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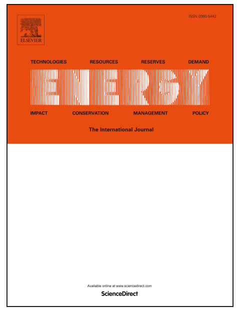

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Implementation of a Solution to the Problem of Reference Environment in the Exergy Evaluation of Building Energy Systems

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ABSTRACT

Exergy analysis is a powerful thermodynamic technique for assessing and optimizing the efficiency of complex energy systems, whose application in building energy systems has recently gained increasing attention. One of the challenges that one faces when evaluating building energy systems from an exergy point of view is the selection of a reference environment. A few solutions to this problem have been proposed. The concept of *ideal heat storage*, which suggests the idea of associating the Carnot cycle to an ideal heat storage, depicts a new way to set the reference temperature for exergy calculations, but there is still a real need to evaluate the practical application of this approach on a building scale. In this study, this concept is implemented in a test case to investigate the applicability of the approach. For this purpose, the concept of *ideal heat storage* is applied to a heat pump system, which is analyzed statically and dynamically in both heating and cooling modes, and exergy destruction of the process is calculated. Two different numbers of control volumes are also investigated and compared to the conventional approach. Regardless of the figures, the results show that the proposed approach is applicable in the exergy analysis of building energy systems. The results of both steady-state and dynamic analysis reveal that the application of the *ideal heat storage* approach leads to a lower exergy destruction in both heating and cooling modes compared to the conventional approach. Moreover, it is noticed that an increase in the number of defined control volumes leads to a decrease of exergy destruction.

Keywords: Ambient temperature; Building energy systems; Exergy; Exergy analysis; Heat pump systems; Reference environment

INTRODUCTION

The amount of energy used for heating and cooling in the building sector accounts for one third of the total energy consumed in the world. The finiteness of natural energy resources on the one hand, and the ever-increasing demand for energy in the world on the other hand, encourages the improvement of building energy systems' efficiency as well as minimizing the usage of primary energy resources and damaging impacts and harmful effects to the environment (Sangi et al., 2013).

Energy analysis is the traditional method to determine the efficient utilization of energy, and assess the way energy is consumed in a system. This method consists of writing energy balances based on the first law of thermodynamics for the system being analysed and may be applied to reduce waste energy. However, energy is independent of environment properties and can be neither produced nor destroyed. As a result, energy analysis is unable to provide information on the quality of energy streams flowing through a system.