ENOUGH
EUROPEAN FOOD CHAIN SUPPLY TO REDUCE GHG EMISSIONS BY 2050

Factsheet 14
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Natural refrigerants

Why should we only use natural refrigerants?

To mitigate climate change, measures must be taken to ensure sustainable action now and in the future. This also applies to the thermal energy supply in the food industry. Vapour compression systems are mainly used for cooling, freezing, and heating in the harvesting, processing, transport, and retail phase of the food value chain. Sustainable solutions such as heat pumps and refrigeration systems play a key role. These processes require a working fluid, also called a refrigerant, which undergoes a phase change from liquid to gas and back again during the process. Generally, a distinction is made between synthetic and natural refrigerants. Synthetic refrigerants, initially chlorofluorocarbons (CFCs), were phased out due to ozone layer depletion. Hydrofluorocarbons (HFCs) replaced CFCs, but their high global warming potential (GWP) prompted regulations for their phase-out, such as the EU's F-Gas regulation, Paris agreement and Kigali amendment. Hydrofluoro-olefins (HFOs), the next generation, have a lower GWP but decompose rapidly, potentially producing trifluoroacetic acid (TFA), belonging to the group of PFAS (also named forever chemicals). A PFAS restriction proposal is currently in the process within ECHA and aims to ban PFAS by 2025, which would lead to a ban of low GWP HFOs.[1;2] Natural refrigerants occur naturally and have no severe harmful environmental impacts. This category includes ammonia (R717), carbon dioxide (R744), hydrocarbons (HCs) like propane (R290) and isobutane (R600a), and water (R718). Ammonia and carbon dioxide were widely used before CFCs where introduced. With the phase-out of CFCs under the Montreal Protocol, interest in natural refrigerants revived and led to innovations so that even the energy efficiency is now equal to or better than when systems apply synthetic alternatives [1].

Where can natural refrigerants be used in the food value chain?

Natural refrigerants are increasingly being selected for their environmental benefits, energy efficiency and sustainability. They do not deplete the ozone layer, have no or a low global warming potential. Ammonia is particularly favoured in the food industry due to its high performance and high energy efficiency. It is commonly used to chill fruits, vegetables, meat, and dairy products, as well as in large industrial cold stores. Carbon dioxide is widely applied for water heating heat pumps and in supermarkets, particularly in refrigerators and freezers. Due to its thermo-physical properties, systems are very compact and in the event of a leakage, CO_2 has no negative effects on the products. Propane and butane are very energy efficient alternatives, they are currently used in smaller capacity cooling systems and heat pumps. On the other hand, high temperature heat pumps, able to upgrade surplus heat, also apply these hydrocarbons as working fluids.

Natural Refrigerants in the Food value chain			
On Farm	Commercial or domestic refrigeration	Cold storage, Milk cooler, AC	R290 (Propane) R744 (CO_2) R1270 (Propylene)
	Commercial or domestic heat pumps	Space heating, Hot water production,	R600a (Isobutane)
Processing Storage	Industrial refrigeration	Freezing applications within food processing from -53°C to +5°C	R290 (Propane) R717 (Ammonia) R718 (H_2O) R744 (CO_2) R600 (n-Butane)
		Warehouses and distribution centre cooling and freezing	
		Chiller	
		Ultra-low temperature applications	R729 (Air) R744 (CO_2) R1270 (Propylene)
	Industrial heat pumps	Industrial heat pumps providing high temperature lifts	R290 (Propane) R717 (Ammonia) R718 (H_2O) R744 (CO_2) R600 (n-Butane) R600a (Isobutane)
Transport Last mile transport	Transport and mobile AC	Passenger cars	
		Chilled and Frozen Transport (Truck, Container, Ship)	
		Public transport (Bus, Train)	R290 (Propane) R729 (Air) R744 (CO_2)
Retail	Commercial refrigeration	Centralised systems, integrated units (heat-pump-chiller)	R290 (Propane) R717 (Ammonia) R718 (H_2O) R744 (CO_2)
	Commercial heat pumps	Hot water heat pumps for hotels, other high-performance buildings	
Domestic	Domestic refrigeration	AC units (split units) Air to air Heat pumps	R290 (Propane)
		Domestic Fridges/ Freezers Commercial plug in Units	R290 (Propane) R600a (Isobutane)
	Domestic heat pumps	Hot water and space heating (liquid to liquid, air to liquid)	R290 (Propane) R744 (CO_2)

[1] *M. Eckert et al. Natural Refrigerants: Applications and Practical Guidelines. VDE Verlag GmbH, 2022. ISBN 9783800753314.*

[2] *Cooling Post, 2023. PFAS ban affects most refrigerant blends [WWW Document]. URL https://www.coolingpost.com/world-news/pfas-ban-affects-most-refrigerant-blends/ (accessed 2.20.23).*

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