

# Accepted Manuscript

Title: Best vortex tube cascade for highest thermal separation

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PII: S0140-7007(17)30390-0

DOI: <https://doi.org/doi:10.1016/j.ijrefrig.2017.10.006>

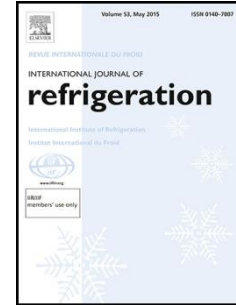
Reference: IJIR 3774

To appear in: *International Journal of Refrigeration*

Received date: 22-5-2017

Revised date: 28-9-2017

Accepted date: 3-10-2017



Please cite this article as: Davood Majidi, Hashem Alighardashi, Fatola Farhadi, Best vortex tube cascade for highest thermal separation, *International Journal of Refrigeration* (2017), <https://doi.org/doi:10.1016/j.ijrefrig.2017.10.006>.

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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	$DeITFC$	Temperature difference between feed and cold exit
$C_p$	Specific heat at Constant Pressure	$DeITFH$	Temperature difference between feed and hot exit
$C_v$	Specific heat at constant volume	$LLCT$	Lower Limit of Cold Temperature
$\gamma$	$C_p C_v^{-1}$	$Nu_s$	Nusselt number for straight Tube
$d_{ii}$	Internal diameter of internal tube	$Nu_c$	Nusselt number for coiled Tube

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