Case study

Tried and tested and increasingly in demand: Propane is gaining ground

Frankfurt/Main (Germany), 18th October, 2013. At the end of June the Environment Committee of the European Parliament recommended a faster and stricter reduction of F-gases (fluorinated greenhouse gases) by operators than expected. This more than ever brings into focus natural refrigerants, such as the hydrocarbon propane. Despite specific safety standards, propane applications are easy to implement and are increasingly popular with planners and engineers who consciously seek new refrigeration systems and a sustainable solution in terms of environmental protection and energy efficiency. Opting for technical innovation pays off immediately: propane does not contribute to the greenhouse effect and has a very low global warming potential. Another advantage is the short payback period due to low energy consumption and operating costs. The following case studies from eurammon members show the areas where propane is particularly suitable.

In the service of people and nature: City of Lübbecke uses environmentally friendly cooling

The Stadtwerke Lübbecke (public utilities) turned to Wilhelm Schriefer GmbH with the desire for a new refrigeration plant which provides both air-conditioning to the building and reliable cooling to the server room. The plant engineers were to find an environmentally friendly solution with a cooling unit whose refrigerant ideally does not increase ozone depletion or global warming. After a thorough examination the choice fell on a brine chiller unit with the natural refrigerant propane. The chemical properties of the hydrocarbon were considered in the project planning. Based on the estimated refrigerant charging amount of 2.5 kg, a concept was created to deal with safety measures. This included the outdoor installation of the system on the roof of the Lübbecke municipal administrative building.

A high level of pre-assembly facilitated the setup of the compact housing, which covers, in addition to the water chiller, all other components, water supply connections, safety system and the controller. In addition to basic components such as condensers and evaporators, the plant engineers opted for the special R290 version of a semi-hermetic reciprocating compressor from HKT Huber Kälte-Technik. Moreover, pressure controllers (for low and high pressure, respectively) and a safety high pressure limiter were used in the system. A vacuum heat exchanger increases the efficiency of the system, since an increased enthalpy

difference for the same amount of refrigerant can absorb more heat energy. The cost savings resulting from this in turn pay back the purchase price of the heat exchanger within a year. Besides the ecological advantages of the system, the overall cost benefits are impressive. "Regardless of all political debates, the stated arguments explicitly speak for this comprehensively sustainable technology. It is particularly noteworthy that the low operating costs compensate for initial extra costs in less than three years," says Karl Huber, the Managing Director of HKT Huber-Kältetechnik-GmbH.

Propane systems in a series: German supermarket chain opts for integral cooling and heating systems

The innovative, compact unit supplied to a renowned German supermarket chain was to meet the latest environmental standards and at the same time be cost efficient. The goal was to develop a prefabricated unit which provides for the generation of the required cooling for refrigeration units and cold storage rooms and the air conditioning of the sales area and the heat supply of a floor heating including the electrical equipment for the entire supermarket.

Futron GmbH provided the concept and developed the new unit together with thermofin GmbH. "Convincing arguments for the use of propane as refrigerant were the high energy efficiency ratio, the low pressure level and pressurised gas end temperature as well as the relatively low price," explains Willy Löffler, a senior official at thermofin®. The compact unit comprises both the refrigeration system with 130 kW cooling capacity for cooling and a heat pump with 40 kW heating capacity. The refrigeration units and cold storage rooms are cooled indirectly with propylene glycol as secondary refrigerant. The need for low temperature is supplemented by an additional cooling unit as a CO_2 cascade system.

An additional evaporator circuit in the lamellar blocks of the air-cooled condenser brings the heat from the ambient air to the floor heating. The low energy consumption of the system and the positive effect in terms of environmental protection are quite impressive. The characteristics of propane reduce the CO_2 equivalent of the refrigerant from 9.07 t to nearly 0. "The prototype of the integral system has even surpassed the expectations of our customers. There are now more than 200 systems in operation, which demonstrates that propane is absolutely qualified for mass production today," says Willy Löffler.

Cascade system cools hops in the Hallertau region

As one of the world's largest hop traders with its own production, Hopsteiner based in Mainburg (Hallertau) relies on natural cooling. Their old R404a refrigeration system was to be replaced by a larger cold brine system with 130 kW. To process the sticky hop cones mechanically, it needs temperatures as low as -35˚C. Based on this, Robert Baust of Robert Schiessl GmbH presented a cascade system with CO_2 and propane, which convinced in no time. The decisive factor was the future-proof, environmentally friendly overall package solution with low operating costs. Moreover, the investment costs balanced out in a short time thanks to the statutory subsidies. Since 2009, the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) has been funding the renovation of old refrigeration plants and the construction of new systems by up to 25 percent of the costs, provided all the prescribed guidelines, such as the use of natural refrigerants, the compliance with a specific TEWI value or a fixed annual power consumption are observed.

To avoid dangerous situations in the event of propane leakage, it was also necessary to take special safety precautions while designing the complex propane/CO_2 cascade system, in addition to accommodating the specific characteristics of the refrigerant. Six Bitzer semi-hermetic reciprocating compressors were installed in total, which are designed for propane and subcritical CO_2 applications. Moreover, the planner decided to use new microchannel technology from Güntner: a desuperheater for R744, a condenser and a subcooler for R290. These components are made of aluminium and belong to a new series which is specially approved for inflammable refrigerants like propane. The key argument was, however, the extremely low refrigerant charge thanks to this technology. Despite the subcoolers, a charge of only 44 kg is needed for the R290 section of the refrigeration plant. Due to all these special components, the system is very efficient and keeps the operating costs low. Additional energy benefits are created by speed-controlled compressors with frequency converters and electronic injection valves. The operator was delighted to report remarkable COP values, which are as high as 2.3 at a brine temperature of -38˚C. "Hopsteiner is so satisfied with the concept that the company has already ordered a second cold brine system with 100kW, of course with propane," says Robert Baust of Schiessl.

Other application areas for propane

These practical examples demonstrate that propane systems are environmentally friendly and energy efficient. It is already feasible to make individual customised systems as well as standard series production models. Today, propane is already established in medium and

small capacities up to 100 kW (as in heat pumps or air conditioners in the food retail sector) as well as in logistic cooling with refrigerating capacities of up to 300 kW. The high efficiency of propane applications is a decisive argument to persuade engineers and operators to go for the environmentally friendly alternative.

[[8.085 Zeichen]]

Please do not hesitate to contact us in case you wish to receive picture material relating to this case study.

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 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.
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