Chapter 7
Retrofitting of R404a Commercial Refrigeration Systems with R410a and R407f HFCs Refrigerants

Mauro Gamberi
University of Padua, Italy

Marco Bortolini
University of Bologna, Italy

Alessandro Graziani
University of Padua, Italy

Riccardo Manzini
University of Bologna, Italy

ABSTRACT
This chapter presents an experimental analysis about the retrofitting of two commercial stationary refrigeration systems marketed by an Italian leading company of the sector. Such systems operate both at medium temperature (MT) and low temperature (LT) and they are originally designed to work with the high global warming potential (GWP) hydrofluorocarbon (HFC) R404a fluid (GWP = 3922). The purpose is to investigate the performances of HFCs R410a (GWP = 2088) and R407f (GWP = 1825) chosen as effective alternatives to HFC R404a, due to their compatibility, non-flammability and market availability. Furthermore, such fluids meet the EU restrictions in force in the next future for high GWP HFCs. The experimental analysis compares the performances, in terms of COP and cooling capacity, of R404a and the two identified alternatives under different operating conditions, i.e. chamber and condenser inlet air temperatures. In case of comparable performances, significant environmental benefits are introduced by the adoption of R407f and R410a in the MT and LT refrigeration systems.

INTRODUCTION
According to the fifth assessment report (AR5) of the International Panel on Climate Change (IPCC), the global emissions of greenhouse gases (GHGs) are at unprecedented level despite the rising attention to policies limiting the climate change. As in Figure 1, the total GHG emissions reach 49(±4.5) GtCO2eq/year in 2010, while the average annual GHG emission growth from 2000 to 2010 is of about

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Retrofitting of R404a Commercial Refrigeration Systems

1.0 GtCO\textsubscript{2}eq/year (+2.2%), compared to the 0.4 GtCO\textsubscript{2}eq/year (+1.3%) measured from 1970 to 2000, showing an exponential trend. However, the climate change scenarios assessed in the AR5 of the IPCC show that to have a likely chance of limiting the increase in global mean temperature to 2°C, and thus prevent undesirable climate effects, means lowering GHG emissions by 40 to 70 percent compared with 2010 by mid-century, and to near-zero by the end of this century (IPCC, 2014).

In accordance with the international agreements on the global warming and climate change, e.g. Kyoto Protocol in the 1997, the European Union (EU) establishes and continuously updates a roadmap to progressive reduce GHG emissions in different sectoral areas. The growing concern on climate change reported on the forth assessment (AR4) of the IPCC (IPCC, 2007) accelerates this process and the European Directive (29/2009/EC), known as “20/20/20 climate and energy package”, sets ambitious targets by 2020:

- 20% reduction in EU GHG emissions from 1990 levels;
- 20% increase of the share of EU energy consumption produced from renewable sources;
- 20% improvement of the EU energy efficiency.
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