

A Medium Model for the Refrigerant Propane for Fast and Accurate Dynamic Simulations

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To address the main challenges arising from the ever-increasing energy demand worldwide and its associated environmental impacts, it is not only essential to optimize the existing energy landscape but it is also necessary to develop new approaches. One of these approaches is to effectively utilize low-exergy demand heating and cooling systems like conventional geothermal heat pump systems by expanding the usage of refrigerants from a simple refrigerant cycle to more complete systems such as direct exchange heat pump systems.

Investigating the use of different fluids and their advantages in new energy systems has increased a need for faster and more robust simulation models. There are different methods of simulating different refrigerants [1, 2] such as R600a, CO₂ and R134a. Although these methods can calculate the properties of these refrigerants accurately, they require a long simulation time. This problem motivated the authors of this paper to develop a fast, accurate and stable refrigerant model for the dynamic simulation of complete systems over a long period of time.

In this paper, developing and improving a medium model for propane is discussed. Besides being fast and accurate, the propane model should also be stable in different dynamic simulation scenarios.

First, one of the existing libraries, namely HelmholtzMedia library is tested and in some cases modified to increase the stability. Since the simulation speeds were not in an acceptable range in the existing models, a new propane model based on the Helmholtz Equation of States is introduced. Unlike the propane model of the HelmholtzMedia library, this model is only valid in a certain range of pressures and temperatures. The range is chosen so that it includes a wide variety of engineering applications, corresponding to temperatures between -10°C and 70°C and pressure between 0.5 up to 30 bars. The new model is then tested as a refrigerant in a direct exchange heat pump system. A comparison between an existing propane model and the new model shows that much faster simulations, up to 30 times, are achievable with the new propane model without sacrificing the accuracy.

References

- [1] C. Heinrich, K. Berthold “A Modelica Library for Simulation of Household Refrigeration Appliances Features and Experiences”. In: *Proceedings of the 5th International Modelica Conference*, 2006, pp. 677-684.
- [2] I. Bell, S. Quoilin, J. Wronski, V. Lemort “CoolProp: An Open-Source Reference-Quality Thermophysical Property Library” In: *2nd ASME ORC International Seminar*, 2013.