Hall 9

CHILLVENTA

Chillventa Specialist Forums 2022
Chillventa Fachforen 2022

CONNECTING EXPERTS.

Lubricants for lower GWP refrigerants

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Climate and energy crisis

Scientists had warned us, the **climate crisis is here**:
how can we deal with this unavoidable challenge?

Energy demand from air conditioners is expected to **triple by 2050**:
how can we find a balance between this need and the soaring energy prices?

Refrigeration lubricants: the key players in the environmental challenge

When discussing refrigerants and their environmental impact, it is necessary to recognise the **importance of the refrigeration lubricant** as the element that carries essential chemicals into the AC/R system to guarantee:

- the stability of its components
- its efficiency
- longer lifespan

AC/R systems and environment: a global evaluation for an actual change

WHAT HAS BEEN DONE SO FAR:

- Montreal Protocol: to phase out the production and use of compounds with high ODP (Ozone Depletion Potential)
- Kyoto Protocol: to focus on eco-friendly and low GWP (Global Warming Potential) refrigerants

VS

WHAT WE NEED TO DO:

- Analyse how AC/R systems affect the environment and find solutions to reduce their effects.

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4 environmental effects of an AC/R system

- possible **refrigerant leaks**, caused by holes or cracks localised in the AC/R system;
- **energy consumption** of the AC/R system, which increases with its use over time, if the system is not properly maintained;
- disposal of **waste refrigerants and lubricants**;
- **disposal** of a damaged and **no longer functioning AC/R system**.

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Refrigerants

Transitioning to eco-friendly or **lower GWP refrigerants** is one of the solutions that has been adopted globally.

Among the most widely used, there are:

- R-744
- Hydrocarbons such as R-600 or R-290
- HFO
- Blends
- R-717

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Problems related to alternative refrigerants:

- working pressure, solubility and, often, chemical stability;
- possible damages that can reduce the lifespan of AC/R systems

New refrigerants and efficient AC/R systems: how?

Efficiency can be obtained through **specific additives** that, carried by the refrigeration lubricant, neutralise the chemical reactions, often causing AC/R system damage.

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4 steps to select the proper refrigeration lubricant

Choose the type of refrigeration lubricant (mineral, semi-synthetic, synthetic)

Evaluate the environmental impact

Analyse the lubricant basic properties

Develop the specific properties of lubricants

Types of refrigeration lubricants

MINERAL	NAPHTHENIC PARAFFIN
SEMI-SYNTHETIC	ALKYL BENZENE PAO (Polyalphaolefin)
SYNTHETIC	POE (Polyolester) PAG (Polyalkyline Glycol) PVE (Polyvinyl ether)

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Synthetic Lubricants and Biodegradability

Synthetic lubricants have a lower environmental impact than mineral ones.

For instance: POE Lubricants can be formulated from natural acids and alcohols, reducing the environmental impact linked to both their production and disposal.

Lubricant Basic Properties

Lubricant compatibility with refrigerant	miscibility solubility
Viscosity 40 °C	the measure of a fluid's resistance to flow
Viscosity Index	the rate of the viscosity change, due to a temperature change
Pour Point	the temperature below which the lubricant becomes semisolid and loses its flow characteristics
Moisture (ppm)	the amount of water contained in the lubricant
Total Acidity (mg KOH/g)	residual acidity
Flashpoint	the temperature at which lubricant vapours ignite

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9 steps of lubricant formulation

- Foam level control
- Anti-foam additivation
- Synthesis catalyst residual control
- Anticorrosive additivation
- Antioxidant additivation

9 steps of lubricant formulation

- Anti-moisture additivation
- Surfactant additivation for suspended impurities
- Acidity-neutralising additivation
- Anti-wear additivation

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The assumptions analysed so far make it easy to understand how important it is to identify the **correct lubricant for the specific purpose** to be developed.

Lubricant groups consist of **different molecules**, and this is most evident in synthetic lubricants. For example, with regard to POE, dozens of Acid-Alcohol blends are used to obtain the right lubricant for different purposes.

Within the lubricant groups, the **choice of specific additives** enables the most efficient lubricant to be obtained for a given purpose **to stabilise the system, reduce corrosion, extend system lifespan** and **improve its efficiency**.

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Lubricants for Hydrocarbons

specifically R-290 and R-600, R-600a

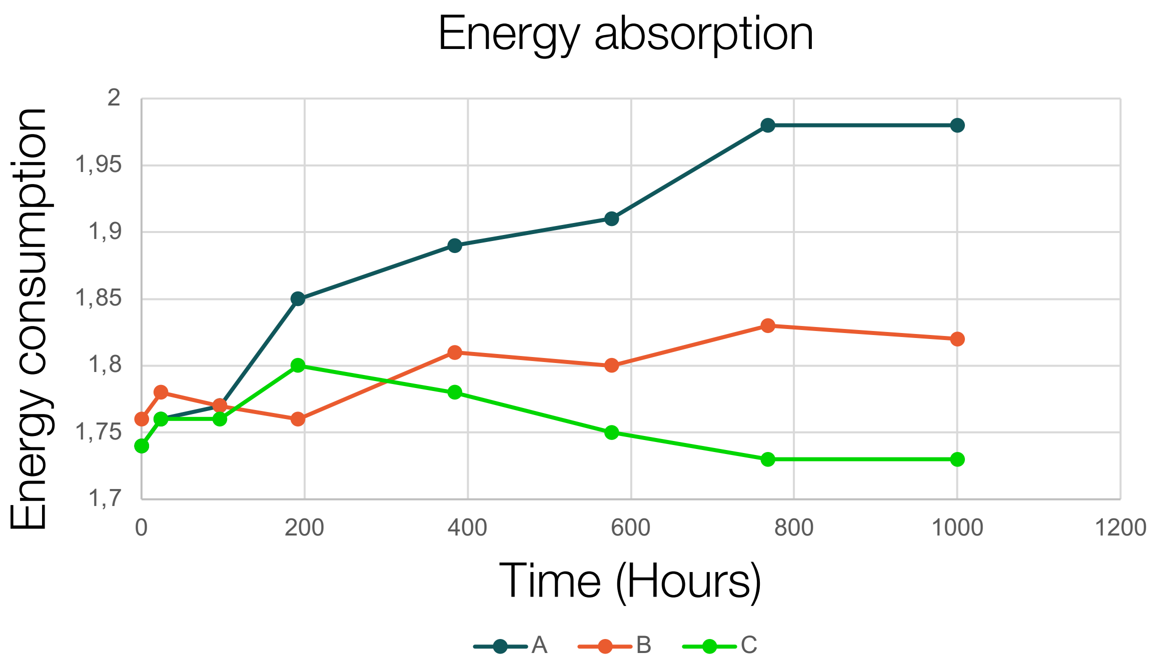
PAG for AC/R: ISO 68, ISO 100, ISO 150

- Selection of the proper polymer chain and end-capping technology
- Anti-foam additivation
- Antioxidant additivation
- Anti-moisture additivation

Selection of the proper polymer chain and end-capping technology

1. Hypothesis of the proper polymer chain and end-capping technology

2. Testing phase through the evaluation of:
   - the energy consumption
   - the wear of the compressor
   - the amount of lubricant in the system after 1000 hours
   - the lubricant properties after 1000 system hours.



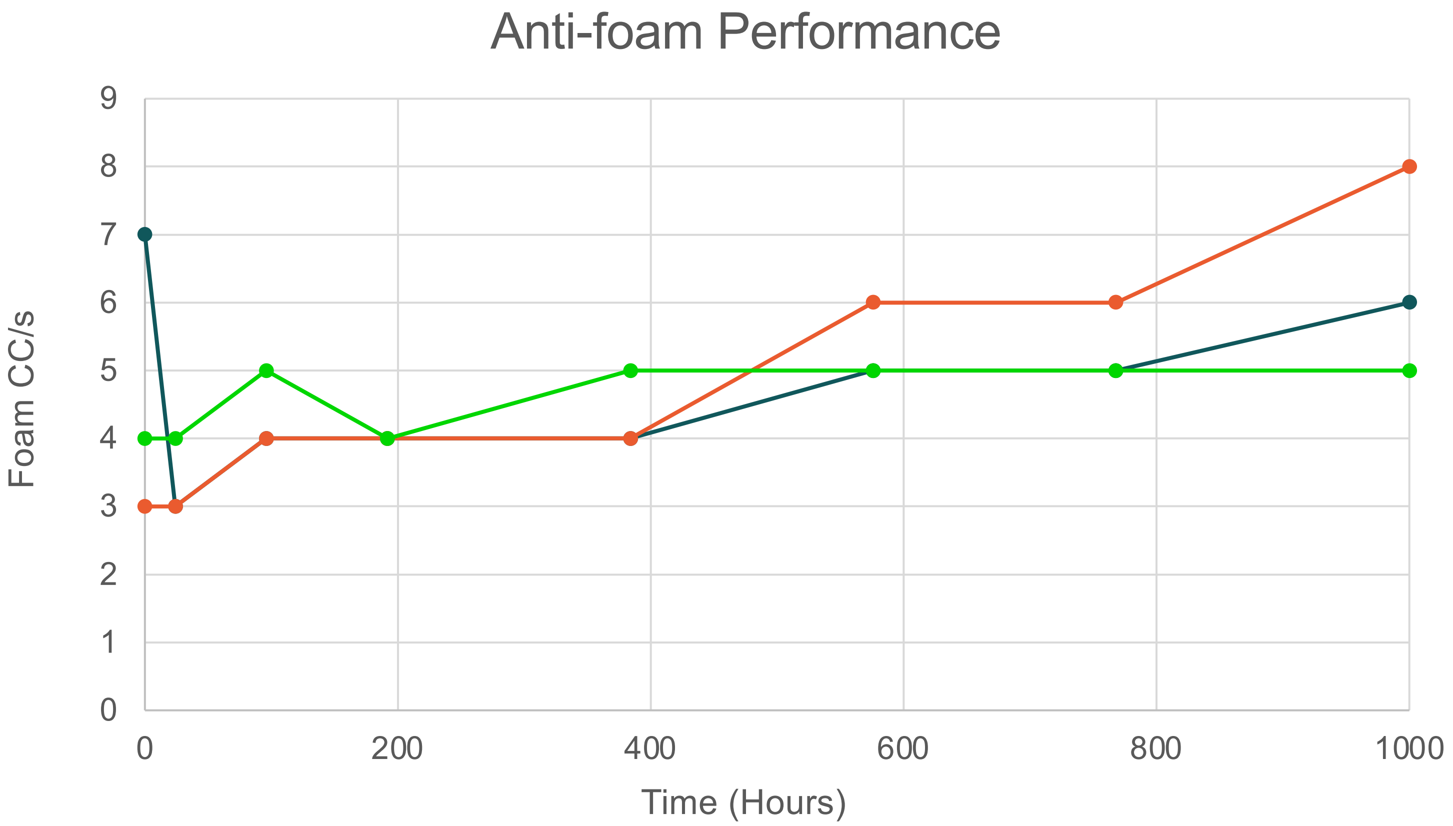
3. Definition of the most appropriate polymer chain and end-capping technology

Anti-foam additive

Comparing:

- Commonly used additives
- New polymer chain A
- New polymer chain B

Polymer chain B added to PAG for hydrocarbons showed a long-lasting reduction in foam formation.



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Antioxidant additive

Purpose: protection of the lubricant, refrigerant, and system components

Filter drier of a system not adequately protected with anticorrosive additive

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Antioxidant additive

How it works: the antioxidant acts as a substitute for other system elements during the oxidation process, by getting consumed before them.

Protected pipe sections

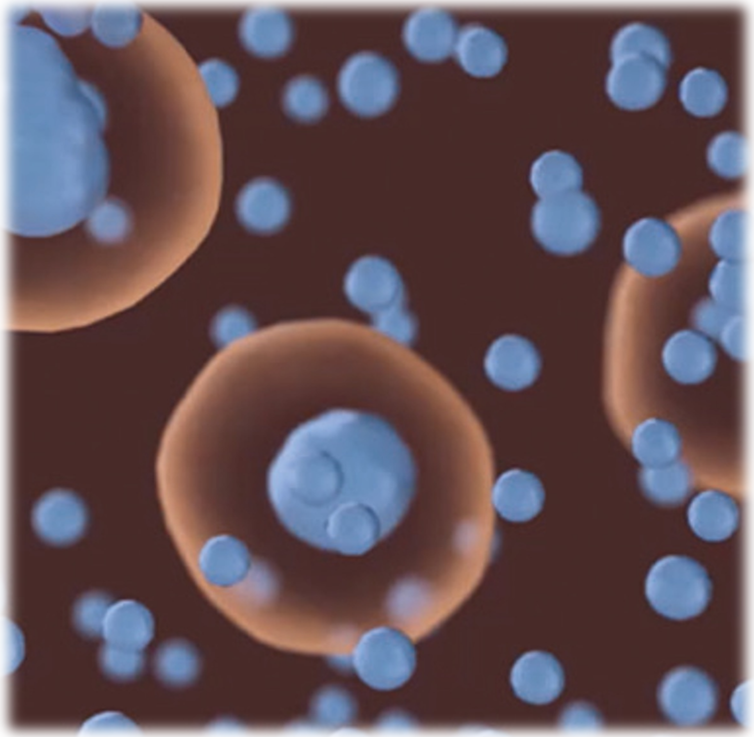
Unprotected pipe sections

For proper maintenance, the antioxidant must be replenished with Antioxidant-Ultra

Anti-moisture additive

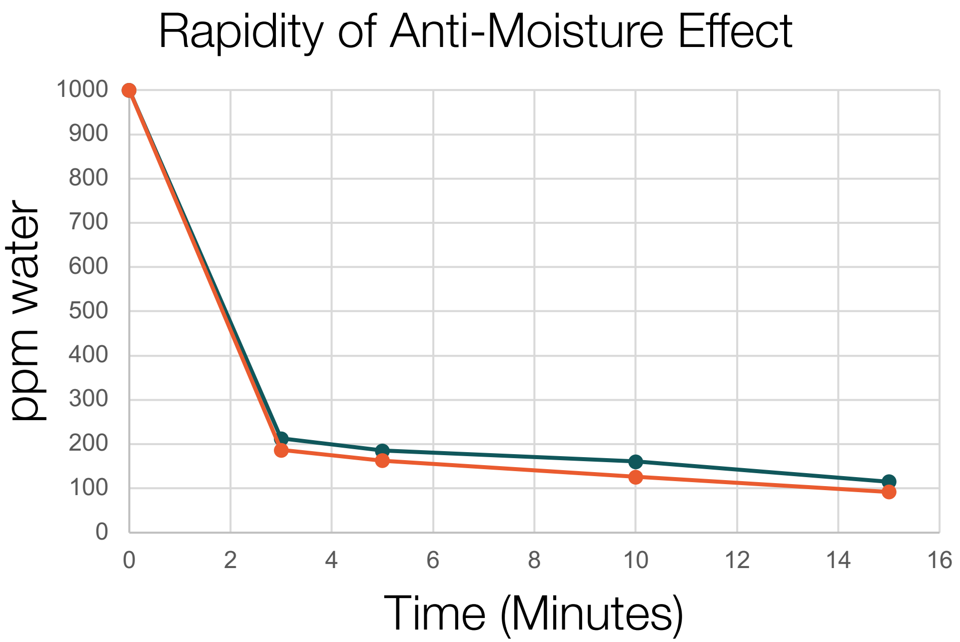
Purpose: elimination of moisture, causing acidity and corrosion

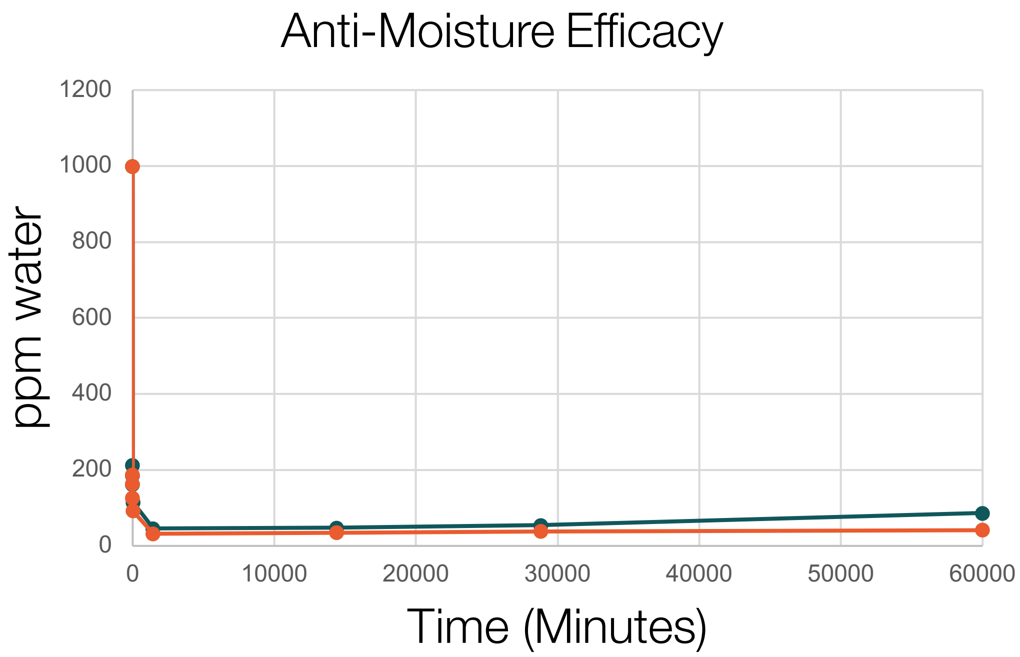
How it works: the dehydrating agent acts by binding to the moisture irreversibly, making it no longer available for reactions in the system



Anti-moisture additive

Old Errecom anti-moisture additive vs New Errecom anti-moisture additive





For proper maintenance, add Super-Dry Ultra

HFOs and HFO Blends

What makes a refrigerant chemically stable in the system?

Additives are fundamental for the systems to work efficiently over the time. They do not get carried by the refrigerant but, instead, they flow into the system together with the refrigeration lubricant.

In the specific case of blends, all the components must be as similar as possible with regard to miscibility.

When it comes to PAGs, it has often been observed that the higher (and the bulkier) the capping, the greater the stability and the lubricity.
The chemistry adopted is much closer to the chemistry of PAGs for CO_2, than that used for hydrocarbons.

Even when it comes to POEs, the best results have been observed with bulkier esters. In fact, also in this case, the chemistry adopted is much closer to the chemistry of POEs for CO_2, than that used for HFCs.

POE Lubricants for CO_2

Errecom's experience with PAGs for CO_2 led to the development of a POE-based line for CO_2: ISO 32, 55, 68, 85 and 100

- Selection of the right ester blend
- Anti-foam additivation
- Antioxidant additivation
- Anti-moisture additivation
- Anti-wear additivation

Selection of the right ester blend

- Energy consumption evaluation
- Solubility curve
- Wear of compressor assessment
- Analysis of the amount of lubricant in the system after 1000 hours
- Lubricant properties evaluation after 1000 system hours

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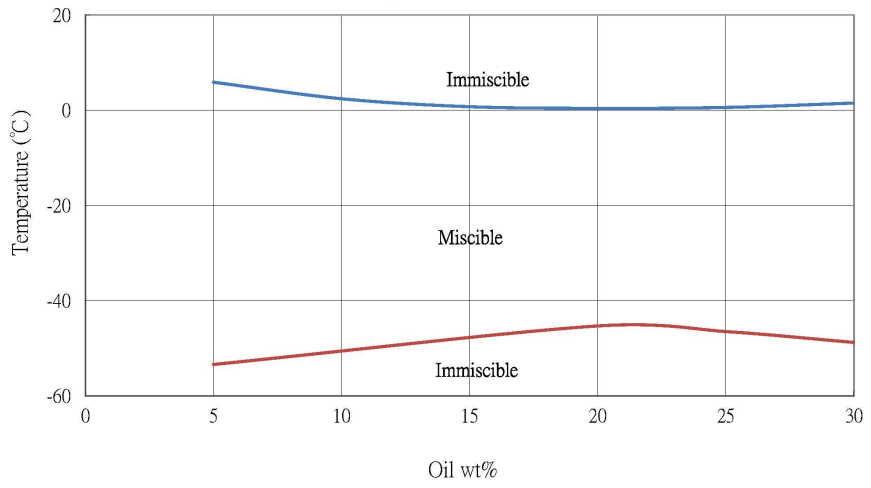
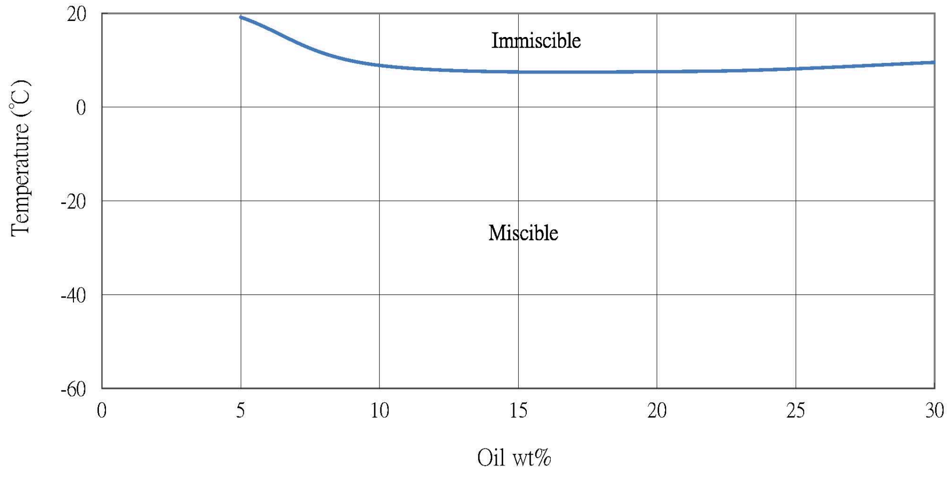
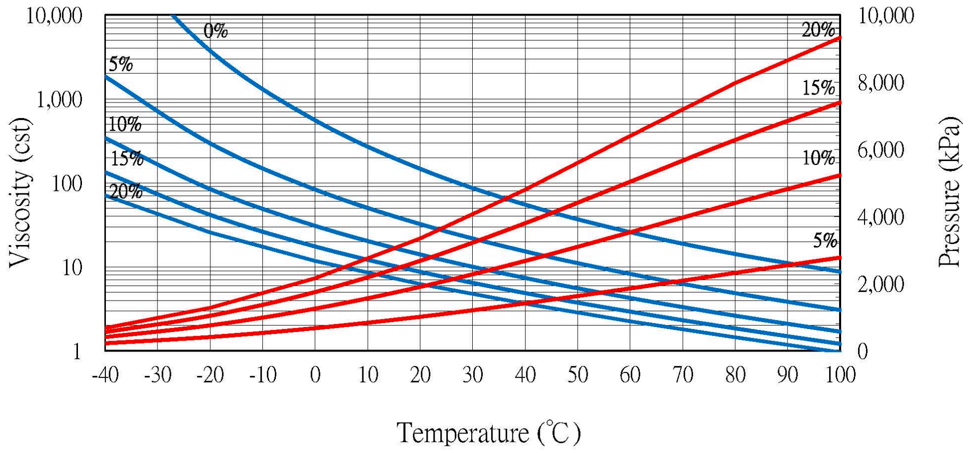
Miscibility of POE 55 for CO_2 in R-744



Miscibility of POE 85 for CO_2 in R-744



Viscosity and Pressure at Constant Concentrations R744 with POE 55 for CO_2



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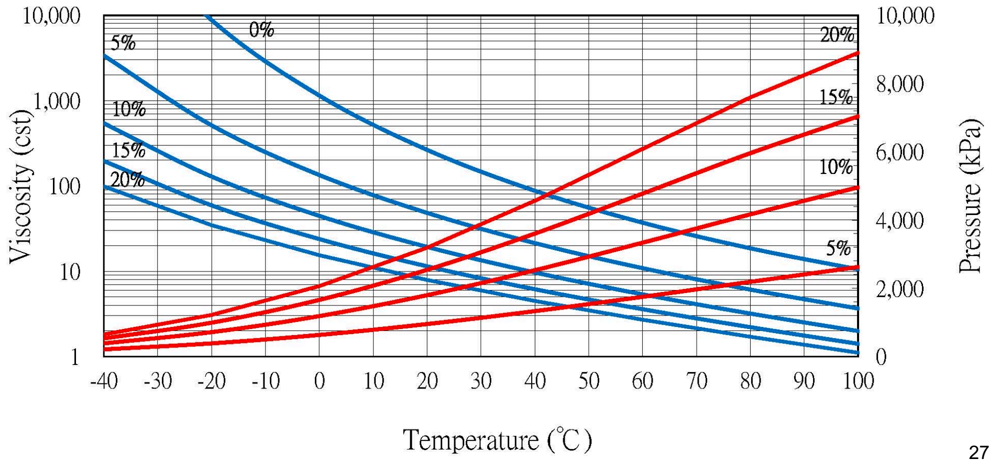

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Anti-foam additive

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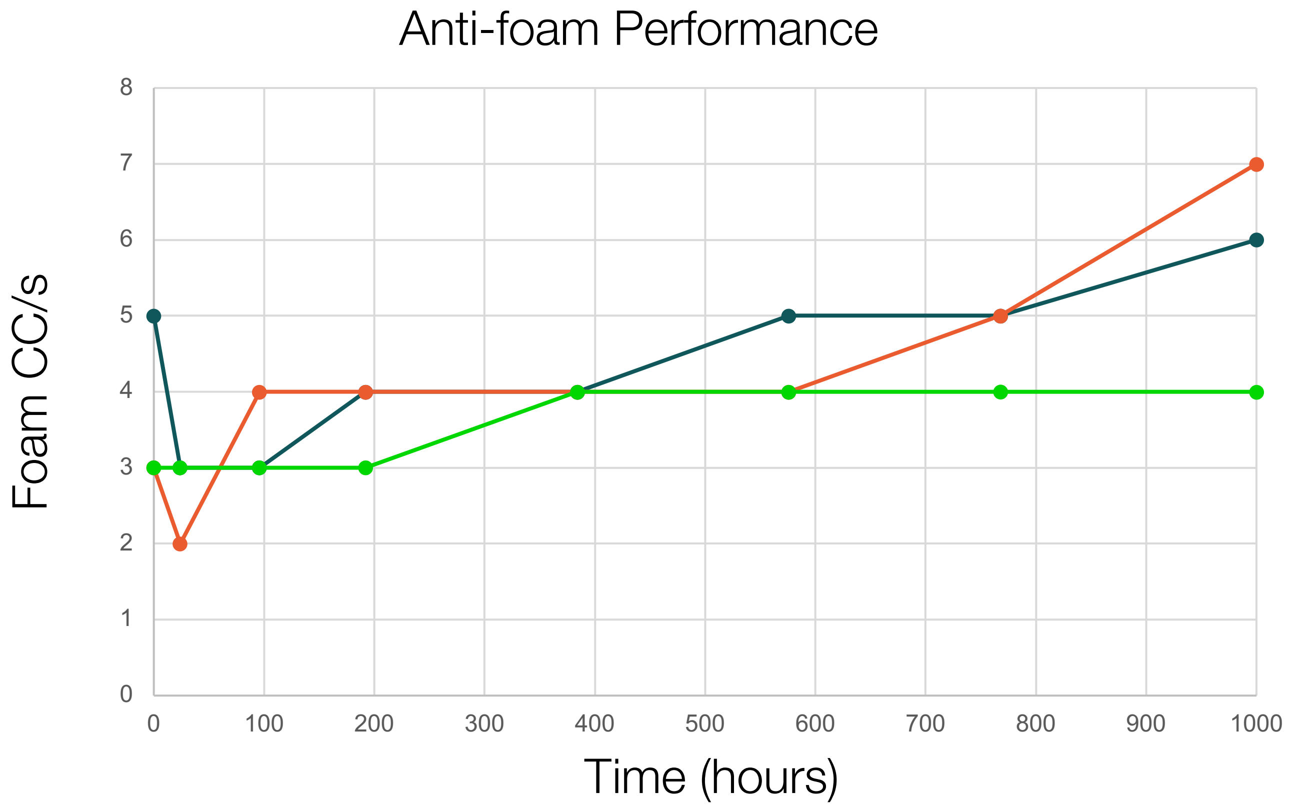

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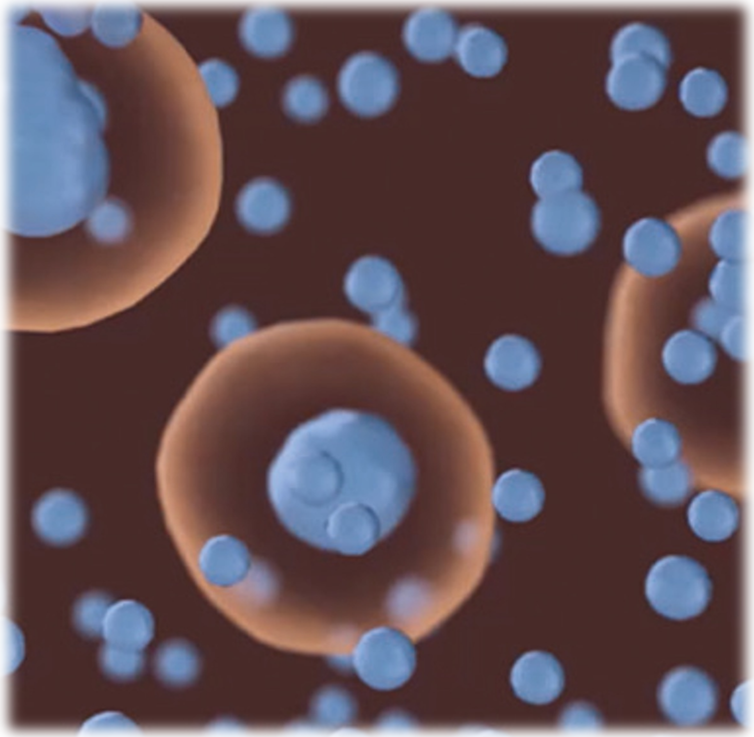
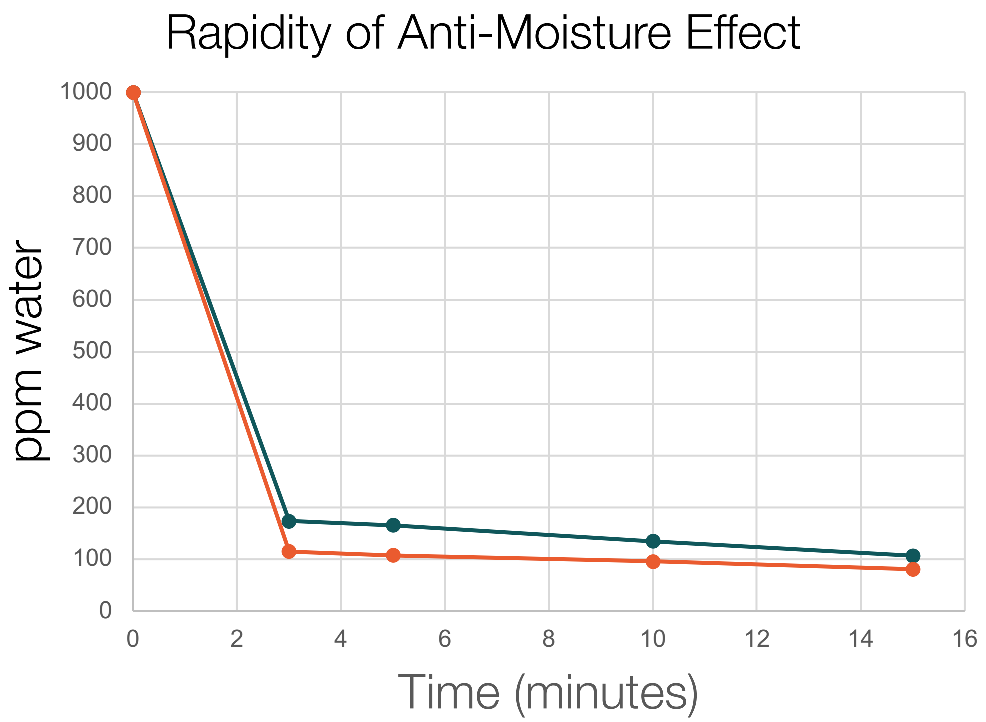
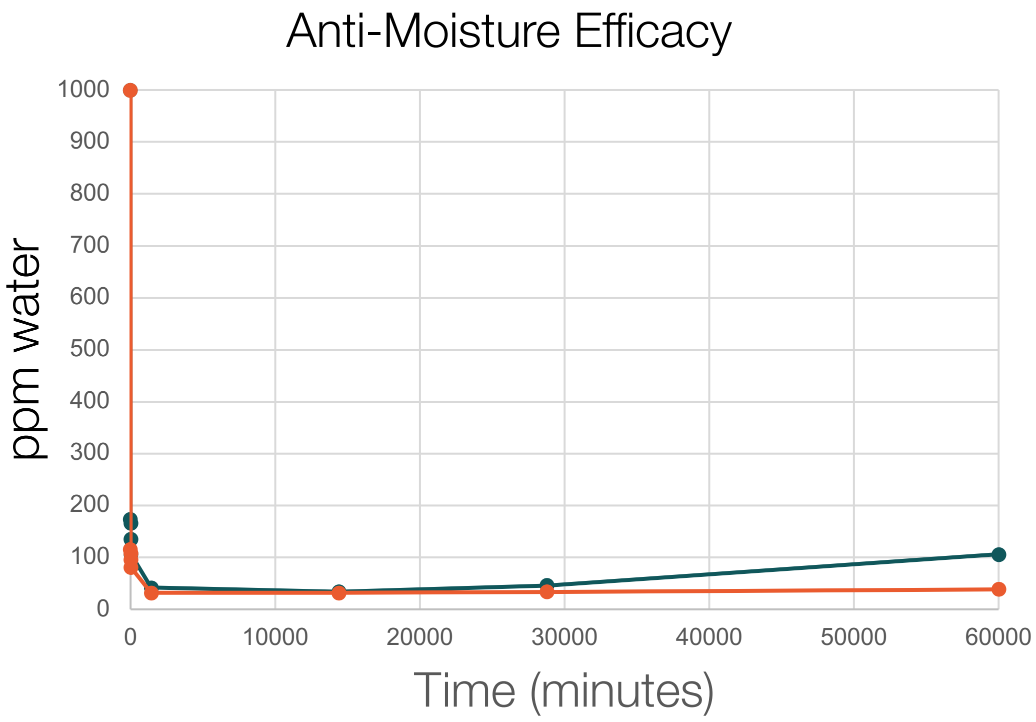


Anti-moisture additive

Old Errecom anti-moisture additive vs New Errecom anti-moisture additive





For proper maintenance, add Super-Dry Ultra

Anti-wear additive

Comparing:
- lubricant flow without additive
- lubricant flow with additive

Purposes:
- mitigate the effects of viscosity reduction even at high temperatures
- avoid viscosity collapse due to the high refrigerant solubility
- assist the lubricant flow with an additive that is little affected by the refrigerant

Selection of the best anti-wear additive

What do we mean by optimisation?

Tests carried out on our pilot plants for a consumption of 100 kW showed a saving of 3 to 5 kW.

The percentage of dissolved metals in the lubricant, due to the combined effect of better lubrication and oxidative protection, has dropped by 22 % (best average data obtained in POE-based systems).

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Can refrigeration lubricants lead to a more sustainable HVAC/R industry?

Yes, but they must be formulated

- to maximise the efficiency of the system
- to work efficiently with the new upcoming refrigerants
- with raw materials that are increasingly sustainable to reduce their environmental impact.

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