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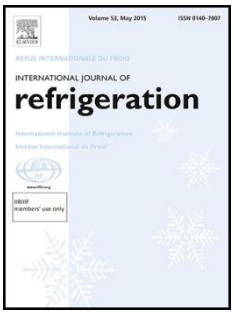

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Best Vortex Tube Cascade for Highest Thermal Separation

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Highlights

- Cascade arrangements of VT are investigated for thermal separation
- Effects of thermo-physical parameters on temperature separation are investigated
- A simple new equation for hot outlet temperature estimation is proposed
- Optimal heat separation in a cascade of three VT & a HEX is reported
- Recycling for feed cooling in cascades cannot always enhance the thermal separation

Abstract

The current study examines different arrangements of Vortex Tubes (VTs) to get higher performances for cooling and heating. The effects of thermo-physical parameters such as inlet feed temperature and inlet/outlet vortex tube pressure on generated temperature gradient are investigated. To estimate the cold outlet temperatures, the available equations in the literature are verified against our experimental data. Moreover, we propose a new equation to estimate the hot outlet temperature based on the upper limit of hot temperature (ULHT) and the lower limit of cold temperature (LLCT), verified with experimental data as well. Further, several arrangements are simulated to obtain the minimum cold and the maximum hot temperatures for the outlet streams. Finally, the optimal arrangement of the three vortex tubes and a double-pipe helical heat exchanger that gives the highest performance is proposed.

Key words: Vortex tube, Cooling/heating, Simulation, Experiment

Nomenclature

CF	Cold fraction, mass flow ratio of cold to feed	$DelTFC$	Temperature difference between feed and cold exit
C_P	Specific heat at Constant Pressure	$DelTFH$	Temperature difference between feed and hot exit
C_V	Specific heat at constant volume	$LLCT$	Lower Limit of Cold Temperature
γ	$C_p\ C_v^{-1}$	Nu_s	Nusselt number for straight Tube
d_{ii}	Internal diameter of internal tube	Nu_c	Nusselt number for coiled Tube