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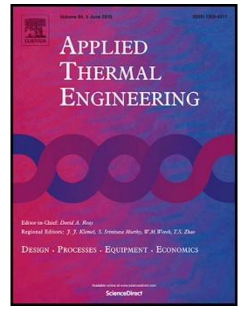

Title: On the effective thermal conductivity of aluminum metal foams: review and improvement of the available empirical and analytical models

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On the effective thermal conductivity of aluminum metal foams: review and improvement of the available empirical and analytical models

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Highlights

- Review of the correlations and models for the effective thermal conductivity of metal foams
- The illustrated models are validated against the experimental data available in the literature
- For the models with empirical constants, a new calibration of the parameters is illustrated
- A revised/implemented version of some of the existing correlations is presented
- The analysis is valid for high porosity Al foams, with air and water as saturating media

Abstract

Open cell metal foams are good candidates for augmenting the thermal performance of heat sinks and compact heat exchangers, with the added benefits of lighter and more compact equipments. Under this perspective, an estimation of the effective thermal conductivity of the medium is fundamental in order to properly design a metal foam heat transfer device. In this paper, a review of the empirical correlations and the theoretical models published in the literature for the prediction of the effective thermal conductivity is presented. In order to test the goodness of the illustrated models, a validation has been performed with the experimental data available in the literature for aluminum foams, for both air and water as working fluids and porosity higher than 0.89. For the models involving empirical or fitting constants, these parameters have been calibrated against the available experimental values, thus to enhance the predicting capability of the models. In addition, the mathematical formulation of some of the existing correlations has been revised and some efficient alternatives are suggested.

Keywords: Metal foams, Effective Thermal Conductivity, Empirical Models, Analytical Models, Constants Calibration

1. Introduction

Nowadays, in view of the increasing costs of energy and materials, heat transfer enhancement is gaining considerable importance in several engineering fields. The employment of more efficient equipments allows, in fact, to reduce both their size and the operating costs.

In the last years, the feasibility of increasing the heat transfer rate by filling, completely or partially, the heat transfer device with a porous medium has been considered. In this regard, metal foams appear as good candidates for heat sinks and compact heat exchangers, in view of their low density and peculiar transport properties. Metal foams have been on market since the 1980s and, beside heat transfer, they found applications in several fields like, to name a few, structural panels and materials, energy and sound absorption devices, air-oil separators, catalyst support in reactors,

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