Position Paper

Fluorinated Greenhouse Gases – Use in analytical, biological and laboratory technologies

The European Federation of Optical and Precision Mechanical Industries EUROM was founded in Brussels on May 17, 1960, shortly after the constitution of the European Community. EUROM represents the interests of large, medium and small companies in the European precision mechanical and optical industries, covers a wide range of both consumer goods and industrial products and is actively engaged in making Europe an outstanding attractive industrial location.

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At a glance

- The manufacturers of analytical, biological and laboratory devices expressly support the objective of the Regulation to reduce the use of fluorinated greenhouse gases.
- The companies are already working on solutions based on natural refrigerants. However, the proposed rules are too restrictive as, in many cases, they cannot be implemented in accordance with state-of-the-art.
- We wish to submit the following proposals for the environmentally-friendly and industrially-compatible elaboration of the Regulation:
    1. Exemption for refrigeration applications in the low temperature range
    2. Increasing charge size for the service ban and increasing GWP and operating time for hermetically sealed systems
    3. Retention of the definition of “hermetically sealed” from 2006
    4. Prefilling in the plant must be possible
    5. Less steep phase-down for refrigerants with GWP < 2,500 for small quantities in hermetically sealed systems
    6. Exemption for applications in the fields of medicine and IVD (*in vitro* diagnostics)
    7. Unlimited validity of the certificates
    8. Use of TEWI when measuring CO_2 emissions

Introduction

EUROM is a high-tech industry association. It represents, among others, companies from the fields of analytical, biological and laboratory devices. Its members likewise include the manufacturers of laboratory devices in accordance with DIN 12876 "Electrical Laboratory Devices, Laboratory Circulators and Laboratory Baths" and in accordance with DIN EN 61010-1 "Safety Requirements for electrical equipment for measurement, control and laboratory use" equipped with compression refrigeration machines and, hence, concerned by this Regulation. Our members are innovative, mainly medium-sized enterprises.

We expressly support the objective of the planned Regulation to reduce global greenhouse gases to which users of fluorinated greenhouse gases are also said to contribute. Our member companies are already working on solutions based on natural refrigerants. However, we believe that the rules laid down in the Commission proposal are too restrictive as, in many cases, they cannot be implemented in accordance with state-of-the-art. In many cases no suitable alternative refrigerants are available. It is far more the case that, to comply with the planned Regulation, companies would have to consider solutions which, in terms of overall consideration of the CO_2 balance (see also "TEWI" [Total Equivalent Warming Impact], Point 8), would be counter-productive because of their poorer efficiency in reducing greenhouse gas emissions.

What products are concerned?

Firstly, we should mention laboratory circulators, special devices and equipment for the tempering of liquids in high-tech applications in research, laboratory and analytical technologies. They are used in the development phase, on a pilot plant scale and in the production process. Application areas include, for instance, medical and semiconductor technologies (e.g. refrigeration of wafers during the production process) and pharmaceutics (e.g. development of medicinal products), petrochemicals or the tempering of equipment in the chemical industry. Laboratory circulators are also used around the world for the refrigeration and optimisation of exothermic processes amongst other things.

Refrigerated laboratory centrifuges are used for the centrifuging of sensitive samples (blood for blood transfusion whereby a steady temperature (4°C) is the precondition for the protein components in the blood not sustaining any damage) under close compliance with adjustable temperatures (-20° up to +40°). They are the standard specification for almost every medical, biological, biotechnical, clinical or chemical laboratory.

High refrigeration capacities are normally needed for laboratory centrifuges, laboratory fridges and freezers because of the higher thermal loads. The requirements to be met by all the refrigeration systems mentioned here are thus explicitly higher than for conventional refrigeration or air conditioning applications.

Where are refrigerants used in the devices?

Compression refrigeration technology is used in the above devices and equipment. A distinction is made between single phase refrigeration devices for minimum temperatures of typically around -55 up to -30° C and two phase refrigeration devices (cascade, two cold circuits in series) for minimum temperatures up to approx. -90° C. Depending on the device or equipment, the maximum refrigeration performance is between approx. 150 watts and several hundred kilowatts. The charge sizes range from a few grams up to 100 kg. The charge size for the centrifuges is around 50 g up to 1.5 kg. The typical refrigerants used are R134a, R404A, R23, R507A, R508A und R508B.

The components in the devices described here are hard-soldered or welded and are deemed to be hermetically sealed equipment in accordance with the harmonised standard DIN EN 378-1:2008 Chapter 3.1.8 ("Refrigerating systems and heat pumps – Safety and environmental requirements"). Installation is undertaken professionally by certified specialist companies in accordance with the Chemical Protection Ordinance (ChemKlimaschutzV), which supplements Regulation (EC) 842/2006 in Germany.

What problems occur with the use of alternative refrigerants?

For use in circulators the currently viable F-gas-free refrigerants are either combustible (e.g. propane) or not suitable (e.g. CO_2, ammonia), for reliably achieving temperatures below -30° C. Furthermore, some customers for certain applications e.g. in semiconductor or medical technology, are still sceptical about the use of combustible refrigerants.

In the first refrigeration devices combustible refrigerants like propane or ammonia (R717) were used because of the energy advantages they offered. At that time, accidents with combustible refrigerants were not rare. Efforts were made to search out and identify new, non-combustible refrigerants. They all belong to the group of CFC, HFC, PFC and HCFC refrigerants. It is true that isobutene (R 600a) has been used for around 20 years as a combustible refrigerant in every household fridge and modern large-scale refrigeration plants are only run on ammonia. The requirements regarding operating technology and operating temperatures are, however, far stiffer for the above-mentioned applications than for a conventional household fridge.

The use of combustible refrigerants in centrifuges is far more difficult because of the high kinetic energy. In the case of rotor breakage in the centrifuge a large portion of the refrigeration equipment is destroyed mechanically. Escaping refrigerant can combust as a consequence of a mechanical spark or electrical drive. The product standard for laboratory centrifuges IEC 61010-2-020 prohibits the use of combustible or explosive materials.

Possibly non-combustible or poorly combustible alternative refrigerants like, for instance, R1234yf (GWP < 150) are not viable substitutes for refrigerants R404A, R507, etc. either as no components of a similar size are available for these refrigerants that have a far lower volumetric refrigeration capacity. Furthermore, the use of alternative refrigerants may lead in part to an increase in the device's energy consumption which would result, counter-productively, in far higher CO_2 emissions (see also Point 8 on the use of an alternative calculation method).

Another possible alternative would be a CO_2 plant. This requires special components for the refrigeration equipment (compressors, valves, liquefiers) that resist the higher pressures. Suitable refrigeration components for high-tech applications are, however, almost non-existent on the market particularly as component manufacturers primarily serve the mass markets air conditioning and food refrigeration. In addition, there is the lower energy efficiency of CO_2 as the evaporation temperature rises. Other aspects are the need for massive component solutions, more space and higher system requirements in accordance with the Pressure Equipment Directive.

There is another economic problem that affects most of the above-mentioned companies in our Association because of their high export share. It stems from the Dangerous Goods Regulation (DGR) of IATA (International Air Transport Association). According to the DGR only the transport of maximum 100 g combustible refrigerant is permitted for shipment by air. This means that the equipment would have to be filled on site which leads to the problems mentioned in Point 4 (see above).

On this basis we believe there are eight points at the centre of a both environmentally-friendly and industrially-compatible elaboration of the new Regulation.

1. **Exemption for refrigeration applications in the low temperature area**

We explicitly support the planned exemption for refrigeration applications in the low temperature range. However, we call for the raising of the threshold to -30 °C. It can be assumed that the currently envisaged threshold of -50° C was fixed with an eye on the mass markets like, for instance, air conditioning and food applications and heat pumps. A lower threshold of -30° C is, however, sufficient to exclude these mass markets from the exemption provision. Failing this, there will be a refrigerant gap for high-tech applications between -30° C and -50° C for special devices.

For an application temperature of less than -30° C only natural refrigerants would be allowed from 2020 onwards according to the current Proposal for a Regulation. Most of them (with the exception of water and CO_2 [R744]) are combustible which leads to the problems raised in the section "What problems occur during the use of alternative refrigerants?"

2. Increasing the charge size for the service ban and increasing the GWP and later start of the service ban for hermetically sealed systems.

The maximum charge size of 5 CO_2 tonnes refrigerant with a GWP greater than 2,500, stipulated in Article 11, paragraph 3 of the Proposal of 7 November 2012, practically means a sales ban for German manufacturers as the devices have very long product life cycles and will not be accepted by customers without the option of servicing and maintenance. It is far more the case that the premature replacement of the devices would lead to considerable indirect CO_2 emissions. This would be counter-productive to reducing greenhouse gas emissions.

In the amendments of the Member States of the European Parliament, there were several calls to raise the quantity limit to 40 or 50 CO_2 tonnes. We explicitly support this position. However, this increase would have no impact if the GWP threshold of 2,500 were retained as most refrigerants above the GWP have already been banned. We, therefore, suggest increasing the GWP indicated in Article 11 paragraph 3 for hermetically sealed systems to 4,000 for service purposes up to 2030.

3. Retention of the definition of "hermetically sealed" from 2006

The previous definition from Regulation (EC) No 842/2006 should be kept at all costs. Its contents mostly correspond to the definition in DIN EN 378-1:2008 Chapter 3.1.8, which applies to most of the manufacturers concerned by the Regulation and is, therefore, widely accepted.

4. Prefilling in the plant must be possible

Prior to refrigerant filling the devices and equipment must be emptied in a complicated procedure. If filling may only take place on the customer's premises, the devices must first be emptied and then filled for transport with an inert gas (e.g. nitrogen). On the customer's premises they must be re-emptied and only then can filling with the refrigerant take place. Filling is done using special equipment. (Particularly in the case of small quantities filling without the appropriate filling device is not possible. Filling devices of this kind are stationary and/or are not suited for service use on site. In the case of large quantities the safety risk rises.) Filling must be done by trained special staff (mechatronics engineer for refrigeration technology) and may take up to 36 hours including emptying.

Manufacturers must, in any case, commission or test finished equipment in the plant. To this end, the equipment is filled in accordance with the instructions in the plant. The manufacturers of special devices with complex refrigeration systems have, on commissioning, to use new refrigerant. After commissioning the refrigerant, however, contains impurities which rule out renewed use of the refrigerant in special devices. The cold test refrigerant must then be disposed of. The CO_2-equivalent emissions that arise during production and disposal of the cold test agent were not taken into account and must be added to the requirement in Article 12.

The companies supply large unit volumes of plug-in devices to customers across Germany. They are not able to carry out filling on the customer's premises in terms of staff and filling devices. Based on an average export quota of 55 % and delivery to almost all countries around the world the logistics challenge is multiplied. Furthermore, leaks generally do not occur during the transport of devices already filled with the refrigerant in hermetically sealed systems.

Article 12 does not contribute in any way whatsoever to greater safety or a reduction in greenhouse gases. Quite the contrary: the large number of necessary on-site service visits and the production and disposal of cold test refrigerants would lead to numerous new CO_2 emissions.

5. Less steep phase-down for refrigerants with GWP < 2.500, for small quantities and hermetically sealed systems

A phase-down is not restricted to the amounts used by the manufacturers but also has an impact on the (growing) demand for (dwindling) refrigerants. As outlined above, no alternative refrigerants are available ad hoc in many cases. A less steep phase-down for refrigerants with a GWP lower than 2,500 would give the manufacturers more scope to find alternative refrigerants.

A less steep phase-down should also be possible for the users of only small amounts of refrigerants. A sensible provision would be to level out the phase-down for the use of up to 5 CO_2 tonnes.

Furthermore, the phase-down for hermetically sealed systems should be levelled out as the escape of fluorinated greenhouse gasses within the statutory leakage rates is very low.

6. Exemption from uses in the fields of medicine and IVD (*in vitro* diagnostics)

We fully support the proposals in Amendments 249 and 266 of the EP ENVIN Committee: To guarantee safe and effective basic medical care critical applications in the medical area with fluorinated greenhouse gases, too, must be maintained if no suitable alternatives are available. A clear exemption for medical uses ensures availability for this important application. Applications in the field of *in vitro* diagnostics should also be exempt for the same reasons.

7. Validity of the certificates

Germany has very high training requirements like, for instance, training last three and a half years as a Mechatronics engineer for refrigeration technology. Our companies are certified firms within the intendment of the German Chemical Protection Ordinance (ChemKlimaschutzV). Hence, in deviation from Article 8 paragraph 5, we call for the unlimited validity of certificates if the requirements laid out in §5 of the ChemKlimaschutzV are met.

8. Use of TEWI when measuring CO_2 emissions

For the ensuing discussion we suggest taking into account the TEWI (Total Equivalent Warming Impact) procedure from DIN EN 378-1, Annex B for the measuring of CO_2 emissions in the Regulation. This will include both the direct contribution of refrigerant emissions in the atmosphere and the indirect contribution of carbon dioxide and other gas emissions (caused by the production of energy for the operation of the refrigeration equipment throughout its service life). The CO_2 emission share from energy consumption (indirect share) may, depending on the refrigeration use, be several times higher than the share of the refrigerant emissions.

This method shows that when using refrigerants GWP > 2500, the total CO_2 emission (direct and indirect contribution) of a refrigeration device may be far lower than for comparable devices with refrigerants GWP < 2500. When considering “reducing CO_2 emissions”, the actual energy consumption of the refrigerated devices could be considered or perhaps even classified. The sole reference to the CO_2 equivalents of the refrigerants used is an indication that the F-Gas Regulation is incomplete and in its current form may not be able to reliably achieve the goals set.