

Background

Fresh for the future – Natural refrigerants in the food industry

The natural refrigerant ammonia has proven its worth in industrial refrigeration for nearly 130 years. After a boom in the use of the now prohibited CFC refrigerants during the 1960s and 1970s, ammonia is today being put to increased use in industrial refrigeration. The main reasons concern the efficiency and low environmental impact of ammonia. It is one of the most efficient refrigerants of all, offering convincing performance in terms of economic efficiency and environmental friendliness – it has no direct ozone depletion potential (ODP = 0) and does not contribute to the greenhouse effect (GWP = 0). The continuing increase in energy costs and a greater awareness of environmental issues will bring about a further increase in the trend for natural refrigerants. Three eurammon members explain how and where they put natural refrigerants to successful, cost-efficient and future-oriented use in the food industry.

Kellermann.ch AG: Combining refrigeration and waste heat exploitation

Kellermann.ch AG produces and sells fresh vegetables and vegetable convenience products, including quickly perishable goods such as chopped and packed salads for the convenience sector. An extension to the company's logistics complex resulted in great additional demand for refrigeration. At the same time, for most of the year the company needs heat for its greenhouses. To offer the most cost-efficient, environmentally friendly solution to satisfy the demand for both heat and refrigeration, eurammon members SSP Kälteplaner and Johnson Controls Refrigeration planned and installed a central refrigeration supply system for the warehouses with a heat pump to heat the greenhouses. The two-circuit refrigeration system with two 550 kW low-pressure refrigeration compressors cover the required refrigerating capacity of around 1,000 kW. The engineers deliberately opted for reciprocating compressors, which stand out compared to screw compressors on account of their far lower operating costs under the given operating conditions. They cool the water/glycol blend in the refrigeration consumer circuit down to approx. -8°C for direct refrigeration of the warehouses. The refrigeration plant is combined with a heat pump in a particularly energy-efficient concept so that the company can make full use of the waste heat generated in the system. The combined heat/refrigeration plant covers Kellermann.ch AG's additional refrigeration demand

in a sustainable, cost-optimised way with significant reductions in heating costs. The environment benefits as well: the integral concept reduces the burden on the atmosphere by around 1,000 tonnes CO₂ each year. It was this environmentally sound business approach, among other reasons, that prompted the Swiss Climate Foundation to support the project.

Verkade: New biscuits, new refrigeration

The ideal temperature in the production and storage facilities of the Dutch biscuit and chocolate manufacturer Verkade (United Biscuits) in Zaandam is about 18°C. The temperature must never exceed a maximum of 22°C as otherwise product quality would suffer. Increased production and the introduction of a new type of biscuit brought the existing refrigeration system permanently to its capacity limits, so that additional refrigeration capacity had to be hired at great expense in order to maintain the required temperatures. Naturally, this problem became particularly acute during the summer months. In its search for a suitable new refrigeration machine with a rated capacity of about 1,000 kW, the company decided in favour of a liquid chilling unit from GEA Grasso, which works with the natural refrigerant ammonia. However, the building which housed the old machine scarcely offered sufficient space for a new refrigeration system. This was another key factor in favour of the highly compact system, which could be installed without any problems thanks to its small floor area of just 5 x 1 m and height of 2.1 m. The refrigeration machine itself offers convincing performance with a particularly high energy efficiency ratio (EER) of 5.0 under full load, with the EER even increasing to about 10 under 25% partial load. This results among others reasons from the frequency converter integrated in the system for demand-related control of the screw compressor speed (European seasonal energy efficiency ratio ESEER 8.0). The solution brought multiple benefits for Verkade. With the new system, the company was able to close down an existing system that ran on the refrigerant R22, thus credibly underlining its sustainable environmental policy. The investment also made economic sense. Among other benefits, the company now saves the great expense of hiring additional refrigeration capacity, as the new system efficiently keeps biscuits and chocolate at the required temperature even during the heat of summer.

CDS Hackner GmbH: Huge warehouse buildings and extreme temperatures

The family-run company CDS Hackner GmbH in Crailsheim near Nuremberg produces and refines natural casings for sausage skins and is one of Europe's market leaders in the processing of animal by-products from beef, pork, and lamb. The company also offers its customers a wide range of deep-freeze services, including storage, freezing and controlled defrosting. In response to the constant increase in demand, CDS Hackner GmbH decided to expand its refrigeration and storage capacities, investing about €13 million in the 6,000 m²

production complex, deep-freeze storage facilities, a fully automated production line and a state-of-the-art refrigeration system. The storage capacity was increased from 15,100 to 26,000 pallet spaces. In order to refrigerate two new deep-freeze warehouses, each with about 20,000 m³ at a ceiling height of 12 m, eurammon member Johnson Controls installed a new energy-efficient refrigeration system with an ammonia filling of approx. 2,000 kg. Two speed-regulated Sabroe screw compressors cover the necessary refrigeration capacity of 760 kW. An economiser is integrated in the screw compressor to maximise overall system efficiency. Frequency converters optimise the output of the drive motors for highly efficient operation in the partial load range. In total, two deep-freeze warehouses are supplied by the new refrigeration system. Three shock-froster rooms were connected to the existing CO₂ refrigeration plant. An industrial NH₃ brine liquid chiller supplies refrigeration energy for the natural casing warehouse and various processing rooms. The system is based on two frequency-controlled piston compressors with ammonia separator and plate evaporator. The cooling system with its entirely new concept gives CDS Hackner GmbH the ideal technical, hygienic and economic conditions to expand its production capacities and continue its successful international expansion.

Clear trend: many reasons and incentives for natural refrigerants

The use of natural refrigerants in the food industry increasingly makes both economic and ecological sense. More and more companies advocate NH₃-based refrigeration concepts in new systems or when expanding existing capacities, for both economic and ecological reasons. The slightly higher initial investment is offset by distinctly lower operating costs, so that systems operating with natural refrigerants have the potential for being more cost efficient in the long run. The increased awareness of environmental issues in the general public, in industry and in the political sector is another important incentive for using natural refrigerants. For example, more and more companies are drawing up their own internal sustainability guidelines and actively communicate this environmental commitment to the outside world. In this context, they can make a relevant, credible statement by changing from CFC to natural refrigerants, which neither deplete the ozone layer nor contribute to the greenhouse effect.

Annex

Ammonia (NH₃)

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 (CO₂)

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.

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 ₃ H ₈ , propene C ₃ H ₆ , isobutane C ₄ H ₁₀)	0	<3
Water (H ₂ O)	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 hydrocarbons (HFCs)	0	122–14310

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 CO₂ equivalent (GWP of a CO₂ 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.
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