Forschungsrat Kältetechnik

Resource efficiency in refrigeration technology

Policy paper

March 2014

Contact:
Dr. Karin Jahn
Managing Director
Forschungsrat Kältetechnik e.V.
Lyoner Straße 18
D-60528 Frankfurt
Phone: +49 (0)69 6603-1277
Fax: +49 (0)69 6603-2277
e-mail: karin.jahn@fkt.com
www.fkt.com

Introduction

The Forschungsrat Kältetechnik e.V. (Research Council for Refrigeration Technology) promotes technical and scientific research and the practical application of research findings in the field of refrigeration and heat pump technology.
Members of the Research Council are enterprises from industrial, commercial, transport and household refrigeration, heat pump industry, chemical industry, lubricant industry, process measurement and control, and also research institutes and inter-trade organisations.

Refrigeration technology can be found in all areas of everyday life - from household refrigerators to air-conditioning systems, from entire cold chains in the food industry to industrial applications, e.g. in the pharmaceutical industry, and in many other areas.

The Forschungsrat Kältetechnik e.V. considers it to be its social responsibility to economically and carefully use resources thereby ensuring sustainable fulfilment of basic needs such as nutrition, health and quality of life.

The Research Council advocates the efficient use of natural resources, the first priority being the safe and efficient operation of refrigerating systems.

The term "resources" comprises **all** raw materials and also clean air, water and soil, and biological diversity.

Relevant for refrigeration technology are:

- **Materials**
  Metallic materials (mostly copper, steel, aluminium)
  Elastomeres
  Insulating materials
- **Operating supplies, working materials**
  Refrigerants
  Refrigerants and heat transfer media
  Oil (lubricants)
  Solvents (e.g. for absorption refrigeration systems)
  Chemicals (e.g. for water treatment)
- **Energy (mostly electric power)**
- **Water.**

Resource efficiency

In accordance with the definition by the VDI (Verband Deutscher Ingenieure - German Engineers' Association) [1], the Forschungsrat Kältetechnik defines resource efficiency as the ratio of the production output and the environmental impact caused by the use of resources and polluting emissions.
Our definition of production output is the fulfilment of cold or heat load requirements (for heat pumps). It must be taken into account that the resources are mainly needed to run the system.

Depending on runtime and operating life, a typical refrigeration or heat pump system requires five to ten times as much energy while running than is required for its manufacture, service and disposal [2].

Improving resource efficiency in refrigeration technology will reduce the environmental impact per kWh of refrigeration load. For this, the environmental impact throughout the entire life cycle must be taken into consideration. The life-cycle assessment provides an international standardised method for quantification of the environmental impact [3] [4].

Relevant topics and possible conflicts of objective

Between 15 and 20% of Europe's electrical power requirements stem from the operation of commercial and private cooling, freezing equipment, refrigeration and air-conditioning systems [5], [6], [7], [8]. For this reason, energy efficiency of refrigeration, air-conditioning systems and heat pumps should be increased further.

Since they have been in use, emissions of hydrocarbons and fluorinated hydrocarbons have been steadily rising,
firstly caused by the replacement of the chlorine-containing refrigerants responsible for ozone depletion,
and
secondly due to the increased global demand for refrigeration.

The direct green-house effect of large amounts of fluorinated hydrocarbons has been documented. Other negative effects caused by fluorine-containing compounds in the atmosphere cannot be excluded. This is why the selection of the right refrigerant and the leak-tightness of refrigeration and heat pump systems are so important for the improvement of resource efficiency in refrigeration technology.

Other factors to be taken into account are investment and operating costs as well as environmental impact.

Saving resources in the field of refrigeration technology is possible by:

- reducing the refrigeration load (e.g. optimisation of refrigerating temperatures actually required, heat removal by ventilation)
- a holistic approach as early as in the planning stage, e.g. taking into account partial/full loads, environmental influences, optimisation of process-related procedures
- choosing suitable working materials (e.g. refrigerants, refrigerant und heat transfer media, and refrigerating machine oils) for the application in question.

Conflicts of objective between energy efficiency and material efficiency might ensue:

- Increased material usage during production can improve the energy efficiency (e.g. larger heat exchanger surfaces, more insulating materials, refrigeration circuits with several compressors).
- A more efficient process measurement and control can increase material usage.
- Using more energy-efficient refrigerants (e.g. natural refrigerant) might require additional materials.
- A system expansion with "free cooling" (temporary operation without refrigerant compressor) will increase material requirements.
- Waste heat utilisation can improve energy efficiency but will cause higher material requirements.
- Using evaporative condensers can help increasing the energy efficiency of refrigerating systems, but requires materials for water treatment.

Activities and results of the Forschungsrat Kältetechnik e.V.

Policy paper

In June 2008, the Forschungsrat Kältetechnik published the first policy paper on potential savings of greenhouse-relevant emissions in refrigeration and air-conditioning technology, "Klimaschutzbeitrag von Kälte- und Klimaanlagen, Verbesserung der Energieeffizienz, Verminderung von treibhausrelevanten Emissionen" (Contribution of refrigerating and air conditioning systems to climate protection Improvement of energy efficiency, reduction of greenhouse-related emissions) [5] [9].

National working group "Energieeffizienz von Kälteanlagen "

The national working group "Energieeffizienz von Kälteanlagen" (Energy efficiency of refrigerating systems) was founded in July 2008 upon the initiative of the Forschungsrat Kältetechnik e.V. in cooperation with Germany's refrigeration technology industry.Activities and results of the working group:

- **VDMA 24247 "Energy efficiency of refrigerating systems"**
  Development and compilation of the VDMA Specification 24247 "Energy efficiency of refrigerating systems", Parts 1-8 [10], [11], [12], [13], [14], [15], [16], [17].
  This specification documents measures for reducing the energy consumption or increasing the overall energy efficiency.
- **VDMA 24248 "Energy efficiency of electrically powered heat pumps"**
  Development and compilation of the VDMA Specification 24248 "Energy efficiency of electrically powered heat pumps" [18].
  This specification documents measures for reducing the energy consumption or increasing the overall energy efficiency.
- **VDMA 24019 "Waste heat utilisation in refrigerating systems"**
  Development and compilation of the VDMA Specification 24019 "Waste heat utilisation in refrigerating systems" [19].
  This specification documents measures for reducing the energy consumption or increasing the overall energy efficiency.
- **"Effizienztool"**
  Development of the calculation model "Effizienztool" (efficiency tool) for the application of the efficiency criteria for refrigerating systems developed in VDMA 24247 [20].

- **"VDMA Effizienz-Quickcheck"**
  Development and programming of the "VDMA Effizienz-Quickcheck" (energy efficiency check) [21] for optimising the energy efficiency of refrigerating systems in food retail.

Project reports

The Forschungsrat Kältetechnik has also published a number of project reports on the leak-tightness of refrigerating systems [22], [23], [24], [25], [26] (see also www.fkt.com).

Study on life-cycle assessments in refrigeration technology

A study by the Forschungsrat Kältetechnik on the state of life-cycle assessment in refrigeration technology was updated in 2010 [27].

Future topics

The research council is continually examining the latest developments in the field of refrigeration technology.

They focus especially on the following key aspects:

- energy efficiency
- leak-tightness of refrigerating systems
- environment-friendly refrigerants
- safety of refrigerating systems.

Implementing these key aspects means increased qualification requirements for all persons concerned.

Political expectations

The Forschungsrat Kältetechnik is gladly available to political organisations to discuss the following topics:

- extension of the promotion guidelines for commercial refrigerating systems to cover refrigerating systems with higher performances
- active integration of the expertise of the Forschungsrats Kältetechnik e.V. into the compilation of funding guidelines
- promotion of research projects to increase resource efficiency
- regulatory policies with long-term planning reliability
- promotion of primary and continuing training

Literature

[1] http://www.vdi-zre.de/, VDI ZRE Zentrum Ressourceneffizienz und Klimaschutz, 2012-08-28

[2] Energetische Betrachtung der Lebenszyklen von zwei unterschiedlichen Wärmeübertragertechnologien (Energetic view of the life cycles of two different heat exchanger technologies), Patrick André Rauch, student research project at Europäische Studienakademie Kälte-Klima-Lüftung, Maintal, 2012

[3] DIN EN ISO 14040:2009-11 Environmental management – Life cycle assessment – Principles and framework

[4] DIN EN ISO 14044:2006-10 Environmental management – Life cycle assessment – Requirements and guidelines

[5] Contribution of refrigerating and air conditioning systems to climate protection, improvement of energy efficiency, reducing greenhouse-related emissions, Forschungsrat Kältetechnik e.V., Frankfurt, June 2008

[6] Preparatory Study for Eco-design Requirements of EuPs; Lot 13: Domestic Refrigerators & Freezers - Task 2: Economic and Market Analysis. European Commission, Faberi S., Stamminger R., Mebane W. and Esposito R, Brussels, 2007

[7] Preparatory Study for Eco-design Requirements of EuPs; Lot 1; Refrigerating and freezing equipment, Mudgal S., Tinetti B., Bain J., Cervantes R. and Trigo A. d. P., European Commission, Paris, 2011

[8] Sustainable Industrial Policy - Building on the Ecodesign Directive - Energy Using Product Group Analysis/2 - Lot 6: Air-conditioning and ventilation systems - Final report of Task 4, Riviere P., Adnot J., Greslou O., Spadaro J. and Stabat P., European Commission, Armines, France, 2012

[9] Contribution of refrigerating and air conditioning systems to climate protection, improvement of energy efficiency, reduction of greenhouse-related emissions, Forschungsrat Kältetechnik e.V. (revised version of the policy paper of June 2008), Frankfurt, March 2012

[10] VDMA 24247-1 Energy efficiency of refrigerating systems, Part 1: Contribution of refrigerating and air conditioning systems to climate protection, improvement of energy efficiency, reducing greenhouse-related emissions

[11] VDMA 24247-2, Energy efficiency of refrigerating systems, Part 2: Requirements for system design and components

[12] VDMA 24247-3 Energy efficiency of refrigerating systems, Part 3: Guidelines for improvement of energy efficiency in cold storage houses

[13] VDMA 24247-4, Energy efficiency of refrigerating systems, Part 4: Supermarket refrigerating, commercial refrigeration, refrigerated cabinets

[14] VDMA 24247-5 Energy efficiency of refrigerating systems, Part 5: Industrial refrigeration

[15] VDMA 24247-6 Energy efficiency of refrigerating systems, Part 6: Air-conditioning

[16] VDMA 24247-7 Energy efficiency of refrigerating systems, Part 7: Control, energy management and efficient system management

[17] VDMA 24247-8 Energy efficiency of refrigerating systems, Part 8: Components heat exchangers

[18] VDMA 24248 "Energy efficiency of electrically powered heat pumps"

[19] VDMA 24019 "Waste heat utilisation in refrigerating systems"

[20] FKT 168/10 Development of a calculation model for the application of the developed energy efficiency criteria of refrigerating systems (efficiency tool), Forschungsrat Kältetechnik e.V., Frankfurt, Juni 2013

[21] VDMA Effizienz-Quickcheck (energy efficiency check) (http://www.vdma-effizienz-quickcheck.org), VDMA, Frankfurt, 2012

[22] FKT 21/96 Dichtheit von Kälteanlagen (Tightness of refrigerating systems), Forschungsrat Kältetechnik e.V., Frankfurt, December 1999

[23] FKT 86/01 Verbesserung der Dichtheit kältetechnischer Erzeugnisse (Improvement of tightness of refrigeration technology products), Forschungsrat Kältetechnik e.V., Frankfurt, January 2003

[24] FKT 107/04 Dichtheitsprüfung von Kälteanlagen mit Formiergas im Kälteanlagenbau (Leak testing of refrigerating systems using forming gas in refrigeration system construction), Forschungsrat Kältetechnik e.V., Frankfurt, August 2005

[25] FKT 134/06 Information brochure on VDMA Specification 24 243 "Kältemaschinen und –anlagen, Dichtheit von Kälteanlagen und Wärmepumpen, Lecksuche / Dichtheitsprüfung" (Refrigerating machines and systems, tightness of refrigerating systems, leakage detection/leak testing), Forschungsrat Kältetechnik e.V., Frankfurt, March 2006

[26] FKT 118/05 Automatische Dichtheitskontrolle basierend auf den Forderungen der F-Gase-Verordnung (Automatic leak testing based on requirements of the F-gas Regulation), Forschungsrat Kältetechnik e.V., Frankfurt, May 2007

[27] FKT 160/10 Ökobilanzen in der Kältetechnik - Stand heute und zukünftiges Potenzial (Life-cycle assessment in refrigeration technology – current state and future potential), Forschungsrat Kältetechnik e.V, Frankfurt, March 2011