Agricultural Waste Valorization for Nanoparticles Synthesis and Enhancement of Vapour Compression Refrigeration System's Performance

Abstract:

Waste management has been a major concern in the society and agricultural wastes can be utilized in the synthesis of nanoparticles and deployed in the vapour compression refrigeration system (VCRS) to enhance its performance. This study analysed the thermophysical properties, performance, energy consumption, pull-down time, and capacities of VCRS using bio-nanoparticles produced from orange and pineapple peels. Eco-friendly refrigerants R600a and R134a with pure polyolester (POE) as the lubricating oil for the compressor were used. The nanolubricants were dispersed in three volume fractions of 0.05%, 0.10% and 0.20% concentration in the lubricant using the two-step method. The degradation of nanolubricants were analysed by examining the thermophysical properties of the nanolubricants before and after use in the VCRS. At 0.2% volume concentration, optimum COP of 6.31 and 5.01 were obtained for pineapple and orange peels respectively for R600a. The nanolubricants of orange peels with the volume fraction of 0.2% had the best pull-down time with a temperature of-2oC. The lowest power consumption was observed for 0.1% volume concentration of pineapple nanolubricants while 0.2% volume concentration of orange nanolubricants was observed to have the least power consumption. Considering the R134a refrigerant, the volume concentration with the optimum COP was 0.1 vol% concentration for the orange bio-based nanolubricants with an increase in the COP of 36.3% when compared with pure R134a while 0.2 vol% had the best pull-down time with a temperature of-3oC. There was a 14.2% drop in the power consumption of 0.1 vol% concentration of pineapple nanolubricants when compared to the various concentrations of the bio-based nanolubricants. From this study, the

optimum performance was observed at 0.20 vol% concentration for the orange and pineapple nanolubricants with a relatively less power consumption. R600a refrigerant can completely replace R134a in its use in refrigeration systems and achieve similar pull-down time and coefficient of performance when bio-nanolubricants are utilized in the systems.

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Oluseyi O. Ajayi, Mercy Ogbonnaya*, Oge Ogo-Ozegbe, Patricia Abimbola Popoola
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* - Corresponding Author

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