Ammonia – The Natural Refrigerant

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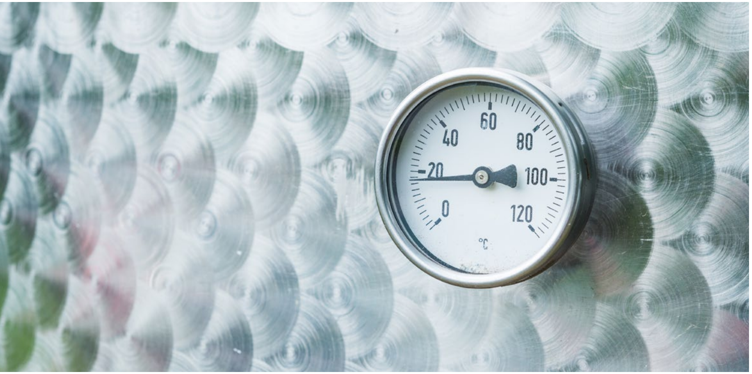
Ammonia – environmentally friendly, economically efficient



Our developed society depends on industrially produced refrigeration. Whether at home, in industrial production processes or in air-conditioning systems – refrigeration is a central element everywhere. Industrially produced refrigeration is what makes a modern lifestyle possible, from production and storage of frozen foods, yogurt and coffee to autos, chemicals and pharmaceuticals. And natural refrigerants such as ammonia, carbon dioxide and hydrocarbons are an integral element in refrigeration.

Natural refrigerants have been used to produce cold energy – mainly in food production and storage – since the mid-19th century. Ammonia (NH_3) in particular has proven its worth in industrial refrigeration for over 120 years. Although "safety refrigerants" such as the now illegal CFCs were increasingly used in plants built in the 1950s and '60s, ammonia has always managed to prevail in industrial refrigeration technology. Due in large part to the environmental debate surrounding ozone depletion and global warming, ammonia's share in the market for refrigeration technology is on the rise again. Companies of long-standing tradition and experience prefer to work with ammonia.

Compelling characteristics

Ammonia is a colourless gas that liquefies under pressure and has a pungent odour. In refrigeration technology, ammonia is known as R 717 (R = Refrigerant). Although it is synthetically produced for use in refrigeration, ammonia is considered a natural refrigerant because it occurs in nature's material cycles. Ammonia is combustible only to a limited degree; its ignition energy is 50 times higher than that of natural gas, and it 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 odour with a high warning effect. It becomes noticeable in the air at concentrations of just 3 mg/m^3 ammonia. This means that ammonia becomes evident at levels far below those which endanger health (> 1,750 mg/m^3). Ammonia is lighter than air and therefore rises quickly.

Ammonia is also an ideal refrigerant relative to climate protection. Ammonia has no ozone depletion potential (ODP = 0) and no direct greenhouse effect (GWP = 0). Its indirect greenhouse effect contribution is also very limited due to its high energy efficiency.

Of all known refrigerants, ammonia requires the lowest primary energy input for the "typical" application fields of the refrigeration and air-conditioning technology to create a given refrigerating capacity, thanks to its excellent thermo- dynamic properties. This means that its indirect global warming potential is also very low. Thus, plants that use ammonia as opposed to other refrigerants have a better TEWI (Total Equivalent Warming Impact). The TEWI is the sum of the direct global warming impact – caused by the refrigerant lost through leakage and recovery – and the indirect global warming impact, in relation to the energy used over the life of the plant.

Ammonia is sustainable from an economic point of view, as well. Unlike synthetic refrigerants, it is an inexpensive feedstock and available everywhere. The difference in price becomes evident when initially charging a plant, but also and especially when topping off leakage losses. Experts assume annual losses of between 2 and 17 percent for ramified industrial refrigeration plants, depending on a plant's age and condition.[1] In addition to the costs of synthetic refrigerants, which are significantly more expensive than ammonia, leakage also puts a considerable strain on our climate whose effects are not yet foreseeable to their full extent.

Energy savings with ammonia

Plants that use ammonia also have an edge when it comes to overhead or running costs.[2] Beyond reducing leakages, ammonia lowers maintenance expenses and – especially for industrial plants – energy consumption. Ammonia is one of the most efficient refrigerants around, resulting in low energy costs. And finally, there's the inexpensive disposal when a plant has reached the end of its life.

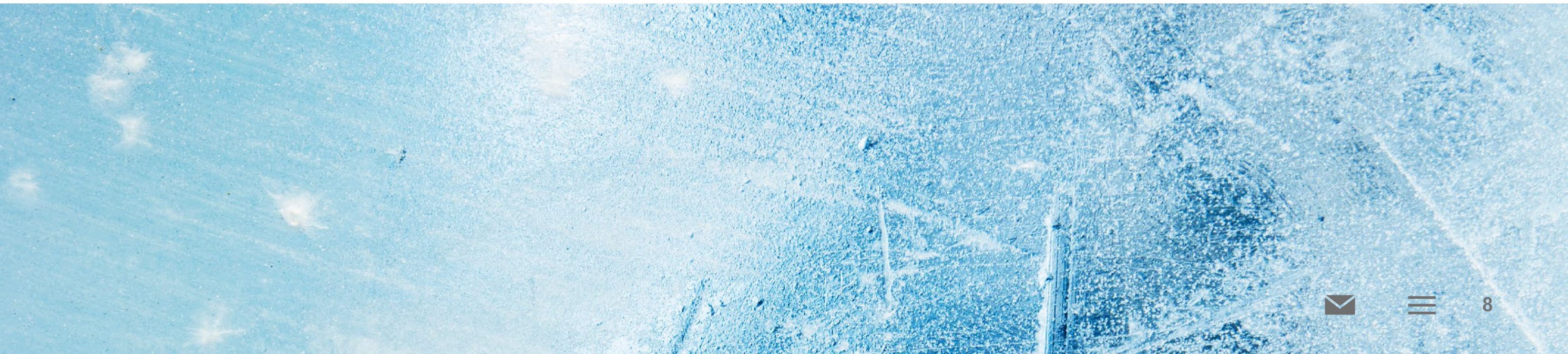
Ammonia's virtues as a refrigerant have opened up whole new fields of application. In light of carbon dioxide emissions trading, which forces operators to curb their energy use, many operators are choosing ammonia refrigeration plants. Today, ammonia is used in such widely different fields as process refrigeration, air-conditioning in airports, office buildings and production halls, and sports and recreation facilities. Indirect refrigeration systems and cascades, e.g., using carbon dioxide as the low-temperature refrigerant, now prevail in plant design. The advantage: ammonia charges are kept low, and the "cooling" is delivered to the consumer loads via fluids like carbon dioxide and glycol water.

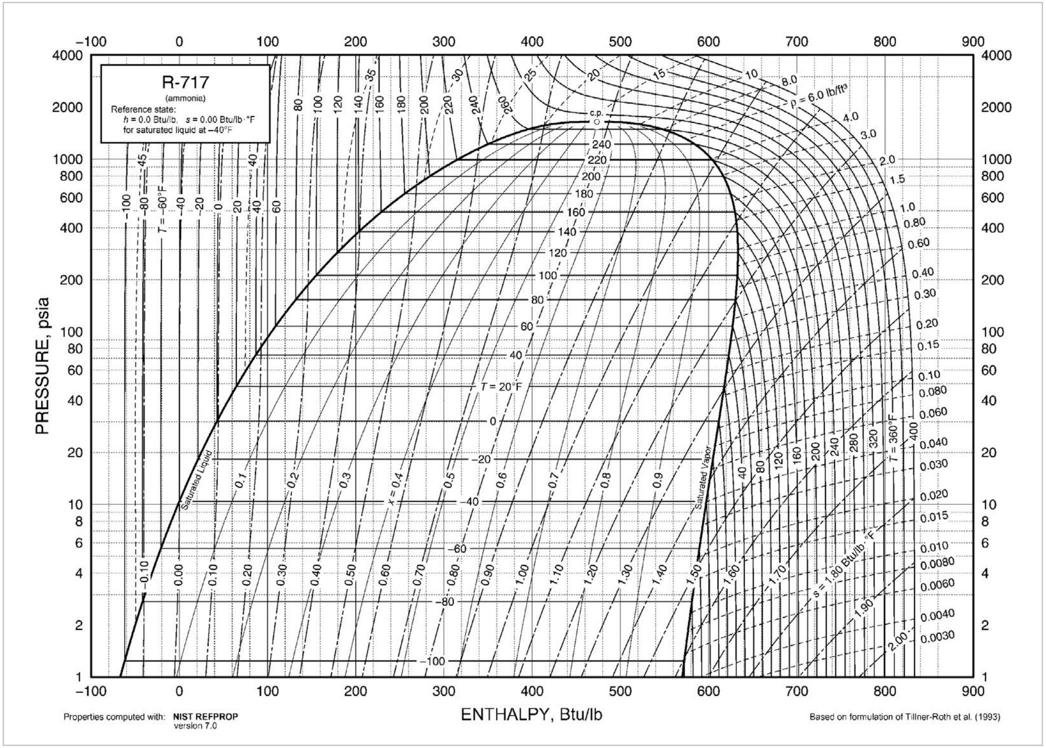
Properties of ammonia

ODP	0
GWP	0
Appearance	colourless
Odour	characteristic, pungent
Solubility in water (20 °C, 1 bar)	0,517 kg oder 650 l(g)/l water
Heat of solution	36 kJ/mol
Molar mass	17,03 kg/kmol
Boiling point (1.013 bar)	–33,3 °C
Density of the saturated vapour (20 °C)	6,7025 kg/m³
Thermal decomposition	> 450 °C
Explosion limits	15 Vol.-% bis 34 Vol.-% 108.000 mg/m³ to 240.000 mg/m³
Ignition temperature	650 °C

Ignition energy (20 °C, 101 kPa)	14 mJ
Water content in the cycle	little relevant
Detection threshold	5 ppm 3,5 mg/m³
MAK-Value	20 ppm 35 mg/m³
Recognition threshold	250 ppm 175 mg/m³
Tolerance limit	500–1.000 ppm 350–700 mg/m³
Symptoms of poisoning	2.500 ppm 1.750 mg/m³
Fatal concentration	> 5.000 ppm 3.500 mg/m³
Long-term effects	not carcinogenic, not mutagenic
Concentration in human blood	0,8–1,7 ppm
Amount produced daily in the human body	17 g ~ 1 mol
Water endangerment category	2, ID No. 211
Enthalpy of evaporation at 0 °C	1.262 kJ/kg

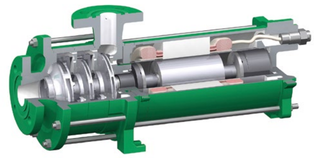
Vapor pressure at 0 °C	4,29 bar
Pressure ratio at 0 / 35 °C	3,15
Volumetric refrigerating capacity at 0 / 35 °C	3.798.2 kJ/m^3
Isentropic refrigerating capacity number 0 / 35 °C	6,75
Isentropic discharge temperature 0 / 35 °C	82,6 °C
Thermal conductivity of the liquid at 0 °C	518,5 x 10-3 W/mK
Kinematic viscosity of the liquid at 0 °C	2.66 x 10-7 m^2/s
Heat transition (evaporation, condensation)	very high



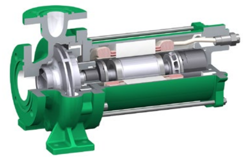


Pressure-enthalpy diagram for NH_3

HERMETIC solution for NH_3



CAM series



CNF series

Ozone Depletion and Global Warming Potential of various 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, Butane C_4H_{10})	0	3
Water (H_2O)	0	0
Chlorofluorocarbons (CFCs)	1	4600–14000[3]
Partly halogenated Chlorofluorocarbons (HCFCs)	0,02–0,06	120–2400[3]
Perfluorinated hydrocarbons (PFCs)	0	5700–11900[3]
Partly halogenated fluorinated hydrocarbons (HFCs)	0	124–14800[4]
Unsaturated fluorinated hydrocarbons (HFOs)	0	< 10 (effects on the environment not known to full extent)

Ozone Depletion Potential (ODP)

The depletion of the ozone layer is driven primarily by the catalytic action of chlorine, fluorine and bromine in compounds, which split up ozone molecules (O_3), thus destroying the ozone layer. A compound's Ozone Depletion Potential (ODP) is shown as its equivalent in chlorine (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).

References

1 Palandre, L., Clodic, D., Kuijpers, L.: HCFCs and HFCs emissions from the refrigerating systems for the period 2004–2015, The Earth Technology Forum, Washington DC, April 14 2004.

2 König, H., Roth, R.: Wirtschaftlichkeitsanalyse für Industrie-Kälteanlagen mit CO_2 als Tieftemperaturkältemittel, KI Luft- und Kältetechnik, C. F. Müller-Verlag, Karlsruhe, S. 333–336, Heft 7, 2002. (Feasibility Analysis for Industrial Refrigeration Plants Using CO_2 as Low-Temperature Refrigerant)

3 IPCC III Status Report – 2001

4 IPCC IV Status Report – 2005 (Basic for F-Gas Regulation 517/2014)

HERMETIC – benefits to you

Short delivery times

Our standard pumps can be delivered in a very short time. We have set up an additional emergency store with common pump designs to support you even better.

Long-lasting pumps

Our canned motor pumps are continuously optimized to ensure long-lasting operation with as little maintenance as possible.

High quality

Our mission is to deliver the highest quality with the best price-performance ratio.

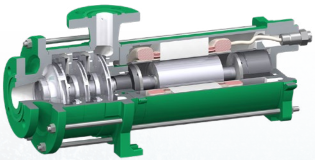
Highest security

With our pumps, you can be sure that no medium will escape. Among other things, we ensure this by using not only the pump housing, but also a can as a safety cover.

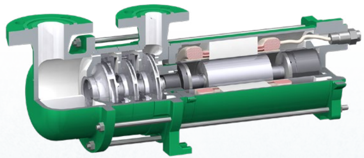
Reliable partner

We will support you with all your questions, whether about the pump design, the preparation of an offer, the installation of the pump or even with pump operation.

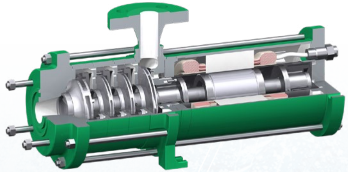
HERMETIC canned motor pumps – portfolio for ammonia applications



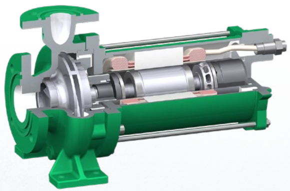
Multi-stage canned motor pump
type CAM



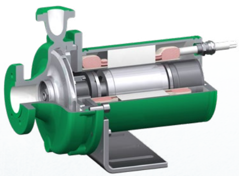
Multi-stage canned motor pump
type CAMR



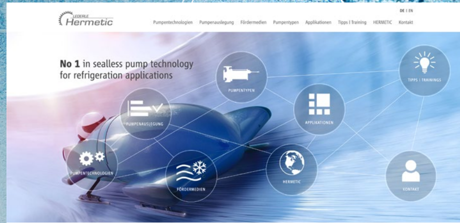
High-pressure canned motor pump
type CAMh



Single-stage canned motor pump
type CNF



Single-stage canned motor pump
type LC



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