

# The Future of Cooling Liquids in ULT Freezers

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Global warming is a challenge for mankind on earth. In addition to direct CO<sub>2</sub> emissions, the hydrofluorocarbons used in cooling systems such as air-conditioners, refrigerators, and laboratory ULT freezers increase global warming due to their chemical structure. Hydrofluorocarbons cause multiple times the damage of CO<sub>2</sub>. As a result, there is a move to switch coolants from hydrofluorocarbons to

hydrocarbons, also known as “green” gases. As one of the very first manufacturers to implement hydrocarbon coolants at -86 °C, Eppendorf now has 15 years of experience in research and development, production, logistics, and service in the field of energy efficient, environmentally friendly ULT freezers.

Sustainability discussions primarily focus on energy consumption of devices. Even environmentally friendly and energy efficient ultra-low temperature freezers traditionally consume a large amount of energy as they maintain extremely low temperatures 24 hours a day, 7 days a week, for years. Aside from energy consumption, the type of cooling liquid used is receiving more and more focus.

## Hydrofluorocarbons

Several years ago, the ozone-depleting CFC-based cooling liquids were phased out (based on the Montreal Protocol). The cooling was and partly is replaced by alternative compounds known as hydrofluorocarbons (HFCs), particularly R508b and R404a. Despite being better for the environment (ozone), these classic cooling liquid HFCs still have a high Global Warming Potential (GWP).

The GWP is a factor to measure the impact of a substance to global warming. The reference point is CO<sub>2</sub> which has a GWP of one. All other substances have multiple factor of CO<sub>2</sub>. The calculated GWP values are provided in CO<sub>2</sub>e. By using the GWP concept, different greenhouse gases can (easier) be compared in regards to their effectiveness in supporting global warming.

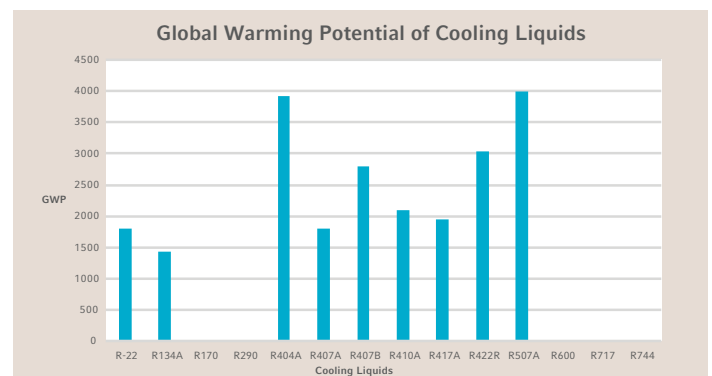
For example, R404a has a GWP of 3,922. This means that 100 g of this substances has the same GWP as 392 kg of CO<sub>2</sub>-equivalent.

## Hydrocarbons

For freezers, hydrocarbons (HC) are also known as “green” or natural coolants. The two most commonly used representatives

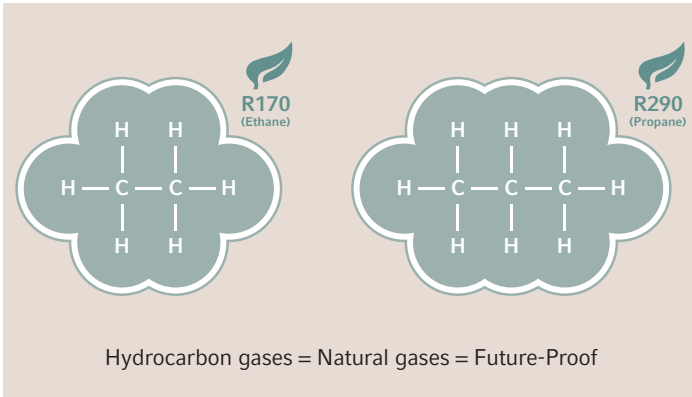
are propane and ethane (known as R290 and R170, respectively). The GWP of HC cooling liquids are more directly equivalent to CO<sub>2</sub> (R290: GWP of 3; R170: GWP of 6).

R290 is a commonly used cooling liquid in large commercial cooling systems. Due to their superior efficiency and performance, the amount of HC cooling liquids used is significantly lower as that of a similar system with classic cooling by HFCs. Due to these advantages, R290 and R170 are both on the SNAP (Significant New Alternatives Policy Program for substitution of ozone-depleting substances by EPA) list for approved coolants for usage in very low temperature instruments.



### Global Warming Potential (GWP)

Each greenhouse gas has a global warming potential (GWP) value. This value reflects the climate impact of a kilogram of emissions compared to the same mass of carbon dioxide (CO<sub>2</sub>). The GWP value is calculated and published by the Intergovernmental Panel on Climate Change (IPCC). The GWP is calculated using a set time horizon. The GWP values are updated periodically based on scientific research.



Years	Percentage to calculate the maximum quantity of hydrofluorocarbons to be placed on the market and corresponding quotas
2015	100 %
2016 – 17	93 %
2018 – 20	63 %
2021 – 23	45 %
2024 – 26	31 %
2027 – 29	24 %
2030	21 %

### Hydrocarbons in the USA

In 2005, [the California Global Warming Solutions Act of 2006 \(AB32\)](#) requires that the Air Resources Board determine the statewide greenhouse gas emissions level in 1990. Further on, the act required that the Air Resources Board approves a statewide greenhouse gas emissions limit be achieved by 2020. This limit is equal to the 1990 level. To avoid any confusion, this limit is an aggregated statewide limit- there is no sector- or facility-specific focus.

In 2016, [the Senate Bill 32, California Global Warming Solutions Act of 2006: Emissions Limit \(SB32\)](#) further intensified the limit: By 2030, California has to reduce statewide greenhouse gas emissions by an additional 40% below the value of 1990. This process also includes a drastic reduction of HFC cooling liquids. The American Innovation and Manufacturing Act of 2020 (AIM Act) was enacted on December 27, 2020. The AIM Act mandates the phasedown of HFCs by 85 percent from historic baseline levels by 2036 and authorizes EPA to address HFCs in three main ways: (1) phasing down HFC production and consumption through an allowance allocation program, (2) facilitating sector-based transitions to next-generation technologies, and (3) issuing certain regulations for purposes of maximizing reclamation and minimizing releases of HFCs from equipment.

To achieve the first part, the phasedown of HFCs through an allowance program, EPA established the HFC Allocation Program in the Allocation Framework Rule, "Phasedown of Hydrofluorocarbons: Establishing the Allowance Allocation and Trading Program under the AIM Act" (86 FR 55116), which codified the AIM Act's production and consumption phasedown schedule of HFCs. This phasedown schedule started with a 10% reduction in 2022 and a further decrease in 2024 to 60% of baseline levels." (<https://www.epa.gov/climate-hfcs-reduction/frequent-questions-phasedown-hydrofluorocarbons>)

Currently, there are no requirements to stop using any specific equipment currently in use.

### Hydrocarbons in Europe

In April 2014, the European Union announced a midterm ban of all non-hydrocarbon-liquids for new cooling systems (EU) No 517/2014, also known as F-gas-regulation. This ban has been implemented by a step-wise reduction of the annual amount of newly produced or imported HFC-liquids in Europe. Producers as well as importing bodies of HFCs received reference quantity values based on their averaged annual quantities brought to market based on 2009 to 2012 (Article 16).

These allocated quotas have been reduced annually from 2015 (100% reference value) on. The major reduction of HFCs has been achieved between 2015 and 2019 by adapting newly produced cooling instruments to HCs. From 2020 to 2030, the cut-down of HFCs will be slower as new production of cooling instruments will be limited to HCs and the reduction is driven by phasing-out older instruments and therefore less servicing of these.

The recovery of liquids has to result in recycling, reclaiming, or destruction in a proper way.

The ban of HFCs in Europe included all cooling devices, with an exception for instruments that run temperatures below -50 °C (Article 13/3). Based on this exception, ULT freezers of -86 °C may continue to be produced with HFCs and can continue to run and be serviced. However, it made sense to replace the HFC cooling liquids in new ULTs with the new ecologically-friendly green coolants as well - in order to counteract global warming.

To aid in this worldwide goal, we at Eppendorf have a clear plan to replace all ULT freezers using classic cooling by hydrocarbon coolants until end of 2024.

Based on an evaluation prepared by the EU Commission, Regulation (EU) No 517/2014 has resulted in a year-on-year decrease of HFC emissions. The supply of HFCs has declined by 37 % in metric tonnes and by 47 % in terms of tonnes of CO<sub>2</sub> equivalent in the period of 2015 to 2019. A clear shift towards using alternatives with a lower global warming potential has been monitored. This has included natural alternatives like hydrocarbons.

However, the evaluation of Regulation (EU) No 517/2014 indicated that the emission savings which were planned to be reached by 2030 will not be achieved to fulfill the European Union climate objectives.

### Regulation (EU) 2024/573

In February 2024, the Directive (EU) No 517/2014 was replaced by Regulation (EU) 2024/573. This new regulation intensifies the rules of using HFC:

“The placing on the market of products and equipment, including parts thereof, listed in Annex IV, with an exemption for military equipment, shall be prohibited from the date specified in that Annex, differentiating, where applicable, according to the type or global warming potential of the gas contained. By way of derogation from the first subparagraph, the placing on the market of parts of products and equipment required for repair and servicing of existing equipment listed in Annex IV is allowed provided that the repair or servicing does not result in:

- (a) an increase in the capacity of the product or equipment;
- (b) an increase in the amount of fluorinated greenhouse gas contained in the product or equipment; or
- (c) a change in the type of fluorinated greenhouse gas used that would lead to an increase of the global warming potential of the fluorinated greenhouse gas used.”

[EU 2024/573 Chapter III Article 11]

As part of (EU) 2024/573, the exception for instruments below -50°C is eliminated. This means, from 2025, all newly produced ULT freezers in Europe must be driven by HFC-free cooling liquids.

### Remember 2008?

The New Brunswick Premium U570-G by Eppendorf was one of the very first commercially available ULT freezers driven by hydrocarbon-based cooling liquids: In 2008, however, the interest was still limited.

After more than 15 years of experience in R&D, production, logistics, and service in the field of hydrocarbon-cooled ULTs, we are now happy to see the concept globally confirmed:

Nowadays, the majority of ULT freezers sold in Europe are hydrocarbon-based, energy-efficient models. A growing number of users take hydrocarbon-driven ULTs for granted, and more and more ULT suppliers are producing hydrocarbon-driven ULT freezers.

It’s one of the most important and lasting trends in laboratory equipment as we work together toward a brighter future. Welcome to the green club.

High performance results in fast pull-down times as well as short recovery times – saving your valuable time in the lab. Higher efficiency results in lower heat outputs into the surrounding space of the freezer which is unloading the aircondition system. By taking advantage of more efficient ULT freezers like the CryoCube® F740hi, you can also save running costs and reduce your carbon footprint for the air condition system.

These steps represent one more building block in a longer Eppendorf sustainability story.



The CryoCube® F740hi ULT freezer is constructed with sealed cooling loops and only hydrocarbon gases to ensure adherence to regulations.

## Safety

One concern about utilizing these hydrocarbon coolants, especially propane and ethane, is safety as they are known to be flammable gases. Just how safe are they and how safe are instruments that utilize these gases?

According to IEC 60335-2-89, no additional safety requirements for using natural gases in ULT freezers are necessary as long as the cooling liquid loops are hermetical sealed and the amount per cooling liquid is limited to 150 g.

Underwriters Laboratories (UL), the publisher of the norm UL471 (Standard for Safety; Commercial Refrigerators and Freezers), has also set the limit for these HC cooling liquids to 150 g for safe handling without additional safety instructions (SB3.2).

All Eppendorf ULT freezers using "green" gases fulfill these conditions for safe usage.

For example, in the CryoCube F740hi ULT freezer, we meet the requirements with:

- ✓ Sealed cooling loops
- ✓ 110 g R290 (propane) within first loop
- ✓ 98 g R170 (ethane) within second loop

## About Eppendorf

Since 1945, the Eppendorf brand has been synonymous with customer-oriented processes and innovative products, such as laboratory devices and consumables for liquid handling, cell handling and sample handling. Today, Eppendorf and its more than 5,000 employees serve as experts and advisors, using their unique knowledge and experience to support laboratories and research institutions around the world. The foundation of the company's expertise is its focus on its customers.

Eppendorf's exchange of ideas with its customers results in comprehensive solutions that in turn become industry standards. Eppendorf will continue on this path in the future, true to the standard set by the company's founders: that of sustainably improving people's living conditions.

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