Topology Optimization with Design Domain Projection applicable to Permanent Magnet Design in Magnetic Fluid Heat Transfer System

Authors: Jaewook Lee[1], Tsuyoshi Nomura[2], and Ercan M. Dede[2]

[1]School of Aerospace and Mechanical Engineering, Korea Aerospace University, Goyang, Gyeonggi-do 412-791 South Korea

[2]Toyota Research Institute, Toyota Motor Engineering and Manufacturing North America, Ann Arbor, Michigan 48105, USA

Abstact:

This paper presents topology optimization with design domain projection for permanent magnet (PM) design. One-dimensional PM design domain is projected to the two-dimensional PM design area to offer the availability of fabrication. Both the distribution and magnetization direction of PM is designed in one-dimension. The proposed method is applied for the design of magnetically controlled convective heat transfer cooling system. It is known that a stationary magnetic field subjected to a temperature gradient generates fluid motion in a magnetic fluid. This physical phenomenon has been applied to drive convective motion without pumps. In this system, the magnetic field source (i.e. PM) is designed to minimize the maximum temperature of a closed loop heat transfer system. To predict the temperature distribution of this magnetic-thermal-fluid system, a fully coupled non-linear multi-physics analysis is performed. The optimization problem is solved using the method of moving asymptotes (MMA). As the design result, one-dimensional PM layout similar to Halbach arrays is obtained. The magnetic field distribution generated by the designed layout generates the body force that the fluid is subjected to and results in optimal fluid flow patterns for maximum cooling performance of the system.

Keywords:

Topology optimization, Design domain projection, Permanent magnet design