Cold Appliances

HIGHLIGHTS

PROCESS AND TECHNOLOGY STATUS – Refrigeration and cold appliances are mature technologies which market has reached the saturation level in most developed countries, with penetration rates of nearly 100%. In 2009, the European Union (EU-27) residential refrigerator and freezer stock were estimated at around 191 million units and 84 million units, respectively. In the EU, about 15% of electricity consumed in households is used to satisfy the energy demand for domestic cold appliances, i.e. **fridges** for fresh foodstuff preservation, **freezers** for preservation at temperature of -18°C, and combined **fridge-freezers**. Today's market is characterised by a significant decrease in the freezer size, with an increase of combined refrigerator-freezers. Commercial refrigeration devices (**service and blast cabinets, walk-in cold rooms, packaged condensing units, process chillers**) are used in restaurants, hotels, pubs, cafes, supermarkets and in industrial processes. In some types of commercial buildings (e.g. supermarkets) refrigeration accounts for up to 50% of the building's energy consumption. All these devices include compressors, expansion valves, condensers and evaporators, evaporator fans, and appropriate process fluids. As far as the process fluid is concerned, in the last decades of the 20th century, freon-based gases, CFC and HCFC have been widely used because they are efficient, stable and safe. However, regulations to protect the atmospheric ozone layer have led to phase out most of these gases, and alternative hydrofluorocarbon (HFC) gases have been developed and are currently used. Fluids with a smaller global warming potential are currently under development. The energy demand for cold appliances can be reduced by efficiency improvements such as thermal insulation by vacuum and polyurethane foams, adaptive defrosters, more efficient heat-exchangers, compressors and fans, and electronic control. The domestic cold appliance market is growing fast in the emerging countries such as China, Brazil and India.

PERFORMANCE AND COSTS – Over the last twenty years, the energy efficiency of new fridge-freezers has been improving in almost all regions. In 2006, the best available refrigerator-freezer used 19% of the energy used by the equivalent product on the European market in 1992, although the average new domestic cold appliance used about 60% of the energy of the equivalent 1992 model. Between 2005 and 2008, the energy use of fridge-freezers has reduced from 0.86 kWh per litre per year (kWh/l-y) to 0.69 kWh/l-y in the United States, from 0.97 to 0.73 kWh/l-y in China, and from 0.92 to 0.84 kWh/l-y in Europe. The annual energy consumption of domestic fridge-freezers is moving toward the common level of 350-400 kWh/y (about 270 to 370 kWh/y for domestic freezers), with exception of China where the energy consumption is smaller (193 kWh/y) due to the smaller average volume of Chinese domestic cold appliances. Room for energy efficiency improvements exists in particular in regions with less efficient devices. As far as cost is concerned, based on the United Kingdom market, prices of domestic cold appliances vary depending on function and performance: Fridge-freezers prices range from €528 for A++ efficiency-rated products to €283 for B rated products; Fridges price ranges from €404 for A++ to €132 for B; Chest freezers cost approximately from €344 for A++ to €141 for C, while upright freezers cost from €509 for A++ to €188 for B rated products. The typical energy consumption (per unit) of European commercial cold appliances are 2,000 kWh/y for service cabinets, 3,500 kWh/y for blast cabinets, 12,200 kWh/y for walk-in cold rooms, 364,500 kWh/y for process chillers, and 22,000 kWh/y for packaged condensing units. Typical, average prices of commercial cold appliances vary significantly as a function of capacity and other features. Service cabinet refrigerators can cost from €850 to €3,000, service cabinet freezers from €1,000 to €3,000, blast cabinets from €2,000 to €30,000. The typical price of an average walk-in cold room is around €8,800. An average process chiller can cost €60,000 and a remote condensing unit is priced at approximately €5,000.

POTENTIAL AND BARRIERS – Today's cold appliances are technologically mature and further dramatic improvements are not expected in the short to medium term. Incremental efficiency increases can be obtained in the short term from vacuum-based thermal insulation, improved gaskets, and other technical improvements of major components (compressors, exchangers, fans, control electronics). More important advances in terms of sustainability could stem from novel process fluids with low-global warming potential. Expected improvements of commercial appliances are likely to enable a 13% reduction in energy consumption by 2020 and a 19% by 2030 (relative to 2011 level). In both the domestic and commercial sectors, a barrier to the adoption of highly-efficient cold appliances is the initial high cost. In the domestic sector, the lack of consumer awareness about efficiency savings is an additional barrier to the uptake of more efficient products. More radical innovations that might bring efficiency benefits in the long term are acoustic refrigeration, ammonia (sealed hermetics), electro-caloric refrigeration, optical cooling and magnetic refrigeration. The incremental cost of these new systems are not yet clear, but evidence suggests they could be very significant. Policy measures aimed to replace old, inefficient appliances (mandatory energy labelling, minimum energy standards) have now been enforced in many countries, particularly in the European countries (Directive 2010/30/EU).

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