural refrigerants

The Ozeaneum in Stralsund was opened mid 2008 by the "Stiftung Deutsches Meeresmuseum". The spectacular new museum with its huge seawater aquariums, the largest of which encompasses 2.6 million litres of water, offers visitors a unique journey through the underwater world of northern seas that is unrivalled in Europe. Altogether the

Ozeaneum's aquariums contain six million litres of water. One key aspect in planning the underwater museum on Stralsund's harbour island consisted in environmentally friendly construction and operation of the whole building.

The refrigeration system needed for cooling the water for the aquariums and for air-conditioning the building also had to meet the high ecological demands. Accordingly, SWS-Energie GmbH, a subsidiary of Stralsund municipal utilities and responsible for the project, contracted Johnson Controls Systems & Service GmbH to draw up the concept and proceed with installation of a sustainable, energy-efficient refrigeration plant. The system was to avoid plumes of steam caused by evaporation as far as possible, while reducing noise to a minimum level.

Altogether, the museum requires refrigeration capacity of 900 kW, with 400 kW for the aquarium systems and 500 kW to air-condition the building. Refrigeration is provided by cold water at a flow temperature of 6°C and a return temperature of 12°C. To warrant reliable, sustainable refrigeration supply for the museum, the refrigeration experts at Johnson Controls opted for a single-stage ammonia refrigeration system with flooded evaporation. The system consists of two separate Chill-Pac chillers and two hybrid evaporative condensers to chill the cold water. To warrant high refrigeration capacity even in the event of a disruption, the refrigeration experts rated the two Chill-Pac chillers with an output of 730 kW each and installed them together with the main switchboard in a separate machine room on the ground floor of the energy centre. Direct condensation takes place using the two Jäggi hybrid chillers installed on the roof of the building, each with an output of 850 kW.

The two Sabroe reciprocating compressor units can be operated independently if necessary so that if one compressor fails, a good 80% of the total needed refrigeration capacity can be provided by the other unit. Each compressor is equipped with a power control to warrant particularly energy-efficient operation of the system. The power stages are triggered and actuated by corresponding power solenoids. In addition, each compressor has a frequency converter for speed control. In this way, the power stages are added constantly and the speed is increased when the system demands more power. When output is reduced, the power stages are switched back accordingly and the compressor speed is reduced. As the total refrigeration capacity of 900 kW is already generated when the two Chill-Pac chillers work at a capacity of 60%, the refrigeration experts managed to considerably reduce the noise levels. In addition, this power buffer permits dry operation of the hybrid chillers at nominal load up to an outside temperature of 21.5°C so that no plumes of steam are emitted over the building as a result of evaporation.

Europe's only elevated ice track – with environmentally friendly refrigeration

On 1 October 2011, the new Lent Park opened its doors in Cologne with ice rink and indoor swimming pool. Europe's only 260 m long elevated ice track is a special attraction which runs around the building as a gallery on the first floor, offering skaters views of the lower 1,800 m² ice rink, the swimming pool and the restaurant.

Energy-efficient refrigeration was the main demand made by KölnBäder GmbH for the new building to be erected on the grounds of the old ice skating and swimming stadium. Accordingly, the Gesellschaft für Kältetechnik-Klimatechnik mbH (GfKK mbH) designed both the elevated ice track and the ice rink as a direct evaporation system with the environmentally-friendly natural refrigerant ammonia. A central refrigeration plant was installed with total refrigeration capacity of 819 kW and a refrigerant charge of 7,000 kg NH_3. The system operates with three GEA Grasso reciprocating compressors. The waste heat is put to energy-efficient use for heating process water and melting the snow pits, as well as antifreeze protection. The remaining waste heat is emitted to the outside with an air-cooled condenser that operates with EC ventilators. Refrigeration supply for the elevated ice track is designed to maintain a constant ice quality even under differing framework conditions and heat loads. The plant itself is equipped with a central GfKK control unit with visualisation.

Fair play for the environment – thanks to natural refrigerants

Natural refrigerants are producing Olympian performance in other applications too: the British retailer Marks & Spencer built a new store in the Olympic Village that uses only the natural refrigerants carbon dioxide and propane for refrigeration. And Coca Cola uses only drink chillers that operate without fluorocarbons (FCs) that would boost the greenhouse effect. "Not every natural refrigerant is suitable for a certain application", says Monika Witt, "but today it is possible to find the right solution for energy-efficient, environmentally friendly refrigeration with natural alternatives for all application areas, thanks to the various properties of ammonia, carbon dioxide and hydrocarbons", explains the eurammon Chairwoman. "As refrigerants, they are definitely worthy of a gold medal."

Annex

Ammonia (NH_3)
Ammonia has been successfully used as a refrigerant in industrial refrigeration plants for over 100 years. It is a colourless gas, liquefies under pressure, and has a pungent odour. In coolant technology, ammonia is known as R 717 (R = Refrigerant) and is synthetically produced for use in refrigeration. Ammonia has no ozone depletion potential (ODP = 0) and no direct global warming potential (GWP = 0). Thanks to its high energy efficiency, its contribution to the indirect global warming potential is also low. Ammonia is flammable. However, its ignition energy is 50 times higher than that of natural gas and ammonia will not burn without a supporting flame. Due to the high affinity of ammonia for atmospheric humidity it is rated as “hardly flammable”. Ammonia is toxic, but has a characteristic, sharp smell which gives a warning below concentrations of 3 mg/m³ ammonia in air possible. This means that ammonia is evident at levels far below those which endanger health (>1,750 mg/m³). Furthermore ammonia is lighter than air and therefore rises quickly.

Carbon dioxide (CO_2)
Carbon dioxide is known in refrigeration technology as R 744 and has a long history extending back to the mid 19th century. It is a colourless gas that liquefies under pressure, with a slightly acidic odour and taste. Carbon dioxide has no ozone depletion potential (ODP = 0) and negligible direct global warming potential (GWP = 1) when used as a refrigerant in closed cycles. It is non-flammable, chemically inert and heavier than air. Carbon dioxide has a narcotic and asphyxiating effect only in high concentrations. Carbon dioxide occurs naturally in abundance.

Hydrocarbons
Refrigeration plants using hydrocarbons such as propane (R 290, C_3H_8), propene (R 1270, C_3H_6) or isobutane (R 600a, C_4H_{10}) have been in operation all over the world for many years. Hydrocarbons are colourless and nearly odourless gases that liquefy under pressure, and have neither ozone depletion potential (ODP = 0) nor significant direct global warming potential (GWP = 3). Thanks to their outstanding thermodynamic characteristics, hydrocarbons make particularly energy efficient refrigerants. Hydrocarbons are flammable, however, with currently available safety devices, refrigerant losses are near zero. Hydrocarbons are available at low cost all over the world; thanks to their ideal refrigerant characteristics they are commonly used in small plants with low refrigerant charges.

Ozone Depletion and Global Warming Potential of Refrigerants

	Ozone Depletion Potential (ODP)	Global Warming Potential (GWP)
Ammonia (NH_3)	0	0
Carbon dioxide (CO_2)	0	1
Hydrocarbons (propane C_3H_8, propene C_3H_6, isobutane C_4H_{10})	0	<3
Water (H_2O)	0	0
Chlorofluoro-hydrocarbons (CFCs)	1	4680–10720
Partially halogenated chlorofluoro-hydrocarbons (HCFCs)	0.02–0.06	76–12100
Per-fluorocarbons (PFCs)	0	5820–12010
Partially halogenated fluorinated	0	122–14310

hydrocarbons (HFCs)		

Ozone Depletion Potential (ODP)
The ozone layer is damaged by the catalytic action of chlorine, fluorine and bromine in compounds, which reduce ozone to oxygen and thus destroy the ozone layer. The Ozone Depletion Potential (ODP) of a compound is shown as chlorine equivalent (ODP of a chlorine molecule = 1).

Global Warming Potential (GWP)
The greenhouse effect arises from the capacity of materials in the atmosphere to reflect the heat emitted by the Earth back onto the Earth. The direct Global Warming Potential (GWP) of a compound is shown as a CO_2 equivalent (GWP of a CO_2 molecule = 1).

About eurammon

eurammon is a joint European initiative of companies, institutions and individuals who advocate an increased use of natural refrigerants. As a knowledge pool for the use of natural refrigerants in refrigeration engineering, the initiative sees as its mandate the creation of a platform for information sharing and the promotion of public awareness and acceptance of natural refrigerants. The objective is to promote the use of natural refrigerants in the interest of a healthy environment, and thereby encourage a sustainable approach in refrigeration engineering. eurammon provides comprehensive information about all aspects of natural refrigerants to experts, politicians and the public at large. It serves as a qualified contact for anyone interested in the subject. Users and designers of refrigeration projects can turn to eurammon for specific project experience and extensive information, as well as for advice on all matters of planning, licensing and operating refrigeration plants. The initiative was set up in 1996 and is open to European companies and institutions with a vested interest in natural refrigerants, as well as to individuals e.g. scientists and researchers.
Internet URL: www.eurammon.com

Contacts

eurammon contact

eurammon
Dr. Karin Jahn
Lyoner Strasse 18
D-60528 Frankfurt
Germany
Phone: +49 (0)69 6603-1277
Fax: +49 (0)69 6603-2276
E-mail: karin.jahn@eurammon.com

Press contact

FAKTOR 3 AG
Anika Hagemeier
Kattunbleiche 35
D-22041 Hamburg
Germany
Phone: +49 (0)40 679446-194
Fax: +49 (0)40 679446-11
E-mail: eurammon@faktor3.de