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pour le développement du froid

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14th Informatory Note on refrigerants

Reduction of emissions of refrigerants and containment in systems

The **Montreal Protocol** has led to the gradual phase out of CFCs (chlorofluorocarbons) and HCFCs (hydrochlorofluorocarbons), used as refrigerants among other applications.
When enforced, the **Kyoto Protocol** governing greenhouse gases will entail reduction of emissions of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), and three other types of gas, including HFCs (hydrofluorocarbons). This reduction will affect the refrigeration and air-conditioning industries by imposing additional controls on:
– emissions of the refrigerants concerned (direct effect);
– CO_2 emitted during the production of the energy used in refrigeration and air-conditioning (indirect effect). From this point of view, criteria such as TEWI can be useful in decision-making.[1]
Finally, **safety requirements** dictate that strict containment of toxic or flammable fluids in plant must be achieved.[2]
Emissions reduction has thus become even more important in the management of controlled refrigerants.
This note presents a series of measures to be taken including general measures, as well as specific containment measures. Commercial and political issues are discussed and recommendations are proposed.

1. REDUCTION OF EMISSIONS

Reduction of emissions must be achieved throughout the life cycle of refrigerants (production, transport, operation, management of plant, management of containers of virgin or recovered refrigerants and recovery, recycling, regeneration and destruction when necessary), and throughout the life cycle of plant (design, fitting, operating, decommissioning).
Particular points concerning containment (maintaining refrigerant fluid within plant) will be covered in Section 2.

1.1. Reduction of the charge used

Reduction of initial charges normally assists in the reduction of emissions. Reduced charge can be achieved in many ways including: use of dry evaporators instead of flooded evaporator coils, low-pressure receiver systems, secondary-refrigerant systems, condensing water systems with cooling towers, etc. However, reduction of the charge has to take into account energy consumption, given that certain solutions such as use of a secondary refrigerant may lead to increased energy consumption.
Reduction of the charge is a field in which considerable innovation can be achieved.

1.2. Monitoring of concentrations of refrigerants in machine rooms

In large plant and in all machine rooms, multiprobe sensing of ambient conditions normally provides the most reliable system of monitoring. Air-flow patterns should be investigated in order to select sensor sites where the refrigerant, usually heavier than air, tends to concentrate. This monitoring known as "threshold monitoring" requires highly sensitive and accurate detectors (able to detect 1 or 2 g/year), suitable for use with new refrigerants.

1.3. Plant monitoring and maintenance logbook

In many countries, a maintenance logbook must be available on site at all plant larger than a specific size. This logbook enables true monitoring of plant to be performed and comprises servicing sheets to be filled in whenever refrigerant is added or recovered, and tightness monitoring sheets. In certain countries, maintenance logbooks must be checked by an independent official inspector.

1.4. Precautions and systematic refrigerant recovery throughout its life cycle

Reduction of emissions is important during all operations involving refrigerants: storage of large volumes at the manufacturing site, transfer into containers by distributors, charge of plant, assembly, maintenance and repair, recovery using suitable containers, and management of “heels”/seams of containers of refrigerants, etc.
Recovery systems must be easy to use and enable the liquid and vapour phases to be recovered and pipes to be drained. For all handling operations, refrigerant charging pipes should be fitted with ball valves (or quick sealing) at each end.
The pressure thresholds at the end of the recovery process must take into account the quantity of residual refrigerant contained in the refrigerant/oil mixture.

1.5. Destruction

Where for technical, financial or regulatory reasons, the CFC or HCFC refrigerant recovered can not be recycled, it must be destroyed in an approved and monitored manner.

2. REFRIGERANT CONTAINMENT

Achieving refrigerant containment is an important factor in preventing leaks and all levels are involved: the design, testing, installation, operation, maintenance, servicing and disposal of equipment. Actions required depend on the type of equipment concerned, and can be divided into broad categories including:

- household appliances: refrigerators, freezers, small air conditioners, etc. Most of these appliances are fully brazed and tightness depends on the quality of brazing: generally, less than 1 or 2 out of 10 000 appliances present defects;
- chillers: all components of these systems are normally located in machine rooms, thus facilitating monitoring of tightness;
- direct-expansion systems with long refrigerant circuits: these systems are used in commercial and industrial refrigeration (particularly in the food industry) and tend to be leak-prone;
- vehicle air-conditioning systems: these systems have flexible elastomer hoses and open-type directly driven compressors, they tend to be leak-prone.

Emission levels vary according to the type of system and thus require containment policies that are appropriate to the system design; these policies are described in guidelines such as those cited in the references at the end of this this note. .[3,4,5 and 9]
Containment guidelines applying to all types of plant are described below.

2.1. Design

The number of screw-on valves and fittings should be kept to a minimum in order to minimize the number of leak sites. Selection of components should be based on reliability and leakage performance. Safety relief valves must be taken into account when defining the Maximum Operating Pressure (MOP) in order to prevent valves from opening when the condensing pressures are too close to MOP levels. Checking the charge level has proved useful in large plant.

2.2. Monitoring of tightness

Information on leak rates in various types of hose, stuffing boxes, flanges, etc. is useful at the design stage. However, only on-site monitoring of concentrations in the air of the room (as described in Section 1.2 above), or of leak rates, makes it possible to achieve acceptable accuracy concerning tightness under real operating conditions. This has been demonstrated in other fields requiring strict tightness monitoring (vacuum, space or nuclear systems).
Leak rate measurement is indirect: it involves measurement of the **concentration in a given space** (room or area around plant). In large commercial or industrial systems, it may be advisable to make systems charge-sensitive and of low charge. If signs of undercharge appear, the leak may be sought using soapy water.

2.3. Analysis of malfunctions

Although initial tightness is achieved very effectively by most equipment manufacturers, the tightness of various components during long-term use is not well-known: for instance, valves under operating conditions or pressure-gauges exposed to compressor vibrations. Tightness monitoring in the field should be performed according to quality procedures which enable Analysis of Modes of Malfunction (Analyse des Modes de Défaillance [AMDEC]) to be performed. Long term, this analysis will make it possible to modify the most critical components. A tightness of components standard remains to be implemented. When such a standard does come into effect, it must take into consideration sufficiently accurate leaktightness and measurement methods.

3. POLITICAL, ECONOMIC AND COMMERCIAL ASPECTS

Although many technological measures described above have been available for years, rate of adoption tends to be slow. How can barriers to implementation be removed? A number of relevant issues are considered below.

3.1. Availability of suitable equipment

Suitable recovery equipment,[7] and where possible recycling equipment, must be available on-site when recovery needs to be performed; staff must be familiar with this equipment and trained in its use. If the recovered refrigerant must/can not be recycled, means of destruction must be available.

3.2. Overall economic equilibrium

Emissions reductions will become widespread only if such reductions are in the interests of each user concerned: fitters, plant managers, refrigerant distributors, etc.
Containment and recovery involve additional expense: staff training and incentives, implementation of monitoring and approval or sanctions, communication with customers, the taking into account of recycling or even destruction. In order for the companies concerned to recover these additional expenses:

- containment must lead to reduced use of refrigerant fluid and where possible, recycling should produce re-usable refrigerant fluid,
- other factors should provide financial incentives for companies to comply with regulations, for example:
  – customer needs: customers may impose special clauses concerning emissions in delivery and/or maintenance contracts;
  – the seeking of an "ecological" image or label, (that must be granted only under well-defined conditions).

However, benefits do not necessarily offset costs, particularly where:

- recycling is not possible, for regulatory (where re-use or resale is illegal), or practical reasons;
- if inexpensive illegal refrigerants are available;
- if the recovered refrigerant fluid must be destroyed.

In this situation, structural measures will then be required to promote emission reductions.

3.3. Structural measures

According to the context, cultural factors and common practice in each country, the state and professional organizations will play more or less important roles which must in all cases converge:

- to curb the black market and ensure that all recovered refrigerant fluid controlled by regulations (and which is not to be recycled) is in fact destroyed,
- to ensure, more generally, that regulations are complied with without disturbing competition,
- to promote standardization, for instance of recovered refrigerant fluids,[8] labelling, as well as interprofessional agreements promoting remuneration of recovered refrigerant fluid at a sufficiently high price level, and packaging guidelines, etc. Where necessary these aspects should be taken into account when tendering.
- to promote appropriate incentives (such as tax reductions), and international assistance, for purchase of specific recovery, recycling, regenerating and destruction equipment when required;

- to avoid unnecessary red tape: recovered refrigerant fluids do not need to be subjected to all the regulations applying to dangerous products.

In certain countries, the re-use, resale of recovered refrigerant or CFC-containing equipment is illegal or will become illegal. Such regulations are a deterrent for the black market, promote the updating of industrial plant and expand markets for equipment and new refrigerants. However, it is important to ensure that the refrigerant is destroyed despite the cost involved and will not be leaked (either accidentally or deliberately) into the atmosphere, when in fact it could have been re-used or contained in plant.

Certain countries levy taxes on new refrigerants or envisage doing so. If this solution is adopted, it will require additional efforts to curb the black market and must not disturb competition.

3.4. Training – Certification

Reducing emissions implies radical changes in maintenance and operating methods, and even attitudes, and requires significant initial training and continuing education. This training and compliance with good practice procedures has more impact where certification of staff and companies is achieved.

In any case, the efficacy of training will depend on the situation in terms of the points raised in Sections 3.2. and 3.3.

3.5. The particular case of Article-5 countries

These countries are generally developing countries. They consume small quantities of CFCs and HCFCs at present and have the right to "consume" CFCs until 2010 and HCFCs until 2040. They can speed up this process by entering into particular agreements, and this has become an important recommendation since global warming has begun to be taken into account. Regeneration and destruction may be more difficult than elsewhere, for instance because refrigeration plant is widely dispersed across countries.

Before implementing subsidized recovery plant, a thorough financial study must be performed in order to ensure that the use of such plant is profitable for everyone involved.

Regulations adopted anywhere in the world concerning the phase out of equipment using CFCs and HCFCs create an incentive to export new or second-hand CFC and HCFC equipment to Article-5 countries. This may contribute to the short-term development of refrigeration in these countries, but simply shifts the environmental problem and is likely to cause major retrofitting problems in the future. Containment technology transfer towards developing countries can help protect the ozone layer and fight global warming.

4. RECOMMENDATIONS

The IIR advises users to take into account suggestions in Sections 1 to 3. Above all, the IIR stresses the need:

- in national, international and corporate policy, **to give top priority to reducing emissions**,[4,5,6,9,10] and in the case of global warming, to bear in mind the major impact on **"indirect" global warming** when implementing measures;
- to promote the setting up of **coherent national plans** covering recovery, recycling and destruction;
- to enforce **regulations,** particularly with respect to **illegal imports and sale**;
- to implement **financial and regulatory incentives** in order to promote recovery, refrigerant emissions reduction and use of replacement refrigerants;
- to promote **staff and company certification** in order to ensure compliance with good practice procedures.[4,5 6 9 10]

Such economic policies are enriched by discussions between the partners involved: national delegates of the IIR, organizations representing the various parties concerned, national associations and national refrigeration committees can be key partners.

The IIR is willing to continue to work in liaison with the various United Nations organizations implementing the Montreal Protocol, as well as with committees, professional organizations and governments of its member countries, in order to develop coherent policies.

References

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5. Order of the Ministry of Housing, Spatial Planning and Environment, on regulations on leak-free refrigeration equipment (1994 Order on leak-free refrigeration equipment). The Netherlands, June 1995.
6. Italian legislation 179/97 on the environment.
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8. US standard ARI 700.95 on recovered refrigerants.
9. Guideline 3.1996 : Reducing Emission of Halogenated Refrigerants in Refrigeration and Air Conditioning Equipment and Systems, ASHRAE.
10. EEC Regulation 3093/94 and revised draft version dated December 21, 1998.

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