Background

Supermarkets advocate sustainable refrigeration

The food retailing sector increasingly uses natural refrigerants

For a long time now, consumers not only look at quality and price when making purchases. In the results of a study conducted throughout Germany by IBH Retail Consultants published in December 2010, 60% of those interviewed indicated that their purchase decisions have also recently started to take account of the extent to which companies implement the meanwhile increasing demands in society at large for a sustainable approach to everyday business practice. Supermarket chains are also increasingly opting for environment-friendly shop concepts with lower emission stores to reduce their carbon footprint.

The refrigeration systems account for a large share of energy consumption in the food retailing sector. Possibilities for taking a sustainable approach include among others the choice of particular refrigerant. "Depending on the local conditions, today it is possible to develop an individual solution with natural refrigerants for every supermarket", confirms Mark Bulmer, member of the Board at eurammon, the European initiative for natural refrigerants. "Natural refrigerants such as ammonia and CO_2 are used for supermarket refrigeration all over the world. In fact, there are two good reasons in their favour: firstly, they have no or only negligible global warming potential. And secondly, supermarket refrigerating systems with natural refrigerants are energy-efficient in operation."

The type of system suitable for a certain supermarket depends among others on the geographic location and the prevailing climatic conditions on site. Outside temperatures warmer than 26°C prevent liquefaction of carbon dioxide because the refrigerant temperature on the high-pressure side is above the critical temperature. Such trans-critical CO_2 solutions therefore tend to be used in moderate climate zones such as Canada, Scandinavia or Central Europe", Bulmer explains. "Ammonia-CO_2 cascade systems on the other hand constitute a suitable possibility for environment-friendly, efficient refrigeration in warmer regions. Ammonia is deemed to be the most energy-efficient refrigerant of them all."

Sustainable freezing and chilling with carbon dioxide

In 2010, SSP Kälteplaner AG developed a completely new refrigerating system for the Migros supermarket in the Tivoli shopping centre in Spreitenbach, Switzerland. The modern

refrigerating solution covers all the requirements made of supermarket refrigeration while taking optimum consideration of the general local conditions with regard to capital expenditure and energy demand.

The new system consists of two 150 kilowatt combined units for chilling and a 53 kilowatt booster combined unit for freezing. Altogether eight Bitzer reciprocating compressors are used for chilling with another four Bitzer reciprocating compressors in the booster combined unit. Direct evaporation of the environment-friendly natural refrigerant CO_2 is responsible for refrigeration distribution in chilling and freezing. Both systems operate in the sub-critical range whenever possible. Under high outside temperatures or when waste heat is called for, the combined chilling units operate in the supercritical range with a working pressure of up to 92 bar.

Additional energy savings are achieved by heat recovery. A heat pump uses the waste heat of the system to provide hot process water and heat for the supermarket and for an adjoining restaurant. The remaining residual heat is discharged to the outside via a gas cooler/condenser on the roof.

Changeover to natural refrigerants in South Africa with ammonia and carbon dioxide

At the moment, many supermarket refrigeration systems in South Africa still use refrigerants with a high global warming potential (GWP) and in some cases even a high ozone depletion potential (ODP). The use of natural refrigerants in supermarkets is still relatively unknown in South Africa and has therefore hardly been tested. In view of the constant increase in energy costs of more than 20% p.a. in some cases, a number of South African supermarkets have decided to change over to natural refrigerants.

In 2009, for instance, the GEA Group provided various supermarkets in South Africa with compressors for NH_3-CO_2 cascade systems. Ammonia and a glycol solution are used in the chilling range to keep the dairy and delicatessen cabinets and the refrigerated warehouses at temperatures between 0 and +2°C. The deep-freeze circuit operates on the basis of direct CO_2 evaporation for the frozen food and ice cream displays. In addition, the waste heat from the ammonia system is recovered to save energy in heating process water for the supermarket.

Various Grasso compressors generate the refrigerating capacity of the ammonia circuits in the various supermarkets, reaching levels between 285 and 860 kilowatt. Furthermore, one supermarket uses part of the compressors to feed a cold water storage tank for air-

conditioning of the premises. To this end, a glycol loop freezes water balls in a storage tank. Outside peak times, all compressors work with the same suction capacity so that free capacities from the supermarket's refrigerating circuit can be fed to the air-conditioning system.

"Operators no longer have to revert to fluorinated greenhouse gases for supermarket refrigeration", says Mark Bulmer. "Applications with natural refrigerants offer a good alternative. Thanks to intensive research and development in recent years, natural refrigerants permit energy-efficient operation today in many areas. Depending on the service life, the partly higher investment in the systems can be recuperated by lower overheads, thanks to reduced energy costs and less expenditure on refrigerants."

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.

Ozone Depletion Potential (ODP)

The ozone layer is damaged by the catalytic action of chlorine and bromine in compounds, which reduce ozone to oxygen when exposed to UV light at low temperatures. The Ozone Depletion Potential (ODP) of a compound is shown as an R11 equivalent (ODP of R11 = 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.

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