Polyol Ester (POE) Power: Cooling a Sustainable World

How POEs can help the world stay green

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Introduction: A sustainable shift

In recent years, global energy company OQ has focused its attention on the 'hot' topic of climate change. As temperatures rise, demand for cooling has also increased which is inadvertently a significant contributor to global warming. Now, OQ is looking to cool this issue and the planet by supporting a sustainable shift to climate-friendly refrigerants with its compatible lubricant raw materials.

The company has substantially supported the transition to new cooling technologies in the Heating, Ventilation and Air Conditioning (HVAC) industry as a leading supplier of carboxylic acids and polyols – the foundational materials needed to manufacture polyol ester (POEs) based refrigeration lubricants. Moving forward, OQ will continue to play a pivotal role in the global drive towards refrigerant alternatives that are more environmentally friendly.

One example of how OQ helped the sector make sustainable changes previously was when it supported the shift to the R410A refrigerant – one of the most commonly used refrigerants for commercial refrigeration, air conditioning, and heat pump systems today. The R410A was one of the successors to the R22, a hydrochlorofluorocarbons (HCFC) refrigerant that was gradually phased out after the Montreal Protocol in 1987 as R22 was found to be severely depleting the ozone layer.

Manufacturers responded by coming up with hydrofluorocarbon (HFC) refrigerants like the R410A, which are comparatively harmless to the ozone layer. These new HFC refrigerants were compatible with POE base oils made from carboxylic acids and polyols. As the leading supplier of these raw materials, OQ played a key role in facilitating the switch to these low-ozone depletion alternatives.

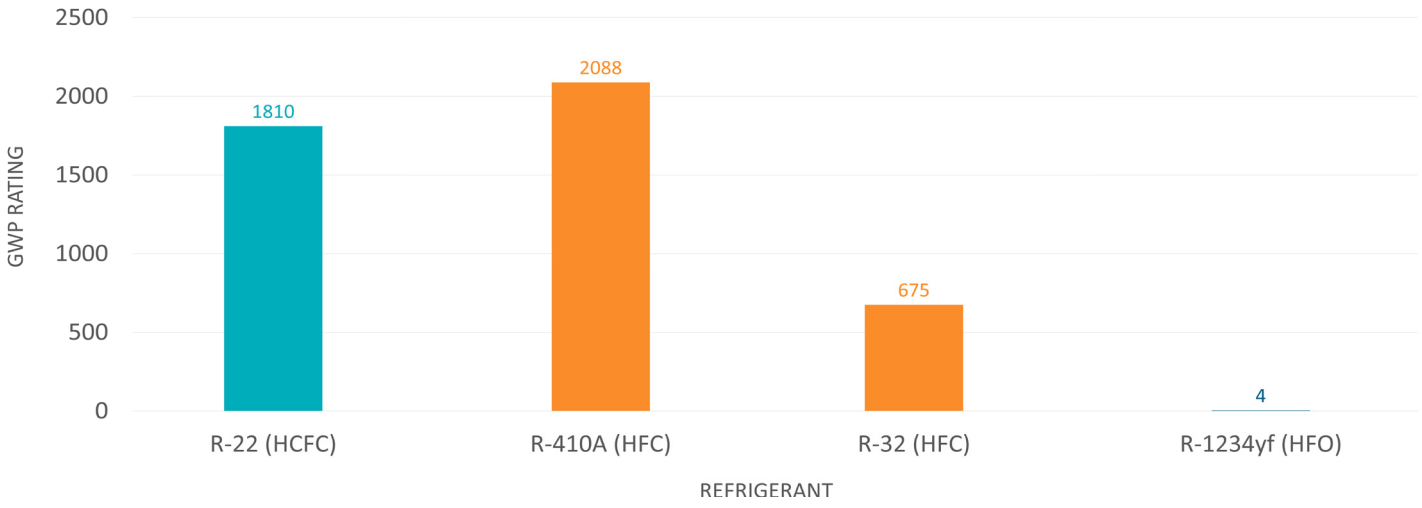
However, as a greenhouse gas, HFC refrigerants still contribute to global warming. To assess their environmental impact, refrigerants are given a Global Warming Potential (GWP) rating. This measures the global warming effects of different gases relative to carbon dioxide, the primary greenhouse gas whose GWP is equivalent to 1. In comparison, HFC refrigerants have a greenhouse effect that is up to 14,800 times stronger than carbon dioxide. For instance, the R410A has a GWP rating of 2,088. This has compelled the industry to search for more sustainable solutions in cooling technologies, which has become more pressing with rapid urbanisation and the subsequent surge in demand for air-conditioners. It is estimated that the cooling sector accounts for about 10 per cent of global CO2 emissions – three times the amount produced by aviation and shipping industries combined.

A global effort to save the planet

The increasing global consciousness of climate change has led to significant changes in the use of HFCs. In 2016, 197 countries agreed to adopt an amendment to the Montreal Protocol. Known as the Kigali Amendment, this will see a progressive reduction in the global production and use of HFCs over the next few decades. The goal is to reduce global HFC consumption by over 80 per cent by 2047, and replace them with more environmentally friendly alternatives.

Countries are already taking action. European F-gas regulations aim to decrease the European Union's emission of fluorinated greenhouse gases by 70 million tonnes of CO2 equivalent by 2030. China has drafted proposals to phase down HFC refrigerants, such as increasing regulations, strengthening the monitoring of its emissions and

GWP OF SELECT REFRIGERANTS



HCFCs

- Ozone depleting
- Types: R22, R123, R124, R142B etc

HFCs

- Minimal impact on ozone layer
- High greenhouse effect
- Types: R410A, R134a, R125, R32 etc

HFOs

- No impact on ozone layer
- Chemically less stable than HFCs
- Flammable
- Types: R1234f

HFC-HFO Blend (new generation refrigerants)

- Minimal impact on ozone layer
- Low greenhouse effect
- Types: R1234ze(E)

The goal is to reduce global HFC consumption by over 80 per cent by 2047, and replace them with more environmentally friendly alternatives.

Customers will be looking for three main criteria in these solutions: safety, its impact on the environment, and affordability. OQ will be able to support this demand on all three fronts.

increasing fines for violations. In May 2021, the United States Environmental Protection Agency (EPA) released a proposed rule that would decrease the country's production and imports of HFCs by 85 per cent over the next 15 years. By October 2021, the agency will determine the amount of HFCs that can be produced and consumed for 2022.

This is the first time the US federal government has set national limits on HFCs. Soon, refrigerants like the R410A will be phased out as companies search for sustainable solutions. Customers will be looking for three main criteria in these solutions: safety, its impact on the environment, and affordability. OQ will be able to support this demand on all three fronts.

New-Generation Refrigerants: From HFC to HFC-HFO

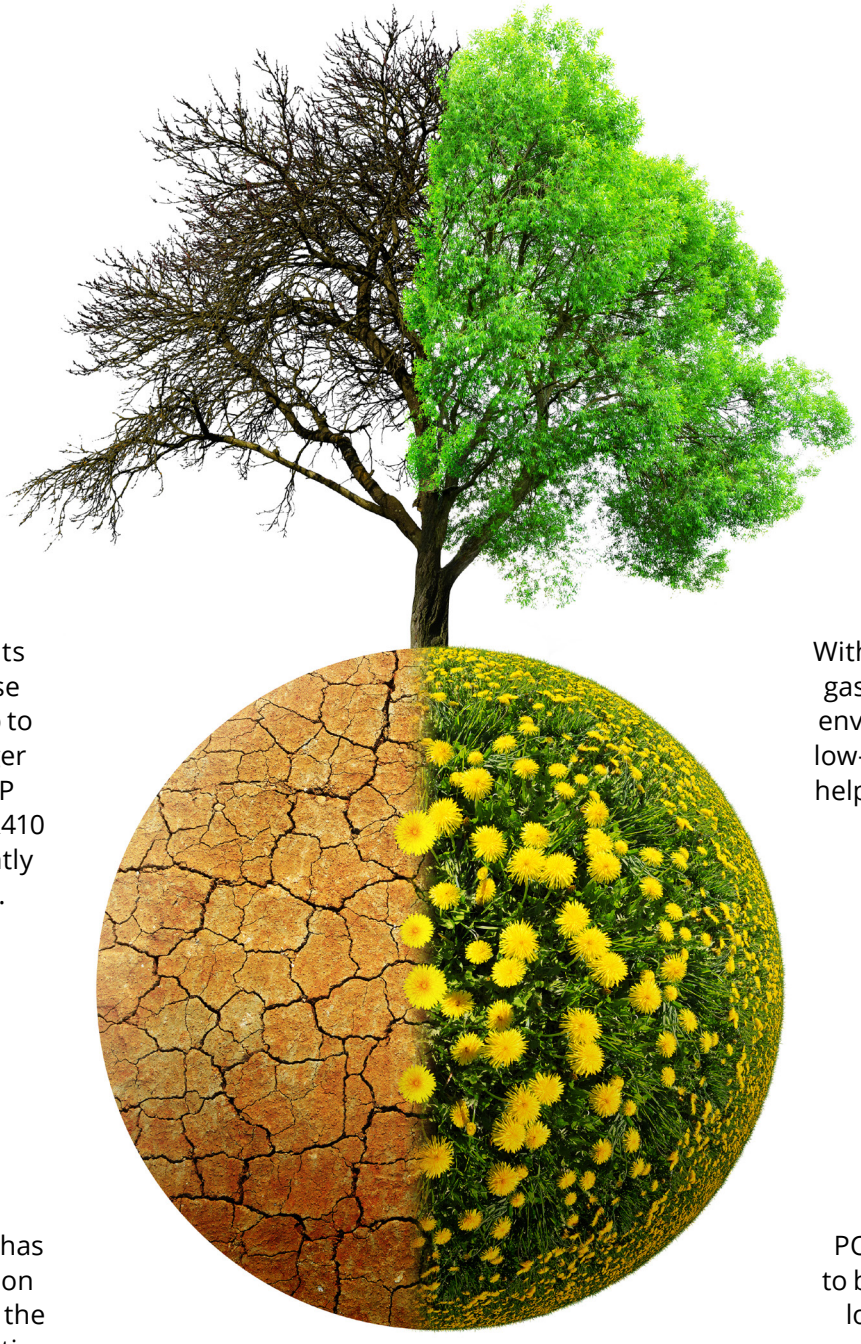
This speed and scale of the regulations have required refrigerant manufacturers to quickly pivot towards low-GWP refrigerant alternatives. With zero ozone depletion potential and low GWP ratings, hydrofluoroolefins (HFOs) have been touted as the next generation of refrigerants. For example, the HFO refrigerant R1234yf has a GWP rating of just 4.

However, HFO refrigerants are chemically less stable than their HFC counterparts. This can weaken an air-conditioner's cooling capabilities. In addition, most HFO refrigerants like the R1234yf are also flammable, which makes them a safety hazard under high temperatures. In terms of volumetric refrigeration capacity, there are also no like-for-like HFO replacements for HFC refrigerants such as the R410A commercially available presently.
As such, HFO-HFC blends are now widely seen as the next-generation successors to HFC refrigerants. These alternatives – a mix of HFCs and HFO refrigerants – are more stable and have low GWP ratings.

Danish engineering firm Danfoss[1] predicts that by 2027, there will be a shift from HFCs to HFO-HFC refrigerants for use in air conditioners. This new generation of refrigerants will require compatible lubricants to be used in the compressor systems. POE oils are currently the most common type of synthetic lubricant being used with HFC refrigerants. They have also been found to be one of the best matches for HFO-HFC blends. With the cooling industry now facing the dual concern of improving sustainability and meeting heightened demand, OQ can once again play a leading role in addressing both issues. POEs derived from OQ's carboxylic acids and polyols will be fueling that charge. The company's long-term expertise and manufacturing capabilities will also enable it to lead the next generation lubricant roll-out.

1 Founded in 1933, Danfoss is a Danish engineering company that has over 27,000 employees in more than 100 countries. The company places heavy emphasis on sustainability. For instance, it develops energy efficient cooling technologies that uses low-GWP refrigerants.

Paving a Sustainable Path and Meeting Urban Demand with New-Generation Refrigerants



With HFC refrigerants having a greenhouse effect that can be up to 14,800 times stronger than CO2, high GWP refrigerants like the R410 contribute significantly to global warming.

With minimal greenhouse gas emissions, the more environmentally-friendly low-GWP refrigerants can help mitigate the effect of global warming.

As of 2018, the world has an estimated 1.6 billion air conditioners, with the cooling sector accounting for 10 per cent of global CO2 emissions. By 2050, it is predicted that two-thirds of the world's households could have an air conditioner.

POEs have been found to be suitable with these low-GWP alternative refrigerants. With the widest portfolio of carboxylic acids on the market, OQ can support the POE market more than any supplier.

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Harnessing the POE potential

A refrigerant lubricant serves multiple purposes in a compressor: reducing the frictional wear on the compressor's moving parts; keeping the compressor cool when the circulation process heats its motors; and acting as a seal against refrigerant leakage.

To be compatible with refrigerants, lubricants need to possess four key attributes:

1. Thermal stability

As the refrigerant circulates the compressor, it results in a temperature increase which can reach up to 180 degrees Celsius. The heat subsequently increases the vapour pressure of the refrigerant oil, which will move through the system to lubricate the compressor. As such, a refrigerant lubricant needs to be stable under vast temperature differences.

2. Chemical stability

A refrigeration lubricant should be chemically stable to avoid any reaction with the refrigerant.

3. Miscibility

The refrigerant lubricant needs to be able to mix well together with the refrigerant. Immiscible oils can build up in the compressor, hindering heat transfer and preventing the system from operating at full capacity.

4. Viscosity

A refrigerant lubricant needs to possess the perfect viscosity levels that provide the optimal amount of sealing and lubricant in the compressor. Too high, and it will be unable to flow through the compressor system. Too low, and it can cause increased wear and tear on the compressor's components.

As a refrigerant lubricant, POEs possess these key attributes which have led to them becoming the primary choice of synthetic oil for HFC refrigerants over the past three decades. In addition,

- **They provide better lubrication and have better miscibility than mineral oils.**
- **They possess dispersant properties that help keeps a compressor's parts clean.**
- **They are the longest lasting of all the lubricant types, reaching up to 12,000 hours of continuous run time in a compressor.**
- **Being biodegradable, they are also an environmentally-friendly choice.**
- **POEs are versatile enough to mix with other additives and base stocks.**

It has been proven that POEs are suitable with HFC-HFO refrigerants and blends. In fact, a 2016 study conducted by Purdue University[2] showed POEs have high miscibility, lubricity, and chemical stability under HFO refrigerant atmospheres.

Its versatility also lends itself well to HFO-HFC refrigerants as the POE properties can be modified accordingly to suit each refrigerant. All that is required is to change the type of polyol and carboxylic acids along with their ratios.

This is where OQ comes in as an integral part of the lubricant value chain. Boasting the widest portfolio of carboxylic acids on the market, the company supports the POE market more than any carboxylic acid supplier.

With its versatile suitability and backed by OQ's manufacturing capabilities, POEs have cemented their place to be the lubricant of choice for the next generation of refrigerants. Moving forward, carboxylic acids and polyols will be in greater demand as cooling technologies move towards sustainable solutions.

2 The Purdue University College of Engineering features one of the United States' leading engineering programmes, ranking 9th overall in 2020.

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OQ - Supporting the shift towards a sustainable future

As a leading global energy company, sustainability forms a major pillar of OQ's operational philosophy. Its sustainability guidelines take reference from international blueprints such as the United Nations Sustainable Development Goals and the Global Reporting Initiative. These guidelines align OQ's commitment to issues such as sustainable development and human rights. In 2019 and 2020, OQ Chemicals achieved two consecutive Gold status from Ecovadis, an international rating agency that assess companies' sustainability activities.

One of its goals is to balance business excellence with environmental stewardship. As such, it is looking to support innovative solutions that minimises harm to the environment, while still enabling societal and economic growth.

Supporting the next generation of cooling technologies will be one way forward. OQ offers the broadest portfolio of carboxylic acids in the industry which aids the overall shift towards low-GWP refrigerants. Being the market leader in the range of C3 to C9 synthetic fatty acids, the diversity of our product portfolio means that there is a limitless potential to create and improve upon the right POEs to complement the next generation of refrigerants.

Currently, OQ boasts five multi-product carboxylic acid plants at three locations: the cities of Marl and Oberhausen in Germany, as well as Bay City in Texas, United States. The expected increase in future demand has also led to the company ramping up its output of carboxylic acids.

The expansion is timely. As incomes and standards of living increase, countries will continue to rapidly urbanise, leading to a growing demand for air conditioning in buildings and cooling technologies for industries.

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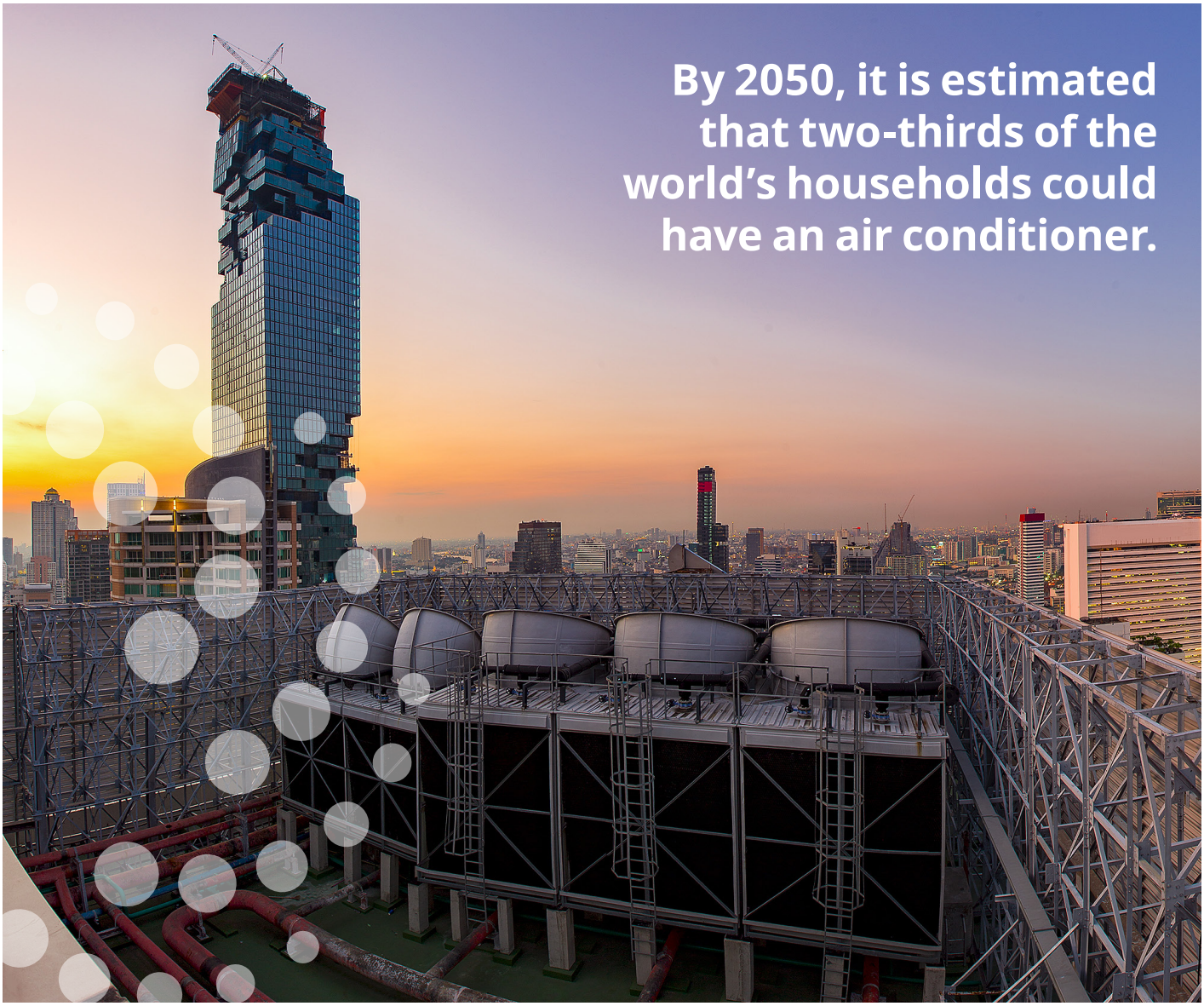

An International Energy Agency (IEA) study in 2018 showed that the world had an estimated 1.6 billion air conditioners (AC) as of the same year. Annual sales of ACs had also nearly quadrupled to 135 million units between 1990 and 2016.

The same study also showed that by 2050, it is estimated that two-thirds of the world's households could have an air conditioner. This in turn will increase the need for more ecological solutions, and environmentally-friendly refrigerants will be imperative if the world is to mitigate the effects of global warming.

With the demand of carboxylic acid accelerating in the years to come, the speed of supplies will be essential. The wide range of carboxylic acids provided by OQ can instantly support the development of urgently needed solutions to address an increasingly regulated market and a changing climate. It will help bolster the security of supplies required by refrigerant manufacturers.

Conclusion

The POEs made from OQ's carboxylic acids and polyols are the lubricants of choice in the next generation of refrigerants.

The materials that OQ provides have helped support the development of innovative solutions for refrigerants in the past, and will continue to do so in the future. From specialised materials to quality solutions, OQ can work with any partner in making a premium product that also ensures a sustainable future.

We are the choice of today, and will continue being the choice for tomorrow.

For commercial enquiries, contact us at **https://connect.oq.com/inquiry** or scan the QR code