Interview

Energy-efficient natural refrigerants – it's time to re-evaluate our approach!

Dr Dieter Mosemann is a highly regarded expert in refrigeration and air conditioning technologies and advises various international committees. Before he retired, he was in charge of the screw compressor development in Berlin, which became part of GEA in 1994. In an interview with eurammon Dieter Mosemann answers the big questions surrounding energy efficiency and natural refrigerants. He explains why systems that achieve maximum efficiency when running at full capacity are often planned without looking at the "real efficiency" of systems running in part load most of the time and he comments on the revised F-gas Regulation.

1) **Everyone is talking about energy efficiency these days – even the specialist media. What exactly does energy efficiency mean in relation to refrigeration and air conditioning systems?**

Dieter Mosemann: Energy efficiency means that I'm able to meet a predefined goal using a minimum amount of energy. In terms of a refrigeration or air conditioning system, it means I'm able to achieve my planned cooling targets using as little energy as possible. To do this, all the processes and components need to complement each other perfectly, such as the refrigerant, compressors, heat exchanger and auxiliary drives such as pumps and fans. But external factors also need to be taken into consideration, like the ambient temperature. Energy efficiency is a crucial factor, because it influences the system's operating costs. So it's part of the cost–benefit analysis. And there's also an ecological dimension, as the less energy you use, the lower your environmental impact.

2) **How do you determine whether a refrigeration or air conditioning system is energy efficient?**

Dieter Mosemann: In practice, there are clearly defined performance figures that can be used to verify the system's energy efficiency. The Carnot cycle efficiency is used as a point of reference – it's the highest theoretically possible level of efficiency for the conversion of energy without any loss. The closer the refrigeration or air conditioning system gets to this zero-loss process, the more efficient it is. The VDMA specification 24247 describes the

calculation method for refrigeration systems and the VDMA specification 24248 details the method for heat pumps. These -performance figures, evaluate e.g. how efficiently the temperature increases from the evaporation temperature to the condensation temperature is done- and demonstrate the temperature difference is between needed temperature and evaporation temperature as well as between condensation temperature and heat sink (cooling water) and assess the effect of auxiliary systems.

3) In practice, the yearly average efficiency of some systems does not reach the planned level of efficiency. Why is that?

Dieter Mosemann: Many systems are planned in such a way that they reach maximum efficiency when they're running at full capacity; this is often part of the contract. However, it doesn't correspond with reality and requires a new approach. A good example of this is an industrial refrigeration plant designed to run at maximum capacity with an external temperature of 35°C. If you apply the temperature profile of Strasbourg, which is often used as the standard, the city's temperatures in 2009 were below 10°C for half the year and for 36 per cent of the year it was even below 5°C – it was only above 35°C for 0.6 per cent of the year. This demonstrates that only 0.6% of the year was considered while designing the system and the majority of the time, more than 99% of the year, was not looked at. To help solve this problem, the Forschungsrat Kältetechnik e.V. (Research Council for Refrigeration Technology) developed an energy efficiency tool that allows to generate seasonal evaluations of refrigeration systems. The EU has recognized the need for a better evaluation of real system conditions and first minimum requirements for the seasonal efficiency of liquid cooling systems for air conditioning and industrial process cooling are expected to be announced by the EU in 2016.

4) Do natural refrigerants offer any advantages in relation to systems with seasonally fluctuating energy efficiency?

Dieter Mosemann: Generally speaking, the thermodynamic properties of both ammonia and hydrocarbons make them very energy-efficient refrigerants that can be used in many areas of industrial cooling and air conditioning. NH_3 has also proven to be excellent for water chiller units that operate all year round with free cooling, if they feature air-cooled condensers or evaporative condensers. Free cooling takes advantage of ammonia's extremely high evaporation enthalpy and very low vapour density: vapour circulates from the evaporator to the condenser and as a liquid from the condenser to the evaporator when the ambient temperature is lower than the cooling water temperature. As such compressors are not required while making use of free cooling. Energy is saved because engines driving the

compressor, pumps and fans are not needed while operating with free cooling and as such energy efficiency of the entire system is improved.

5) Systems with natural refrigerants often require a higher initial investment, but they also provide greater energy efficiency. Is it worth it?

Dieter Mosemann: Yes – this has been demonstrated successfully in numerous systems already in operation. Ammonia dominates the larger industrial refrigeration systems, despite the higher initial investment involved, because it is so efficient – and it's also becoming more important in the air conditioning sector. There are already ammonia liquid cooling systems with over 200 kW being used to cool public spaces. In Berlin, these systems are used in some shopping centres, bank buildings and arenas. But there are also famous international buildings, such as the theatre in Copenhagen and the Skylink terminal in Vienna, that are cooled using NH_3. For smaller cooling units, I believe hydrocarbons will be used more and more, although they too place particular demands on the system's safety.

6) How will the revised F-gas Regulation affect the use of natural refrigerants?

Dieter Mosemann: Although the new F-gas Regulation stipulates a phase-down of partially fluorinated hydrocarbons to 21 per cent by 2035, synthetic refrigerants won't automatically disappear from the market. In fact, new HFO refrigerants are being developed – even though their thermal decomposition products can be problematic, as research into mobile air conditioning units has shown. The long-term effects of these new substances are also not sufficiently understood. This, in turn, raises the question of why the industry doesn't finally switch to natural refrigerants with no ifs or buts. After all, the natural substances are environmentally friendly and have proven to be energy-efficient in most applications. The HFOs, however, represent a continuation of the halogenated chorine and fluorine chemicals saga – and we already know how that ends.

((Insert figures here))

The temperature profile of Strasbourg shows that **more than 99%** of the year was not considered while designing the system.

About eurammon

eurammon is a joint European initiative of companies, institutions and individuals who advocate an increased use of natural refrigerants. As a knowledge pool for the use of natural refrigerants in refrigeration engineering, the initiative sees as its mandate the creation of a platform for information sharing and the promotion of public awareness and acceptance of natural refrigerants. The objective is to promote the use of natural refrigerants in the interest of a healthy environment, and thereby encourage a sustainable approach in refrigeration engineering. eurammon provides comprehensive information about all aspects of natural refrigerants to experts, politicians and the public at large. It serves as a qualified contact for anyone interested in the subject. Users and designers of refrigeration projects can turn to eurammon for specific project experience and extensive information, as well as for advice on all matters of planning, licensing and operating refrigeration plants. The initiative was set up in 1996 and is open to European companies and institutions with a vested interest in natural refrigerants, as well as to individuals e.g. scientists and researchers.
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