

The Future of Cooling Liquids in ULT Freezers

November 2018

Global warming is a challenge for mankind on earth. In addition to direct CO₂ 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 CO₂. 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 green coolants at -86 °C, Eppendorf now has 10 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

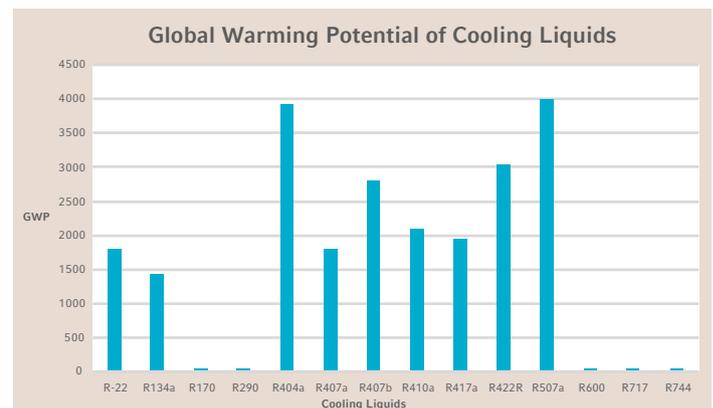
Several years ago, the ozone-depleting CFC-based cooling liquids were phased out (based on the Montreal Protocol). The cooling was and partly is replaced by alternative compounds known as hydrofluorocarbons (HFCs), particularly R508b and R404a. Despite being better for the environment (ozone), these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

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 CO₂-equivalent.

Hydrocarbons

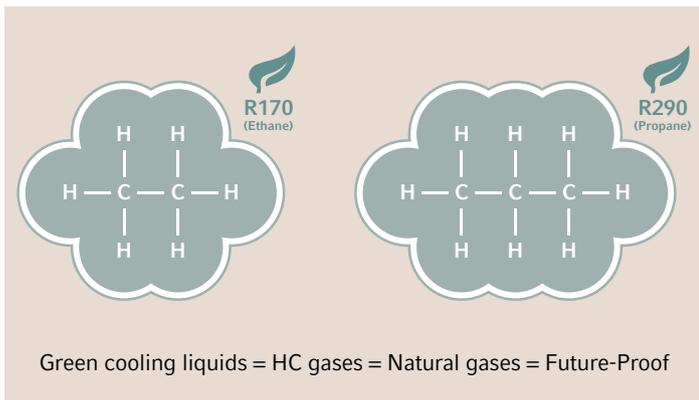
For freezers, hydrocarbons (HC) are also known as green or natural coolants. The two most commonly used representatives are propane and ethane (known as R290 and R170, respectively). The GWP of HC cooling liquids are more directly equivalent to CO₂.

R290 is a commonly used cooling liquid in large commercial cooling systems. Due to their superior efficiency and performance, the amount of green 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 (CO₂). 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.



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 requires 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. The 2020 limit of GHG emissions is 431 million tons of carbon dioxide equivalent.

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.

Hydrocarbons in Europe

In April 2014, the European Union announced a ban of all non-hydrocarbon-liquids for new cooling systems (EU_517/2014) by 2020, also known as F-gas-regulation. This ban is being implemented by a step-wise reduction of the annual amount of newly produced or imported non-hydrocarbon-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).

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 %

These allocated quotas are reduced annually from 2015 (100% reference value) on. The major reduction of HFCs down to 50% will be achieved until 2020 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 includes 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 makes 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.



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

To aid in this worldwide goal, we at Eppendorf have a clear plan to replace all ULT freezers using classic cooling by hydrocarbon coolants within the next few years.

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 air-conditioning 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 green Eppendorf story.

Remember 2008?

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



After 10 years of experience in R&D, production, logistics, and service in the field of green ULTs, we are now happy to see the concept globally confirmed:

Nowadays, the majority of ULT freezers sold in Europe are green, energy-efficient models. Asia and America are beginning to focus on the benefits of employing power-saving freezers. A growing number of users take green ULTs for granted, and more and more ULT suppliers are producing green 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.

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

The safe usage of e.g. Eppendorf CryoCube F740 series freezers with green cooling liquids were also confirmed by external tests at UL. The standard UL471 is fulfilled and certified.

The US EPA requirements for warning/ caution text and symbols are clearly marked on every green Eppendorf hydrocarbon ULT freezer.

Discuss with your facility's safety officer to make sure the Eppendorf F740 series ULT freezer is right for your lab.

Summary

ULT freezers with green cooling liquids (e.g. R290/ R170) provide you with an energy saving, future-proof cooling system, as well as actively reduce your greenhouse gas emissions and combat the threat of global warming.

For additional information, please visit
www.eppendorf.com/freezers

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