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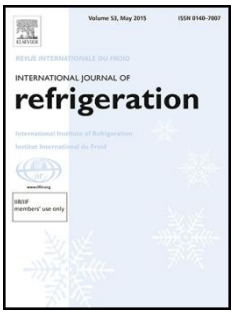

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Diesel combustion of oil and refrigerant mixture during pump-down of air conditioners

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Highlights

- Compressor destruction accidents during pump-down was experimentally investigated.
- Mixture of refrigerant, air and lubricating oil was adiabatically compressed.
- It was revealed that the accidents are caused by diesel combustion of mixture.
- Even non-flammable refrigerants could burn in the compressor.
- The oil was necessary for burning, however, the refrigerant led intense combustion.

ABSTRACT

Compressor-destruction accidents during the pump-down operation of air conditioners were experimentally investigated. Assuming air penetration into refrigerant tubes, the gaseous mixture of the air, refrigerant, and lubricating oil for a compressor was compressed by the compressor with different refrigerant concentrations, and the diesel combustion of the mixture was examined. The compressor was simulated by a small-scale engine. R1234yf, R32, R410A, R134a, R22, and R125 were tested as refrigerants. The mixture burned via adiabatic compression when the refrigerant concentration was low, which means that accidents during the pump-down were caused by the diesel combustion of the mixture. The refrigerant burned and caused intense pressure increase. The mixture without the oil did not burn under any refrigerant concentration, which suggests that oil is necessary for the combustion. These phenomena were observed in the results for R1234yf, R32, R410A, R134a, and R22. Thus, combustion was observed under certain conditions even for refrigerants categorized as non-flammable.

Keywords: Heat pump, Pump-down, Low-GWP refrigerant, Mildly flammable refrigerant, Diesel combustion, Safety

1. Introduction

The Montreal Protocol abolished refrigerants with ozone-depleting potential (ODP) for ozone-layer protection, and a transition to hydrofluorocarbons (HFC) refrigerants is underway. However, most HFC refrigerants have a large global-warming potential (GWP), and the emission of the HFC refrigerant into the air causes global warming. It is recognized that the transition to low-GWP refrigerants is extremely important across the globe. New low-GWP refrigerants—R1234yf ($CH_2 = CFCF_3$) and R32 (CH_2F_2)—are attracting attention. In the European Union, DIRECTIVE 2006/40/EC for mobile air conditioning and REGULATION (EC) No 842/2006 for residential air conditioning regulate the usage of refrigerants with a high GWP [1] [2]. North American countries (the United States, Canada, and Mexico) proposed a step-down schedule for the production of HFC refrigerants at the Conference on Montreal Protocol [3]. In Japan, the Act on Rational Use and Proper Management of Fluorocarbons was enforced in April 2015, which demanded the production of lower-GWP refrigerants, the development of refrigeration and air conditioning equipment that use lower-GWP

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