Tech Science Press

ICCES, 2024, vol.29, no.2
DOI: 10.32604/icces.2024.012210

PROCEEDINGS

Topology Optimization for Conjugate Heat Transfer Problems Based on the k-omega Turbulence Model

Ritian Ji[1], Zhiguo Qu[1,*], Hui Wang[1], Binbin Jiao[2] and Yuxin Ye[2]

[1] MOE Key Laboratory of Thermo-Fluid Science and Engineering, School of Energy and Power Engineering, Xi'an Jiaotong University, Xi'an, Shaanxi, 710049, China

[2] Institute of Microelectronics of the Chinese Academy of Science, Beijing, 100029, China

[*]Corresponding Author: Zhiguo Qu. Email: zgqu@mail.xjtu.edu.cn

ABSTRACT

In this manuscript, a finite volume discrete topology optimization method based on the continuous adjoint method is proposed to simulate turbulent flow using the k-omega turbulence model for solving the topology optimization problem of conjugate heat transfer at high Reynolds number. The manuscript simulates the conjugate turbulent convective heat transfer problem at high Reynolds number with a set of Reynolds-Averaged Navier-Stokes (RANS) equations coupled with energy transport equations and control equations of the k-omega turbulence model, and implements the methodology by using the variable density method, interpolates the material values of thermal conductivity, heat capacity, turbulent diffusivity, and Darcy's force, and adds the volumetric force to the momentum equations and the turbulence control equations to penalize the solid material region. Continuous adjoint method is used to get the overall sensitivity distribution, combined with the moving asymptote method for optimization. Taking the chip microchannel heat dissipation as an optimization example, with the global maximum temperature as the optimization target when given the pumping constraints, the topology optimization morphology is computed at Reynolds numbers of 3000, 5000, and 10000, respectively. It can be seen the optimization method used in this manuscript can greatly improve the heat transfer coefficient of the microchannel.

KEYWORDS

Topology optimization; RANS; k-omega turbulence model; continuous adjoint method; sensitivity analysis

Acknowledgement: The authors are grateful to relevant programs of the Institute of Microelectronics, Chinese Academy of Sciences, for supporting this study.

Funding Statement: The authors received no specific funding for this study.

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.