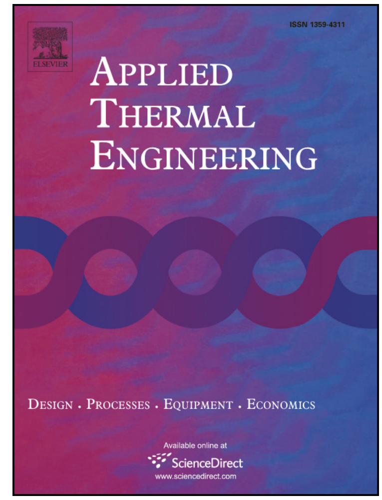
Accepted Manuscript



Modeling, cross-validation, and optimization of a shipboard integrated energy system cooling network

S. Yang, M.B. Chagas, J.C. Ordonez

PII: S1359-4311(18)34666-0
DOI: https://doi.org/10.1016/j.applthermaleng.2018.09.070
Reference: ATE 12679

To appear in: *Applied Thermal Engineering*

Received Date: 28 July 2018
Accepted Date: 15 September 2018

Modeling, cross-validation, and optimization of a shipboard integrated energy system cooling network

S. Yang*, M. B. Chagas, J. C. Ordonez

Department of Mechanical Engineering, Energy and Sustainability Center, and Center for Advanced Power Systems, Florida State University, Tallahassee, FL 32310 USA

Abstract

This work presents the modeling, cross-validation, and thermodynamic optimization of a shipboard integrated energy system (IES) cooling network to assess (1) the practicality of a dimensionless graph-based model for scalability; (2) the reliability of different statistical metrics in cross-validation; and (3) the effects of design and operational parameters on the system thermal performance. The IES comprised two 2.5 MW induction motors representing a ship propulsion system which operated at different torques over time resulting in different heat generation profiles. A dimensionless first-law graph-based model was formulated with the lumped capacitance approach, and the unknown physical parameters were estimated using the ant colony optimizer with three different calibration metrics. The validated model was used to distribute the total heat exchanger inventory N optimally across the IES by minimizing the peak system temperature. Subsequently, the study demonstrated the robustness of the optimal heat exchanger area allocation against N and the 20x reduction in N with a ten-fold increase in the motor cooling power.

Keywords: Experimental validation, parameter estimation, ship cooling, ship thermal management, thermodynamic optimization

*Corresponding author.

Email addresses: syang@caps.fsu.edu (S. Yang), mb14s@my.fsu.edu (M. B. Chagas), ordonez@caps.fsu.edu (J. C. Ordonez)