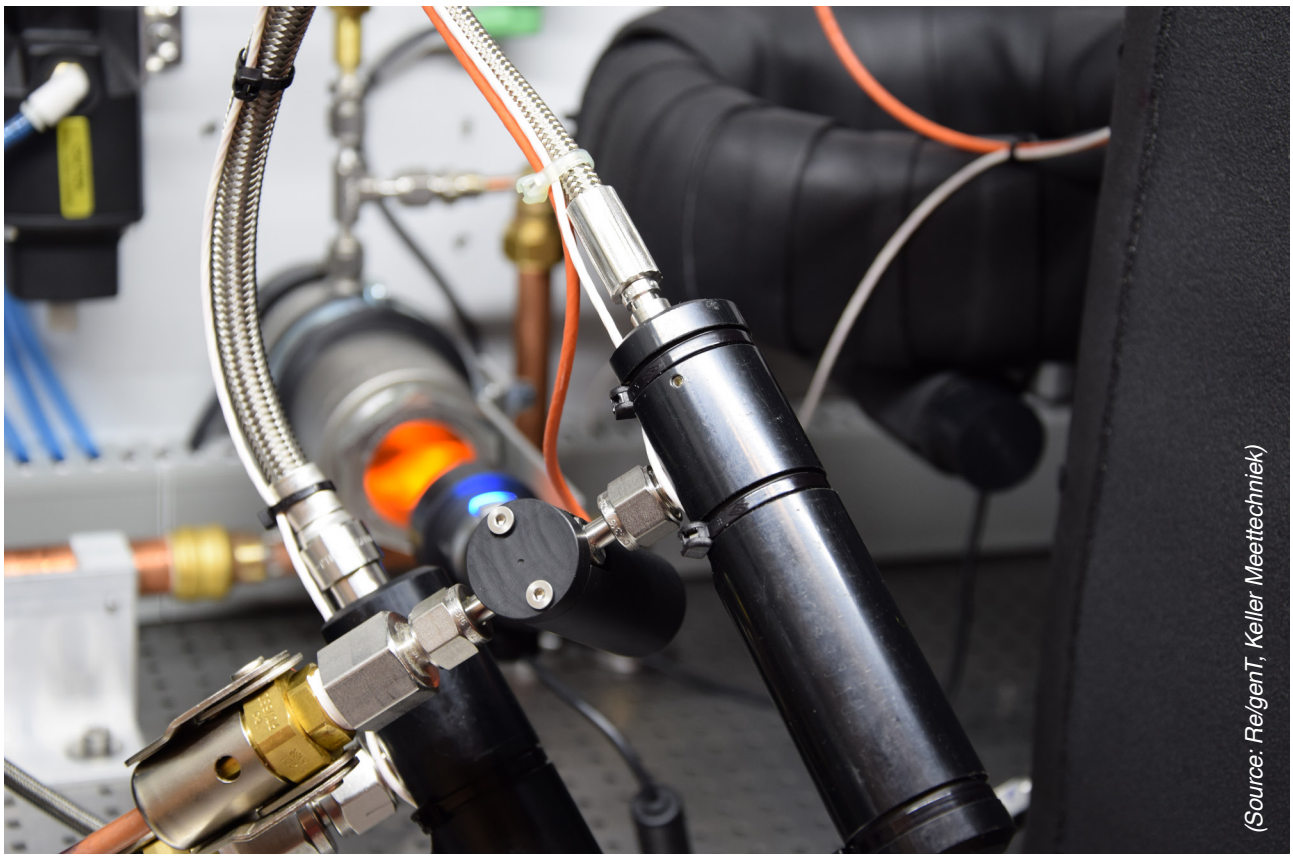
# Pressure sensors improve cooling

*Refrigeration is vital to ensuring the shelf-life of food. The need for cooling became even more urgent for the distribution of Covid vaccines. Pressure measurements are helping refrigeration evolve.*



(Source: RelgenT, Keller Meettechniek)

Refrigeration is a broad sector and includes the following:

- Appliances for retail and commercial applications;
- Medical coolers and refrigerators;
- Domestic refrigerators and freezers;
- Air conditioners and heat pumps.

All of these appliances use coolants or refrigerants in their cooling systems or heat pumps as a means of transporting heat. Developing these refrigerants is paramount as they have a significant impact on the environment.

In the past, the use of synthetic refrigerants known as chlorofluorocarbon refrigerant gases (CFCs), and later hydrochlorofluorocarbon refrigerant gases (HCFCs), caused a large hole to form in the ozone layer. Both were banned, and have since been replaced by less harmful refrigerants. The hydrofluorocarbon refrigerants (HFCs) are free from environmentally damaging chlorine-based components, but even these still contribute to global warming. Whereas refrigerants used to be measured in terms of their ODP (ozone depletion potential), HFCs are evaluated based on their GWP (global warming potential) – a relative measure that assesses the impact of a greenhouse gas based on its contribution to global warming as compared to carbon dioxide ($CO_2$).

## Natural refrigerants research

Carbon dioxide has a GWP value of 1, while the GWP value of a HFC can be between 124 and 22 800 times higher. This means that leakages of carbon dioxide, which is a naturally occurring refrigerant, result in a much less pronounced greenhouse effect, making carbon dioxide an ideal alternative to synthetic agents. The drawback of using $CO_2$ is that it creates extremely high pressure in refrigeration systems, resulting in low efficiency.

Other natural refrigerants, such as isobutane or propane, have the downside of being flammable. In the United States of America, people did not want to work with flammable refrigerants for a long time, which is why most research has focused on $CO_2$-based solutions. Given that ▷

### Specialized in testing refrigerators

One of the key factors in terms of sustainability in refrigeration is the choice of refrigerant. Based in the Dutch city of Helmond, Re/genT is a company that specializes in testing refrigerators, and is deploying its test systems to make the coolants used across the refrigeration engineering sector more cost-effective.

The name Re/genT is an abbreviation that stands for “Refrigeration related to the Global Environment and Technology”. Johan Wijnstekers is one of the four owners of the company and is responsible for its test systems production department. His team specializes in researching and developing test systems for refrigeration and heat pumps. The company carries out its own in-house tests to the applicable testing standards, and also has its own research and development department for developing products and software.

the priority in research and development is on energy consumption, however, manufacturers stateside are slowly switching to using flammable refrigerants for products such as domestic and small commercial refrigerators. Switching from HFCs to HCs (hydrocarbons) requires a lot of development work, and not just in terms of safety.

Energy consumption and the environmental impact of the refrigerant are indicated with a TEWI (total equivalent warming impact) value. The following three factors can influence energy consumption:

- The compressor extracts heat from the appliance;
- Insulation can be applied in various thicknesses and types;
- A good heat transfer ensures the smallest possible temperature/pressure difference between the cold and hot side of the cooling system, which reduces how much energy the compressor consumes.

Regulating the TEWI value makes it possible to develop creative solutions for any application in the field of refrigeration engineering.

## Testing standards

The Dutch company Re/genT is a developer of energy-efficient solutions in refrigeration engineering. The company is also involved in testing and verifying energy labels and ecodesign requirements.

Over time, it became clear that refrigerators behave differently under standard test conditions than in daily use. Whereas testing used to be conducted at a single ambient temperature of +25 °C, the manufacturer currently tests at two different temperatures of +16 °C and +32 °C. The differences in the test results obtained at both temperatures make it possible to provide realistic evaluations of daily energy consumption.

Historically, testing has been carried out to different country-specific standards across the world. IEC standards have made sure that testing is now conducted under the same conditions worldwide, which ensures ▷

*Figure 1: Re/genT uses measurement and control equipment to assess how a compressor and its electronic components can be further optimized (Source: Re/genT, Keller Meettechniek)*

*Figure 2: Johan Wijnstekers in front of the test system (Source: Re/genT, Keller Meettechniek)*

the comparability of results. Re/genT is ISO/IEC 17025 accredited.

## Measurement laboratory

Re/genT has 13 temperature- and humidity-controlled climate chambers. Some of them are designed to hold a single refrigerator, while others are larger. The company's measurement laboratory features every type of test setup and system used by manufacturers, including compressor calorimeters, test benches for heat exchangers, evaporators, condensers and secondary refrigerants, a test bench for air-to-air heat pump systems and an air conditioning test bench for portable air conditioners. It is essential that all of these devices provide highly accurate and repeatable test results.

The company has used Keller sensors in its measurement lab for over a decade. This began when Bosch explicitly asked Re/genT to use Keller's piezoresistive pressure transmitters. The combination of cost-effectiveness, quality, and high accuracy impressed the Dutch company and earned Keller a permanent place in Re/genT's measurement lab.

Different sensors are used for the various test devices. The 33X series is Keller's flagship high-precision piezoresistive transmitter with digital communication via EIA-485 (Modbus compatible). Digital communication is vital in order to read the test values and display them in the company's proprietary software. The 23SX series is another commonly-used sensor with CANopen connectivity (see insert). It is welded, which means that it has no internal O-rings, and is therefore suitable for use with all AISI 316L stainless-steel compatible media. The M5-HB pressure transmitter is used to take certain specific measurements. This matchstick-sized sensor has a bandwidth of 50 kHz.

## Measuring and testing

Improvements are being made to a number of devices in order to continue reducing energy consumption even further. Compressors, for example, are becoming more and more efficient. The current most widely used speed-controlled compressor can boost the efficiency of the refrigeration system as a whole. Varying the speed minimizes the pressure difference across the compressor, which maximizes its efficiency. Also, the electric motors that power the compressor are becoming more efficient. Modern brushless DC electric motors used in speed-controlled compressors have far fewer losses than induction motors.

Re/genT uses measurement and control equipment to assess how a compressor and its electronic components can be further optimized, both in terms of noise and energy. For example, when a ventilator blows a little stronger, the heat exchange improves. But blowing too strongly uses up more energy, so determining the optimal blowing speed is a precise undertaking.

Insulation is another area in which progress can be made. Thicker insulation and various alternatives to classic insulation are being tested, as are vacuum insulation panels, and different types of foam. Researchers can vary both the raw materials that the foam is made from, as well as the gas used as the foaming agent. Heat transfers more efficiently when the temperature fluctuates as little as possible between the air and the evaporator or condenser. This is another area in which developments in refrigeration engineering are constantly seeking to improve on what was previously considered optimal.

### CANopen pressure sensor

In the 23SXc pressure transmitter series, temperature dependencies and non-linearity are compensated by means of a mathematical model in the micro-controller. With the CANopen interface, Keller offers an accurate pressure transmitter that is suited for a wide variety of automation solutions. The welded construction without internal seals is suitable for dynamic applications. Only the stainless steel is in contact with the media.

The product complies with the CiA 404 version 1.2.0 CANopen device profile for measuring devices and implements a CAN high-speed transceiver as specified in ISO 11898-2.

## What comes next

Re/genT currently sees the rise of heat pumps as a realistic prospect. While costs will fall, a lot of knowledge is still needed to further optimize heat pump systems. The company is working in this area. When it comes to cooling, it is likely that natural refrigerants will be used more and more for this purpose. All domestic refrigerators in Europe already contain the natural refrigerant isobutane, but it is still being developed for use in other cooling systems and heat pumps. The recent introduction of an energy label for commercial and retail refrigeration systems will also lead to energy savings.

An EU-funded bottle cooler project, in which Re/genT is involved, leads to energy savings, too. “In this project, the cold is stored in what is called a ‘phase-change material’. We just use ice in this case, which absorbs a lot of heat when it defrosts and thereby ensures that the system can handle high peak demands. This in turn makes it possible to use a very low-power compressor, which gives us a very efficient cooling system with excellent heat transfer and very low differences in pressure across the compressor. All of this, together with all sorts of other adjustments such as improving the insulation used for the fridge door, helped us to reduce our energy consumption by no less than 75 %”, explained Johan Wijnstekers, Head of production department of test systems and co-owner from Re/genT. ◀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