Climate change: melting glaciers, diminishing water resources, trapped sunrays increase global warming

HIGH-ENERGY EFFICIENCY FLUID FOR SECONDARY REFRIGERATION SYSTEM

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GENERAL GAS

TEMPER – THE HIGH-ENERGY EFFICIENCY FLUID FOR SECONDARY REFRIGERATION SYSTEM

A Food Manufacturer in Crete Has Achieved Considerable Energy Savings By Using Temper -15 As A Secondary Refrigerant Fluid

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After a devastating fire, a food entrepreneur working in Crete, when facing the reconstruction, decided to choose a solution that could guarantee the highest energy saving.

EcoRef, a company in Athens, proposed a solution that could meet that requirements. The idea was to combine a Performax LT-R407F primary cycle with a secondary cycle with high performance in heat transfer.

Temper -15 was taken into consideration. The result far exceeded the expectation. Let us examine the data in detail.

Plant data:
Primary Refrigerant:
R407F, (GWP 1674, ODP 0)
Secondary Refrigerant:
Temper -15 (15 000 L)
Temperature of Program:
HTF -6° C, T. evap. -10° C
Temperature and Kw in Refrigerated chamber:
@ 0-2 °C, 330 Kw
Plastic Pipes:
AquaTherm
Defrosting:
Defrosting achieved through Temper -40 directly on aero refrigerants (blast freezer) (-20°C)

Advantages:

- Considerable reduction in energy saving if compared to the traditional solution with Propylene (about 50%)
- Smaller and less expensive components
- Low pressure plant with increasing reliability and long-life
- Improved quality in food refrigeration thanks to temperature stability
- Reduction in Greenhouse effects
- Defrosting uses the heat produced by exhausted compressor and so the efficacy increases

The Production Site in Rethimno

Crete Farm, thanks to EcoRef, has installed a modern secondary refrigeration system (with high reliability) in order to meet F-gas standards.

Refrigeration System

The old R22 compressors were in good conditions, so they have been saved and used in the new plant. The new plant has been designed for R407F as primary refrigerant and Temper-15 as heat-transfer fluid. An 8 m³ storage tank contains Temper-15@ -6 ° C that is sent to the refrigerant areas through a number of pipes electronically controlled. The primary circuit is a DX system with R407F. High Energy Efficiency in Defrosting with Temper-40.

Temper-40 is also used for defrosting DX air coolers in cold chambers. The plant is designed to obtain heat through a heat exchanger from the warm side of the refrigerant. This system consistently reduces energy consumption and carbon dioxide emissions, if compared with the electric defrosting. Now, let's move to a detailed analysis of technologies used in Crete.

Primary Refrigeration Circuit – Information about Performax LT (R407F)

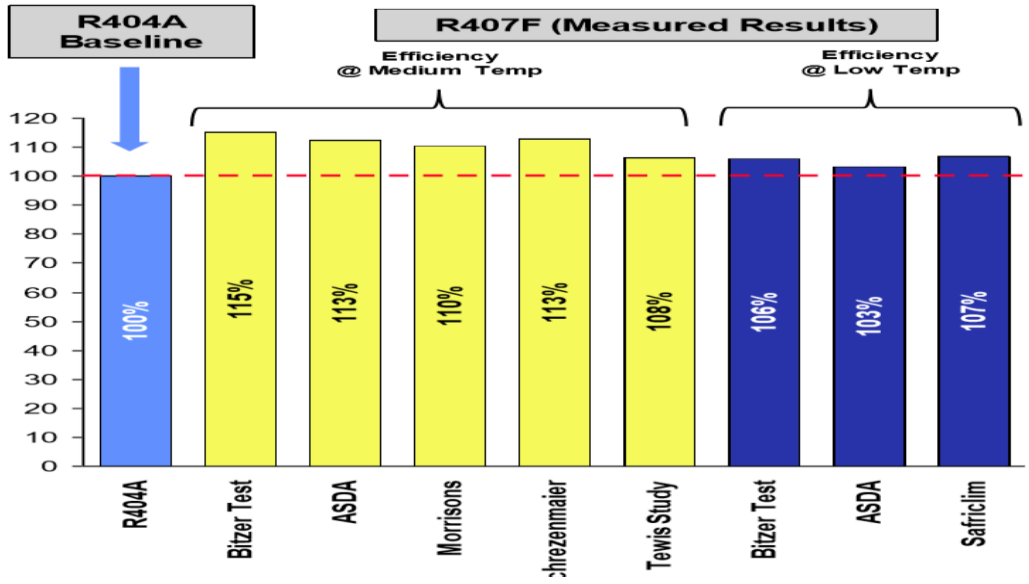
R407F refrigerant fluid, also called "Performax LT", has been initially designed for R22 retrofit so that similar energy efficiency was guaranteed (COP or EER).

Since 517/2014 standard came into force, Performax has conquered the European market thanks to the excellent price/performance ratio and the approval of all major manufacturers of compressors and electronic devices for the control of refrigerant systems.

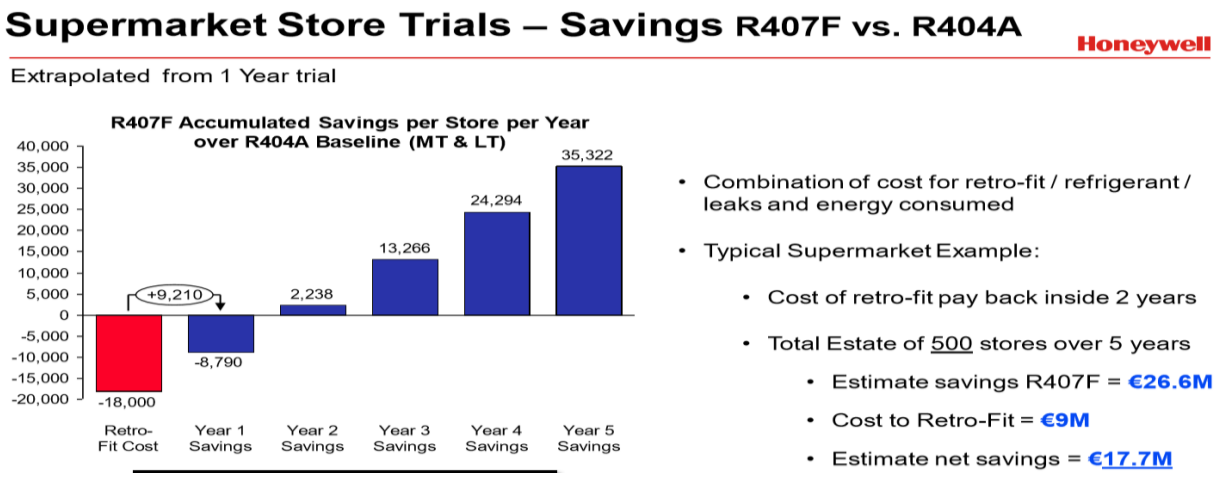
R407F, as all R4xx mixtures, is a zeotropic mixture with an almost 6° K temperature glide, even if a few tenths of a degree can be actually observed under operating conditions. Its chemical composition is: R32 30%, R125 30%, R134a 40%.

This mixture gives the blend excellent thermodynamic properties, as widely demonstrated by many years of testing performed by the European Union.

The following imagine shows an extract from the main end-users at which the performance of R407F fluid was monitored.



Therefore, economic data related to the use of R407F were detected and compared to the performance of R404a, still widely used in industrial and commercial refrigeration.



Acts for an Appropriate Retrofit or Design of Industrial Refrigeration Plant

High-energy efficiency of R407F is achieved by the combination of 3 components (R32, R125, R134a) that when mixed together, generate the “glide” event (in this case equal to almost 6° K).

Now, it is necessary to take into account the Tdew, Tbubble and relative pressures. After observing the matches in the PT saturation table, and after examining the Mollier chart (all documentation can be downloaded from our website www.generalgas.it) it soon becomes clear that it is worth considering the medium T of evaporators and condensers. Electronically controlled TXV valves are strongly recommended (with up-to-date firmware and now available at the major well-known manufactures).

Changing condensers and/or evaporators will not be necessary, neither synthetic oil, nor other elements of the system. The superheating control will be quite similar to what happens with R404a. Therefore, everything is pretty simple with Medium Temperature applications, as in the case of Crete above analysed.

When dealing with Low Temperature, however, it will be necessary to provide the compressor with a liquid injection. The presence of head cooling fan in Low and Medium temperature is always strongly recommended (and anyway always necessary in Low Temperature).

Futurity of Performax LT

After F-Gas 517/2014, all producers involved in the sector had a question: “Can the refrigerant I intend to use be rechargeable also in a few years?” The answer is quite simple and requires the consultation of the tables as shown in 517/2014 standard and annex showing the gwp values.

In short: Performax LT has no limits of use for serving that is the restoring amount of refrigerant. Limits only subsist in “commercial refrigeration” (supermarkets). It is worth noting that these limits apply to “power plant manufacturers” and do not involve the assistance.

Instead, there are no limits of use of R407F in industrial refrigeration. See the following chart.

ANNEX III

PLACING ON THE MARKET PROHIBITIONS

Products and equipment		Date of prohibition
Fire protection equipment that contain HFC-23		1 January 2016
Domestic refrigerators and freezers that contain HFCs with GWP of 150 or more		1 January 2015
Refrigerators and freezers for commercial use (hermetically sealed equipment)	that contain HFCs with GWP of 2 500 or more	1 January 2020
	that contain HFCs with GWP of 150 or more	1 January 2022
Stationary refrigeration equipment, that contains, or whose functioning relies upon, HFCs with GWP of 2 500 or more except equipment intended for application designed to cool products to temperatures below – 50 °C		1 January 2020
Multipack centralised refrigeration systems for commercial use with a rated capacity of 40 kW or more that contain, or whose functioning relies upon, fluorinated greenhouse gases with GWP of 150 or more, except in the primary refrigerant circuit of cascade systems where fluorinated greenhouse gases with a GWP of less than 1 500 may be used		1 January 2022
Movable room air-conditioning equipment (hermetically sealed equipment which is movable between rooms by the end user) that contain HFCs with GWP of 150 or more		1 January 2020
Single split air-conditioning systems containing less than 3 kg of fluorinated greenhouse gases, that contain, or whose functioning relies upon, fluorinated greenhouse gases with GWP of 750 or more		1 January 2025
Foams that contain HFCs with GWP of 150 or more except when required to meet national safety standards	Extruded polystyrene (XPS)	1 January 2020
	Other foams	1 January 2023
Technical aerosols that contain HFCs with GWP of 150 or more, except when required to meet national safety standards or when used for medical applications		1 January 2018

Note: HFCs refers to blends, not to individual components of blend

Maintenance and Servicing	Date of prohibition
Virgin F-Gases with GWP>2500 or more for servicing refrigeration equipment with a charge size of 40 tons of CO2 eq or more. This service ban is not applicable to military and low temp. (- 50ºC) equipment.	1 January 2020
Recycled and reclaimed F-gases with GWP of 2500 or more for servicing refrigeration equipment with a charge size of 40 tons of CO2 eq or more	1 January 2030
Pre-charged equipment	Date of prohibition
Refrigeration, air conditioning and heat pump equipment pre-charged with F-gases may not be placed on the market unless F-Gases charged into this equipment are accounted for within the quota system referred to in Chapter IV. When placing pre-charged equipment on the market after that date, manufacturers and importers must issue a declaration of conformity, which must be verified by an independent auditor.	1 January 2017

Secondary Circuit – Information about Temper

Since 1996 Temper Technology, a Swedish company, has been produced high efficiency and low viscosity ecological fluids that have been largely used in industrial applications in food industries and cold chain management. Temper fluids are supplied ready-to-use for refrigeration up to -60°C, in order to ensure the highest quality and performance.

What does Temper Contain?

• Temper	10° C
• Temper	15° C
• Temper	20° C
• Temper	30° C
• Temper	40° C
• Temper	55° C
• Temper	60° C – new –

Temper has been designed and developed by the Swedish company Temper Technology AB in the Aspen Group. Temper is a synthetic solution based on salts, different from glycol-based solution. Its colour is pale yellowish; it does not contain amines or nitrites, although it does contain specific corrosion inhibitors. Temper is always supplied ready-to-use and must not be diluted to ensure the high quality and optimum characteristics in a stable manner over the time. Temper is available in different freezing point versions.

Physical-chemical Characteristics that Enable the Achievement of Energy Efficiency

Temper has a high specific heat capacity (3,3 kJ/kg for Temper -20° C in a +20/+30°C temperature range). It also has outstanding thermal conductivity, especially compared with propylene glycol. Special additives in Temper provide optimal corrosion protection and lubricating properties. Its viscosity is relatively low: this leads to a LOSS OF LOAD IN THE LOWER pumps and pipe, and, in turns, LOWER PUMPING POWER: the work can be smaller for the same performance. This cuts the cost of purchasing, installing and running the system.

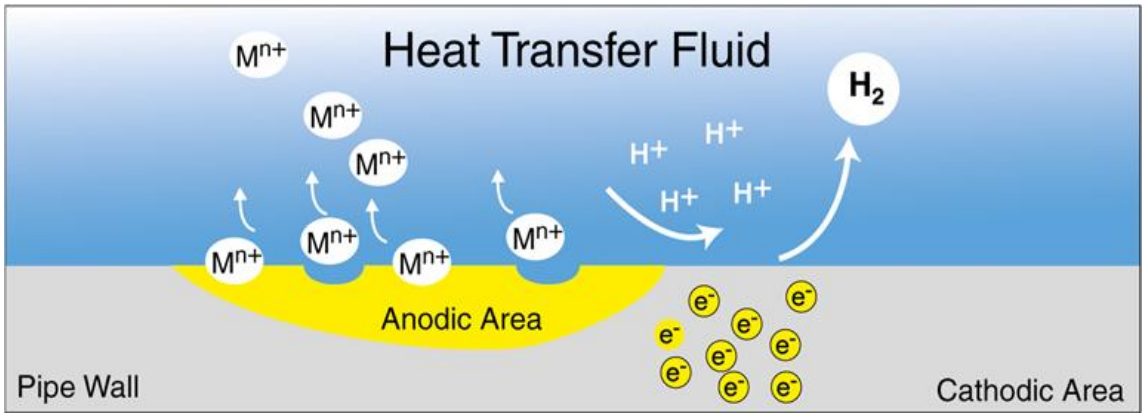
Specific Corrosion Inhibitor Used in Temper Product

In the initial phase of corrosion, electronic potential displacement occurs, without metal atoms being dissolved from the surface. Therefore, corrosion arises because of differences of electric potential between different surfaces.

Temper contains special corrosion inhibitors, which act only where electronic potential differences arise. That means that the inhibitor does not accumulate where the electronic potential differences do not arise. The optimum heat transfer is ensured.

The Temper corrosion inhibitor is not consumed in the time because once the electric potential difference on a surface is equalized; the inhibitor molecules are released and are free and ready to accumulate at any other site where there is an electric potential displacement. With Temper, it is very easy to assess the corrosion condition of a system by determining the concentration of inhibitors. If the number of inhibitors falls below a given value, optimal corrosion protection can be restored by adding pure inhibitor.

The following imagine shows the phenomenon from an electro-chemical point of view.



The Design of Secondary Refrigeration Circuit with Temper

The secondary circuit

Temper should only be used in sealed systems, since oxygen from the air increases the tendency of metal parts in the system to oxidise. It is worth noting that aqueous solution generates galvanic corrosion when in presence of oxygen and wrong coupling of metals. This phenomenon is clear in ethylene and propylene glycol solutions. The same process is accelerated in case of salt-based solution as Temper.

The water evaporates from open systems. This alters the composition/ concentration of Temper and might lead to an alteration of the characteristics of the solution and to the formation of crystals. Air purger equipment must be installed in the system working with Temper.

Pipes and valves

Commonly used materials such as iron, copper, brass, cast iron, stainless steel and some plastics (ABS, PE) may be used for pipe work and valves. Galvanised iron and tinned iron are not suitable. For more technical information, please contact our supply organization.

Filters

We recommend the use of filters with a mesh size of 0.6 to 0.8 mm, so that any dirt or corrosion products picked up by the heat transfer fluid are trapped.

Pumps

When choosing pumps, you should inform the manufacturer that Temper will be used. Make sure that the correct material is used for the seals. Because of the way Temper works, small amounts of Temper will appear at the shaft seal, close to the seal.

Traces of salt crystals must be regularly washed off. Alternatively, pumps without seals may be used.

Seal materials/gaskets

We recommend EPDM, provided that they can withstand the temperatures of the application. Specific alternative seals (such as Uni-Pack, Locher) may also be used.

Calculus of Thermal Expansion

There are different possibilities for calculating coefficient of thermal expansion. In some cases, the coefficient of expansion is used. Generally, we want to predict how the volume of a liquid expands, as soon the temperature increases. Fluids always expand at high temperature and consequently their density decreases.

Shown below a method of calculus relative to the temperature range defined:

Note: Please, consider that each Temper solution (-20, -40, …) has a different density.

D(TO) = Density of fluid at low Temperature TO.

D(T1) = Density of fluid at high Temperature T1:

V = Total volume of circuit.

ΔV = Expansion of fluid volume.

ΔV = V • [D(TO)- D(T1) / D8T1) Litres or ΔV = 100 • [D(TO)- D(T1)

Eco Friendly

Temper has very good environmental properties: it is readily biodegradable. Salt-based solutions like Temper are completely biodegradable, nontoxic, non-flammable and approved for use in food industry (Unilever certification).

Shown below the declaration of producer.

Biodegradability	OECD 301 A	97% degradation after 7 days 99% degradation after 28 days	Biological Easy degradable

Also, any disposal would be easy and convenient. The only source of environmental risk could arise from the presence of contaminants in Temper, such as oil, gas in solution, oxides, and particles of elastomeric components.

Performax LT and Temper are supplied by General Gas S.r.l.

For further information and details, please visit our website: www.generalgas.it

Temper was developed by Temper Technology AB in the Aspen group. Temper is a synthetic and homogenised solution based on salts.

It is colourless to yellowish and contains no amines or nitrites, although it does contain additives, which give it anti-corrosion and lubricating properties. Temper is supplied ready for use and must not be diluted. Different versions are available, each with a designation that indicates its freezing point:

• Temper –10 °C
• Temper –15 °C
• Temper –20 °C
• Temper –30 °C
• Temper –40 °C
• Temper –55 °C
• Temper -60 °C