OPEN ACCESS
IOP Publishing
Journal of Physics A: Mathematical and Theoretical
J. Phys. A: Math. Theor. **55** (2022) 065001 (19pp)
https://doi.org/10.1088/1751-8121/ac47b0

Low-dissipation model of three-terminal refrigerator: performance bounds and comparative analyses

Zhexu Li[1], Julian Gonzalez-Ayala[2,3], Hanxin Yang[1], Juncheng Guo[1,*] and A Calvo Hernández[2,3]

[1] College of Physics and Information Engineering, Fuzhou University, Fuzhou 350116, People's Republic of China
[2] Departamento de Física Aplicada, Universidad de Salamanca, 37008 Salamanca, Spain
[3] Instituto Universitario de Física Fundamental y Matemáticas (IUFFyM), Universidad de Salamanca, 37008 Salamanca, Spain

E-mail: jcguo@fzu.edu.cn

Received 18 November 2021, revised 20 December 2021
Accepted for publication 4 January 2022
Published 19 January 2022

Abstract

In the present paper, a general non-combined model of three-terminal refrigerator beyond specific heat transfer mechanisms is established based on the low-dissipation assumption. The relation between the optimized cooling power and the corresponding coefficient of performance (COP) is analytically derived, according to which the COP at maximum cooling power (CMP) can be further determined. At two dissipation asymmetry limits, upper and lower bounds of CMP are obtained and found to be in good agreement with experimental and simulated results. Additionally, comparison of the obtained bounds with previous combined model is presented. In particular it is found that the upper bounds are the same, whereas the lower bounds are quite different. This feature indicates that the claimed universal equivalence for the combined and non-combined models under endoreversible assumption is invalid within the frame of low-dissipation assumption. Then, the equivalence between various finite-time thermodynamic models needs to be reevaluated regarding multi-terminal systems. Moreover, the correlation between the combined and non-combined models is further revealed by the derivation of the equivalent

*Author to whom any correspondence should be addressed.