Thermophysical Assessment of Low-GWP Refrigerant Blends in Vapor Compression Refrigeration Cycles by Means of the Polar Soft-SAFT EoS

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Given the F-gases emission prospects in the near future, Kigali's amendment has committed to restrict the manufacture and further supply of high global warming potential (GWP) 3rd generation refrigerants in nowadays refrigeration and air conditioning applications (RAC). Particularly, up to one-fifth of today's RAC systems that operate with hydrofluorocarbons will have to be completely replaced in the years to come in harmony with eco-friendly European policies. In this context, it is important to explore new approaches focused on low-GWP specimens. This work presents a detailed study of the capacity of new refrigerant blends using the soft-SAFT coarse-grain methodology, improved with a multipolar term [1]. Phase and interfacial properties are accurately described for a wide variety of systems. Vapor-liquid equilibria descriptions provide excellent agreement for all tested isotherms. Once the model is valid to describe mixtures, a versatile study concerning glide and midpoint designing temperatures to pattern the process working conditions based on both efficiency and environmental criteria is performed next. This assessment has direct consequences in the design of key process input variables that assure an adequate operation of the refrigeration cycle. Subsequently, the main thermodynamic simulation is completed with the aim to examine each mixture's most efficient composition ratio and simultaneously, profit from this data to find out the 4th generation blend with the highest coefficient of performance. Results indicate that the cycle's efficiency gets maximized when the optimal ratio computed by the molecular-based model is added to the mixture, with the consequent energy consumption cutback.

Acknowledgement: This research is supported by projects CIRA2018-121, KET4F-Gas–SOE2/P1/P0823, co-financed by the European Regional Development Fund (Interreg SUDOE Program) and PID2019-108014RB-C21 supported by the Spanish Ministry of Science and Innovation.

References

[1] I.I.I. Alkhatib, L. Pereira, J. Torne, L.F. Vega, Phys. Chem. Chem. Phys. 19 (2020). 10.1039/D0CP00846J.