



CASE STUDY

New trends: reducing GWP impact on GMP freeze drying processes

How to turn an older refrigeration system in an existing freeze-dryer into a new environmentally friendly cooling system



ABSTRACT

In the fight against climate change, the pharmaceutical industry is challenged to reduce its carbon footprint. Cooling systems used in industrial freeze dryers are typically a high contaminant due to the presence of high global warming potential (GWP), HFC refrigerants or the use of a huge equivalent of energy consumption such as Liquid Nitrogen (LN₂) technology. This case study explains the retrofitting of a new cooling system in an existing freeze dryer, developed to be environmentally friendly and energy efficient using a long-term and commercially available solution.

Customer

European parenteral product manufacturer

Challenge

This Parenteral Product Manufacturer owns three freeze dryers between five to eight years old, with mechanical refrigeration based on R-507A refrigerant gas. Because of the high price increase and the foreseeable shortage of these kind of refrigerants, together with the commitment of the company social responsibility to reduce the carbon footprint of its activities, this customer contacted Telstar to change the refrigerant in its systems with a low GWP alternative.

However, there was a non-negotiable requirement. The system performance had to be maintained as the qualified system. This meant that special attention needed to be given to the shelves and the condenser cooling ramps.

Solution

An innovative ecofriendly cooling system named Arctic developed by Telstar has been implemented. Natural gases allow to efficiently resolve the green transition process.

- Uses natural gases.
- Has zero ODP and almost zero GWP.
- Has high energy efficiency by use of frequency inverters.
- Easy to upgrade existing installations.
- Its maintenance can be done by a refrigeration technician.

URS challenges

The customer's URS that are treated in this article are the following:

Green technology

The use of a low carbon footprint solution was required as a main point. Artic® cooling system uses

natural refrigerants with close to zero GWP. The total charge is optimized using highly efficient and low volume heat exchangers. As a result, the greenhouse impact in case of a leak is significantly reduced.

In addition, two frequency inverters are used to increase the energy efficiency and in consequence, the cooling capacity.

Future proof regulatory

The implementation of the European F-Gas regulation is a key driver for the present and future refrigerant market. The typical freeze dryer cooling technology is not directly impacted because there is an exemption in Annex III, point 12, for systems working below -50°C.

However, high GWP refrigerant gasses are indirectly affected by restrictions on most applications and the market GWP cap limit, impacting the gas availability and price. Figure 1 shows the average refrigerant GWP to fulfil the new market limit:

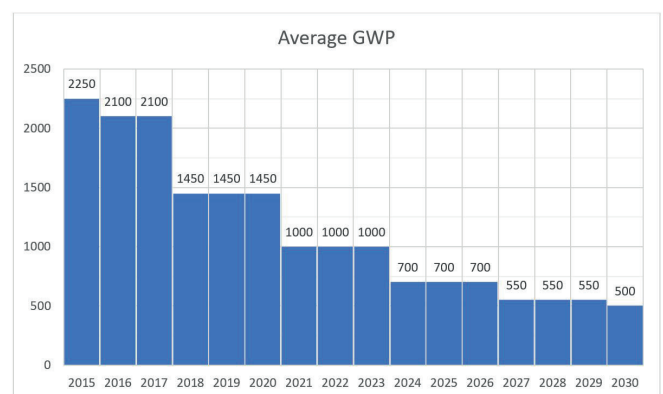


Figure 1: F-Gas average GWP

A future proof refrigerant needs to have as low as possible GWP with a maximum value of 500. As the above graphic shows, common R-404A and R-507A alternatives, like R-448A, R-449A and R-452A have GWP values around 1350 and 2150 which means that in 2024 their values will be 200% or 300% than recommended in 2030. It is expected that the current situation with R-404A and R-507A will be reproduced again in the next few years but deteriorate as this time refrigerant distributors could not buy in advance without restrictions. The quota reduction of 2021 is

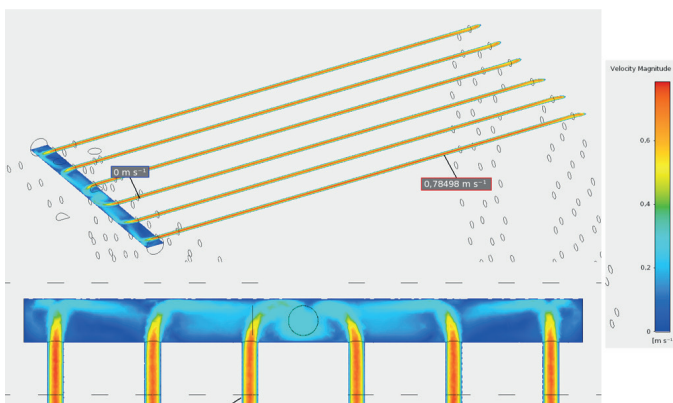
starting to come into effect with a new important deadline in 2024. Nonflammable refrigerant suitable for retrofitting in existing installations is not expected.

Artic cooling system uses refrigerants with GWP lower than 10. With this low value, new future regulations will not expect to restrict its use.

Minimum intervention time

At the request time, the customer was in full production, so the urgency was to reduce the retrofitting time as much as possible. Telstar's proposal was:

- Due to layout restrictions, install new system and condenser silicone oil circuit in the technical room five meters away from the main frame of the freeze dryer.
- Bypass the old cooling system.
- Reroute silicone fluid shelves. Silicone flow was maintained with detailed pressure drop calculations and new heat exchangers selection.
- Ice condenser pressure drop and oil distribution is simulated to ensure a uniform ice distribution.



Technical area requirements

Typically, the use of flammable gases requires a ATEX zone classification around the system. Artic is designed by implementing two independent safety measures, intelligent control, and closed enclosure, which eliminate that ATEX requirement. The customer did not have to define an ATEX zone in the technical room.

For a safe operation, Artic cooling box requires:

- Continuous fresh air intake from the technical area.
- Air exhaust conduit to a safe area, typically the rooftop, without any ignition source.
- SAI connection for safety instrumentation and fan.

The system maintenance can be done by a refrigeration technician.

Retrofitting activities

Once the customer specifications and the project scope were understood and well defined, the retrofitting activities began. The works took a total of 20 days and after it was finished the qualification of the equipment was performed showing an invariable result in terms of freeze dryer capacities.

Results

- Future proof cooling system with very low GWP.
- Same shelves cooling fluid ramp.



- Higher lowest condenser temperature but this is acceptable for the freeze-drying process.
- Fluid in condenser. No condenser area loss in case of one cooling system failure.
- No ATEX zone.
- Maintenance is done by the previous refrigeration company.

Customer feedback

Refrigeration technician

“At the start of the project I was very concerned with the use of flammable refrigerant gases. However, after Telstar's training on safety philosophy and how to work with natural gases I am much more comfortable. I can work as I did before by taking some light precautions.”

Conclusion

In today's global climatic crisis, it is necessary to take measures. Europe decided to take a clear step towards a green economy, and this has a significant impact on the pharmaceutical industry. Current freeze dryers are affected by the price increment and shortages of high GWP refrigerants due to F-Gas regulation. In a fast-changing world, where non-natural refrigerants have been proved as short alternatives, only natural refrigerants are the long term and sustainable option. Telstar's Artic cooling system has proven to be an efficient, safe, and future proof alternative for both new and existing freeze dryers.

The author



Sergio Ferrer, Lyophilization Technology Specialist at Telstar, holds an MEng in Industrial Engineering from the "Universitat Politècnica de Catalunya (UPC)" Spain. In 2014, Sergio joined Telstar as a Refrigeration Engineer. Since 2019, Sergio has been a Lyophilization Technology Specialist, participating in a wide variety of projects and leading technical improvements. Currently, Sergio is focused on offering technical support to the Sales Teams, Product Manager and Project Managers at Telstar.

About Telstar

Telstar, part of the azbil Group, is a company specialized in the development of engineering & construction projects, integrated process equipment and GMP consultancy solutions, including turnkey projects and critical installations, for companies associated with Life & Health Sciences (pharmaceutical & biotechnology, healthcare, cosmetic, veterinary and food & beverage industries, hospitals, laboratories & research centers). Acknowledged as one of the 10 major suppliers for the pharmaceutical industry, Telstar is one of the few international manufacturers able to offer integrated process solutions for the biopharmaceutical industry with in-house sterilization, freeze drying, containment, process water & waste treatment, clean air and cold storage technologies.

