Technical article:

“Evolving tightness requirements for natural refrigerants”

Frenzelit is developing a new generation of gaskets called novapress® 850 for refrigerant applications

Secure, climate-friendly sealing

The 2014 F-Gas Regulation (F-Gases = Fluorinated Gases) governing the reduction of emissions has compelled refrigeration system operators and manufacturers to check and retrofit or redesign their refrigeration systems. Fluorinated gases, which are ideally suited for all types of refrigeration applications – from refrigerators to air conditioners to refrigerated counters in supermarkets – contribute significantly to global warming and climate damage. This is why there are guidelines in place to successively reduce (“phase down”) these synthetic gases and ultimately replace them entirely with more climate-friendly, natural alternatives. One of the main challenges is that these natural refrigerants, such as CO_2 or ammonia, which are considered to be less harmful to the environment, are much more difficult to manage. New technologies are needed that enable the use of natural refrigerants. These include, in particular, more powerful gasket materials, as cooling systems that use natural refrigerants require significantly higher pressures, while the refrigerants are more aggressive, making it even more vital to ensure that they cannot escape. Frenzelit has developed a cutting-edge, high-performance gasket material that delivers groundbreaking results in all sealing categories and is much more mechanically and chemically resilient: novapress® 850.

Fluorinated gases are extremely harmful to the environment

The properties and requirements of natural refrigerants compared to synthetic refrigerants should first be examined in more detail. Synthetic gases are actually ideally suited for cooling applications: They are easy to compress and can thus be liquefied and transferred back to the gaseous structure without a great deal of effort. This change in the aggregate state generates the cooling effect. However, the gases can easily escape from common cooling systems because the standard gaskets used are in lower sealing categories, which results in permanent leakage. What initially appears safe for humans has serious effects on the environment. Unlike natural refrigerants, the synthetic compounds remain stable for centuries, persisting in the atmosphere and thereby exacerbating global warming.

It seems counterintuitive that of all compounds CO_2 is seen as a climate-friendly alternative in this area when climate protection efforts often revolve around reducing carbon emissions. However, fluorinated gases are many times more harmful to the climate than CO_2. To clearly illustrate just how harmful they are, CO_2 was used as a benchmark and other gases were measured against it with the GWP (Global Warming Potential). This CO_2 equivalent shows how much a given mass of a greenhouse gas contributes

to global warming over a certain period of time (usually 100 years) compared to the same amount of CO_2. Methane, for example, has a GWP of 28, while R134a (tetrafluoroethane), a refrigerant very common in vehicle air conditioning systems, has a value as high as 1,300. Traditional CFCs (chlorofluorocarbons) actually have a GWP of 13,900. In contrast, the natural refrigerant ammonia has a GWP of zero.

Natural refrigerants are more difficult to manage

To sum up, the objective is to establish natural refrigerants over the long term. The pitfalls in the handling of these alternative refrigerants, however, lie in the significantly different properties, e.g. in terms of vapor pressure and evaporation enthalpy. For instance, R134a can be liquefied at room temperature at a pressure of approx. 7 bar, while the natural refrigerant R744 (CO_2) requires a pressure of approximately 70 bar. As a result, systems must be able to withstand considerably higher operating pressures in the cooling process. Natural refrigerants like ammonia are also much more chemically aggressive. Systems must be more mechanically robust overall. Furthermore, gases must never escape under any circumstances, as has often been the case with refrigeration systems that use synthetic refrigerants until now. This would pose immediate health risks to anyone in the vicinity of these systems.

novapress® 850 – a new generation of gaskets

Andreas Will, Head of Research & Development Industry at Frenzelit GmbH, points out the following: “The targets for reducing greenhouse gases are welcome, and it’s right to impose them on industries. Nevertheless, they also need to be feasible and will require new technical solutions. We developed our new generation of gaskets for refrigeration system operators to provide a potent solution to increasingly demanding requirements. The alternative would require elaborate design changes to systems to prevent aggressive coolants from leaking.” In contrast, novapress® 850 makes it possible to migrate toward greener refrigerants in a simpler and more cost-effective way. This novel material meets sealing categories that were not previously achievable with conventional fiber gaskets. novapress® 850 can be used to create reliable gasket systems even with minimal surface pressure. novapress® 850 gaskets are 10,000 to 100,000 times denser than standard products. Andreas Will explains how the new gasket material was developed: “We develop and produce all of our materials ourselves. All of this rests on high-quality raw materials, individual components in our formulation and, in particular, Frenzelit’s very complex and effective manufacturing process.” A process control system monitors and controls the composition of the formulations, the mixing process and the actual calendering process. The result is a gasket material that pairs the advantages of fiber gaskets and elastomer gaskets: As adaptable as an elastomer gasket, yet as mechanically stable as a fiber gasket. Even low surface pressures are sufficient to achieve maximum tightness, for virtually indetectable leakage. novapress® 850 gaskets can withstand the stresses caused by the higher pressures resulting from the use of natural refrigerants over time. Another

Frenzelit GmbH | Postfach/P.O.B. 11 40 | 95456 Bad Berneck | Germany | Phone: +49 9273 72-0 | info@frenzelit.com

distinguishing feature is their chemical resistance. Many natural refrigerants are aggressive and can attack gasket materials, making them porous.

Own test facility for comprehensive confirmation

Frenzelit carries out extensive tests and confirmations on the materials to ensure these requirements are met. Frenzelit built its own cold test system for this purpose. The system can be operated with any refrigerant. Based on specific standards and customer specifications, the gasket experts perform various stress tests to demonstrate the performance of the gasket material. For instance, stress tests are required in which the material comes into contact and is flushed with the respective refrigerant for several weeks. The following parameters are taken into account:

- Test against liquefied refrigerant (instead of in the “harmless” gaseous state)
- Media removal at real operating pressure
- Test according to the ASTM F146 standard, but with significantly longer storage times (7 or 14 days instead of 5 hours)
- Inclusion of aggressive compressor oils – keyword: “oil spill” (according to operator specifications), usually with a 5% share compared to 2 to 3% in real-world scenarios

The following criteria are tested:

- Weight changes
- Changes in thickness
- Visual assessment of discoloration, cracks, or other damage such as slime, delamination, dissolution, blistering, and shrinkage
- Possible flocculation of refrigerant/compressor oil

Image 1)

Optical inspection of novapress® 850 after 14 days storage in R32 with BSE 32 compressor oil at a pressure of 14 bar: The material can withstand the conditions without any damage whatsoever. Image: ©Frenzelit GmbH

Frenzelit GmbH | Postfach/P.O.B. 11 40 | 95456 Bad Berneck | Germany | Phone: +49 9273 72-0 | info@frenzelit.com

“Designers greatly appreciate the fact that we can provide advance confirmation thanks to our own test system, as this enables us to speed up and simplify the entire costly and time-consuming procedure,” says Andreas Will. It is no longer simply a matter of retrofitting existing systems, but also increasingly of coming up with entirely new designs to cope with the sensitive handling of natural refrigerants. It pays to seek the advice of the gasket experts in the early stages of planning to optimally match the gasket materials to the respective application.

Other areas of application

Due to this new gasket material’s tremendous sealing performance, novapress® 850 is also of interest for other applications and industries: For example, it is also used in the gas supply to ensure the required sealing performance and safety requirements. Frenzelit has already submitted the corresponding approvals and confirmations. Other areas of application for the high-performance gasket material include drinking water applications or F&B applications such as brewing plants. Andreas Will: “The goal in the further development of our gasket materials, regardless of the application, is always to significantly and sustainably reduce emissions and achieve even higher sealing categories. After all, this is the ultimate task of a gasket: To make the system as technically tight as possible in order to reduce emissions.”

Characters: approx. 9,263

Additional images:

Image 2) Refrigeration systems with gasket materials from Frenzelit are significantly denser than others and thus enable the use of climate-friendly natural refrigerants. Image: ©Frenzelit GmbH

Frenzelit GmbH | Postfach/P.O.B. 11 40 | 95456 Bad Berneck | Germany | Phone: +49 9273 72-0 | info@frenzelit.com

Image 3) novapress® 850 gaskets are 10,000 to 100,000 times denser than conventional fiber gaskets, even at the lowest surface pressures. Image: ©Frenzelit GmbH

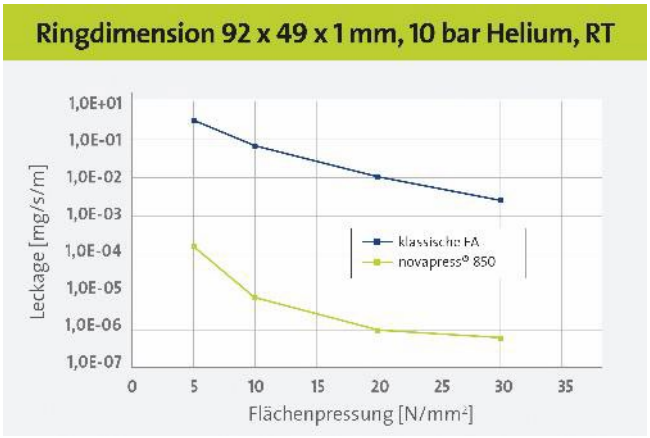

Image 4) Comparison of leakage properties – novapress® 850. Image: ©Frenzelit GmbH

For questions, contact: pr@frenzelit.com

Frenzelit GmbH | Postfach/P.O.B. 11 40 | 95456 Bad Berneck | Germany | Phone: +49 9273 72-0 | info@frenzelit.com