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# Performance of liquid-line magnets and CNT nano-lubricant in a refrigerator with varying mass charge of R600a refrigerant

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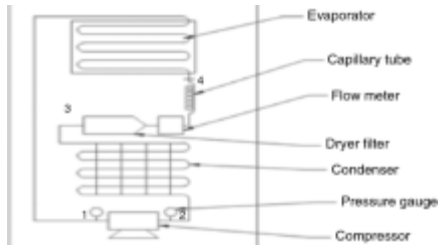
## Abstract

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Improving the performance of drop-in hydrocarbon refrigerants for the increasing in-flow of conventional refrigerators to Nigeria is a necessary sustainable strategy. This experimental study investigates the enhancement limits of a liquid-line magnetic field, CNT nano-lubricant, and a combination of both on an R134a domestic refrigerator with 40–70 g each of R600a refrigerants. The study compares the performance of R600a refrigerant without enhancements (pure) and with two pairs of 3000 Gauss liquid-line mounted O-ring permanent magnets (Mag), 0.2 g L<sup>-1</sup> concentration of CNT nano-lubricant (Nano), and both liquid-line magnet and CNT nano-lubricant (Mag-Nano). Test parameters include evaporator air temperature, discharge pressure, power consumption, coefficient of performance (COP), and total equivalent warming impact (TEWI). The results show that enhancement methods led to higher COP in the range of 16.64–42.38%. At the same time, evaporator air temperature, discharge pressure, power consumption, and TEWI were lower by 9.76% to 20.96%, 17.75% to 34.26%, 5.22% to 13.42%, and 5.88% to 10.86%, respectively. In conclusion, the proposed enhancement techniques in the refrigeration system provide normal, safe, and efficient operation.

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## **Abbreviations**

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***h*** : Enthalpy of refrigerant (kJ kg<sup>-1</sup>)

***ṁ*** : Refrigerant mass flow rate (kg s<sup>-1</sup>)

***P*** : Pressure (kPa)

***T:*** Temperature (°C)

***E:*** Energy consumption (kWh)

***COP:*** Coefficient of performance

***GWP:*** Global warming potential

***CNT:*** Carbon nanotube

***Gs:*** Gauss

***S:*** Refrigerator service ( $\text{kJ s}^{-1}$ )

***1:*** Suction line

***2:*** Discharge line

***3:*** Liquid line

***r:*** Refrigerant

***l:*** Life

***yr:*** Yearly

*e:*  
Equivalent

*c:*  
Cumulative

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### Contributions

Damola S ADELKAN was involved in experiments, data curation, writing original draft, review and editing, visualization. Olayinka S OHUNAKIN helped in conceptualization, supervision, data curation, writing—review and editing, visualization. Babu Sena PAUL contributed to conceptualization, supervision, data curation, writing—review and editing, visualization. Tien-Chien Jen assisted in conceptualization, supervision, data curation, writing—review and editing, visualization.

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## Ethics declarations

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### Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence this research work.



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