https://r744.com/about-co2-refrigeration-why-use-co2-as-a-refrigerant/

R744.

CO_2 COOLING MARKETPLACE

About CO_2 refrigeration: Why use CO_2 as a refrigerant?

Using carbon dioxide (CO_2) as a refrigerant began in early industrial times and has been revived in the past couple of decades. But what is CO_2 refrigeration? And why is CO_2 a good thing when it comes to refrigeration? It is, after all, common knowledge that CO_2 emissions from fossil fuel consumption are one of the main drivers of climate change.

CO_2 and all other refrigerants used in air conditioning, heat pumps and refrigeration systems have been given a Global Warming Potential (GWP) value. The GWP explains the magnitude of its effects on the climate over a period of time, traditionally 100 years. As the main greenhouse gas, CO_2 — also called R744 when used as a refrigerant — has been given a GWP value of 1. This is to make comparisons between different refrigerants easier.

So why is CO_2 refrigeration a good thing?

This becomes apparent when looking at synthetic refrigerants promoted by the chemical industry. These have GWPs that, in many cases, are thousands of times higher. Two of the most popular synthetic refrigerants around the world, currently, are called R410A and R32. R410A has a GWP of 2,100 and R32 has a GWP of 771, calculated over a period of 100 years. In other words, R410A's GWP is more than two thousand times higher than R744's, meaning that while CO_2 that escapes from cooling or heating equipment does have a small impact on the climate, the alternatives are thousands of times worse.

These values are even higher when looking at short term effects. If calculated over a period of 20 years, the GWP values for R410A and R32 becomes 4,400 and 2,530,

respectively. This is relevant because many of these fluorinated synthetic refrigerants break down in the atmosphere much quicker than 100 years – with atmospheric lifetimes closer to 20 years (or even less). (For more information about GWP values and how they are calculated, see below.)

This doesn't mean that CO_2 emissions from burning fossil fuels are suddenly unproblematic, most certainly not. We should still do our best to minimize those emissions as much as possible. However, in the cooling and heating industries, CO_2 refrigeration is a very environmentally friendly option compared to synthetic refrigerants. So using CO_2 can actually help reduce the effect these industries have on the climate – significantly.

Moreover, because it is benign to the environment, CO_2 can be considered a "future-proof" refrigerant, which will never be encumbered by the regulations that have targeted fluorinated refrigerants.

Other refrigerant options

CO_2 is not the only refrigerant with a low GWP. Other natural refrigerants[1] like ammonia and hydrocarbons (propane and isobutane), have even lower GWPs, less than 1. For more information about ammonia and hydrocarbons,
visit Ammonia21.com and Hydrocarbons21.com.

The newest generation of synthetic refrigerants (called HFOs) also have low GWPs compared to their predecessors. However, these HFOs have other concerns. They are flammable, and there are growing environmental concerns that they are damaging to the environment, and to human health.

Scientists are looking at byproducts created when HFO refrigerants break down in the atmosphere. These byproducts can enter water bodies and drinking water supplies and be consumed by humans and other animals.

One of the main concerns is about trifluoroacetic acid, or TFA, because some HFO refrigerants (especially R1234yf) produce TFA when broken down in the atmosphere. According to a definition used in Europe, TFA belongs to a group of chemicals better known as forever chemicals (or PFAS) because they are very persistent and don't break down any further once in the environment. So any problems will only increase over time as more HFOs are released. The issue with TFA is that a growing number of peer-reviewed studies are providing evidence that it is, among other things, damaging to the liver and thyroid function in humans.

In other words, the conclusion is that using CO_2 for refrigeration is one of the safest and most environmentally friendly options we currently have.

[1] *Natural refrigerants are non-synthetic and naturally occurring substances, as opposed to synthetic refrigerants, which are compounds created by chemists in a laboratory.*

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Impact of Refrigerants: Fact Sheet #1 (V.1.1.)

Real GWP: 20 years vs.100 years

Refrigerant	Type	Composition	GWP 100 years	"Real" GWP 20 years
R404A	HFC	44% R125 / 4% R134a / 52% R143a	4,200	**6,600**
R22	HCFC	100% R22	1,780	**5,310**
R407A	HFC	20% R32 / 40% R125 / 50% R134a	2,100	**4,500**
R410A	HFC	50% R125 / 50% R32	2,100	**4,400**
R407C	HFC	23% R32 / 25% R125 / 52% R134a	1,700	**4,100**
R134a	HFC	100% R134a	1,360	**3,810**
R448A (Solstice N40)	HFC/ HFO	26% R32 / 26% R125 / 21% R134a / 7% R1234ze / 20% R1234yf	1,400	**3,100**
R449A (Opteon XP40)	HFC/ HFO	24,3% R32 / 24,7% R125 / 25,7% R134a / 25,3% R1234yf	1,400	**3,100**
R449C (Opteon XP20)	HFC/ HFO	20% R32 / 20% R125 / 29% R134a / 31% R1234yf	1,200	**2,900**
R32	HFC	100% R32	704	**2,530**
R452B (Opteon XL55)	HFC/ HFO	67% R32 / 7% R125 / 26% R1234yf	710	**2,100**
R513A (Opteon XP10)	HFC/ HFO	44% R134a / 56% R1234yf	600	**1,700**
R454B	HFC/ HFO	68.9% R32 / 31.1% R1234yf	490	**1,700**
R450A (Solstice N13)	HFC/ HFO	42% R134a / 58% R1234ze	570	**1,600**
R744	Natural	CO_2	1	**1**
R600a	Natural	Isobutane	<1	**<1**
R290	Natural	Propane	<1	**<1**
R1270	Natural	Propylene	<1	**<1**
R717	Natural	NH_3	0	**0**
R718	Natural	H_2O	0	**0**
R729	Natural	Air	0	**0**

Table 1: The "real" impact of refrigerants on the environment over the next 20 years. Source: UNEP[1]

Why Measure GWP over 20 Years Instead of 100?

Why is the 100-year global warming potential (GWP) time frame not recommended? Because we do not have another 100 years to achieve our 2050 climate neutrality and net zero targets – we need to make changes now! The policies decided in next decade is crucial for reaching these targets and limiting the damage to the environment. To take the right decisions, policymakers need to be as informed as possible on the real impact of refrigerants – something that is more accurately reflected in the 20-year GWP metric.

Hydrofluorocarbons (HFCs) and new generation refrigerants such as hydrofluoroolefins (HFOs) and HFO blends are marketed as "climate friendly" because they are not ozone-depleting and have seemingly low GWPs. However, when assessing the real lifetime of these refrigerants, their negative impact on health, safety, and the environment raises concern.

Currently, the GWPs. of refrigerants is usually measured over a period of 100 years with reference to CO_2. This means that CO_2 (R744) is the benchmark at a GWP of 1 and everything else is measured in terms of how much more of an impact it makes on global warming. Nevertheless, considering the relative short lifetime of synthetic refrigerants in the atmosphere, a shorter horizon, such as 20 years, would much better reflect the true effects of these gases on the climate.

For instance, promoted as a "low-GWP" solution, R32 has a GWP100 of 704[1]. However, this gas has an atmospheric life time of only 5.4 years and when its GWP is measured over 20 years instead, it is almost four times higher at 2,530. Presenting GWP100 data instead of more accurate GWP20 data is misleading the public as well as policymakers in terms of which refrigerants are in fact truly climate-friendly and sustainable.

For more information, visit atmosphere.cool

[1]UNEP. 2019. 2018 Report of the TOC Refrigeration, A/C and Heat Pumps Assessment Report. Kenya, Ozone Secretariat.