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Experimental Study On The Performance Of A Refrigeration System Using A Low-GWP Ternary Mixture Of R32, R1234yf, And R13I1 As A Drop-In Replacement For R410A

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Extended Abstract

Heat pumps are frequently used in heating, ventilating, and air conditioning (HVAC) systems due to their high efficiency. One of the most widely used refrigerants in the heat pump is R410A, whose global warming potential (GWP) is 2088. To reduce the impact of refrigerants on global warming, the European Union (EU) has established a regulation banning refrigerants with GWP above 750 in building HVAC systems after 2025 [1]. R290 is gaining attention in the EU with high performance and low GWP. However, its high flammability is the main hurdle to adopting R290 as a drop-in replacement for R410A [2]. Therefore, alternative refrigerants with low GWP, high performance, and safety are required to replace R410A.

Various studies have been conducted on drop-in replacements for R410A. Zilio et al. [3] compared the performance of reversible heat pumps using R410A and R32, whose GWP is 675. They reported that the capacity and seasonal coefficient of performance (COP) of the heat pump retrofitted using R32 were improved by 6% and 5% compared with those of R410A, respectively. Panato et. al [4] investigated R452B and R454B, the refrigerant mixture of R32 and HFOs, as an alternative refrigerant for R410A. With GWPs of 676 and 467, these alternatives in the refrigeration system showed 6.6% and 6.2% COP reduction, respectively. Lee et al. [5] analyzed the energy and environmental performance of R466A as an R410A replacement. R466A is a ternary mixture of R32, R125, and R13I1, which has a GWP of 733. R466A showed a 3% lower capacity and 3% higher COP, achieving 23.3% lower life cycle climate performance (LCCP) than that of R410A. However, research on the ternary mixture of R32, R1234yf, and R13I1 as an alternative to R410A is limited in the literature.

In this study, a heat pump using a ternary refrigerant mixture of R32, R1234yf, and R13I1 was experimentally investigated to find the feasibility of a drop-in replacement for R410A. Two different mass fractions were suggested with different GWP limits. The mass fractions of the ternary mixture were 44:28:28 and 22:39:39 for GWP limits of 300 and 150, respectively. The heating and cooling performance of the heat pump was measured under AHRI Standard 1230 conditions. The performance of the heat pump was evaluated in terms of the heating and cooling COPs and LCCP. As a result, the heating and cooling COPs of the ternary mixture with GWP-300 limit were reduced by 7.2% and 7.9% compared with those of R410A, respectively. For the ternary mixture with GWP-150 limit, the heating and cooling COPs were reduced by 17.2% and 20.8%, respectively. The LCCP for the ternary mixture of GWP-300 and 150 limits were reduced by 9.1% and 4.9%, respectively. In conclusion, the refrigerant mixtures used in this study could be an option for alternative refrigerants for R410A with lower environmental impacts and compatibility with shifting GWP regulations.

References

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