Thermo-Fluid Dynamic Modeling of Cu Based Metallic Foams for Heat Exchanger Applications

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Abstract

In this work the innovative concept is the use of a metallic foam in Cu based alloy, characterized by open cell structure, as active element for heat exchangers. The metallic foam has been produced by liquid infiltration method using a vacuum induction melting system [1]. Then, after the removal of the space holders using a chemical etching, the produced foam (see Figure 1) was introduced inside a stainless steel tube, as base element for the exchanger. In the configuration under investigation, an air flow at few hundreds of degrees passes through the metallic foam and the heat is transferred to the water, flowing in the opposite direction, at room temperature in a coaxial tube, external to the previous one, as shown in Figure 2.
The modeling of this complex system was done using COMSOL Multiphysics®, because of the request of a multi-physical approach. Some physics were taken under consideration in this study; conduction and convection for the modeling of the heat transfer as well as the fluid-dynamic field in both laminar and turbulent modes were considered for different heat exchanger conditions. Moreover, the presence of warm air was also considered in the presented modeling. Steady state condition of the problem was considered in the numerical analysis because of the negligible contribute of the initial transient behavior of the device for its characterization. Moreover, in the first approximation a bidimentional and axial-symmetric geometry was firstly tested. Results show how the contribute of the Cu based foam can improve the efficiency in the heat transfer in comparison with the configuration without the metallic foam.
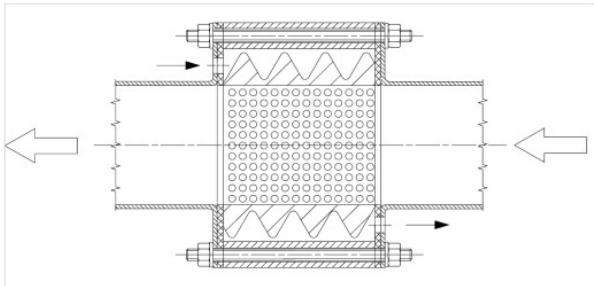
Reference

[1] A. Tuissi, P. Bassani, C.A. Biffi, CuZnAl Shape Memory Alloys Foams, Advances in Science and Technology Vol. 78, 2013, pp 31-39, Trans Tech Publications, Switzerland, doi:10.4028/www.scientific.net/AST.78.31.

Figures used in the abstract
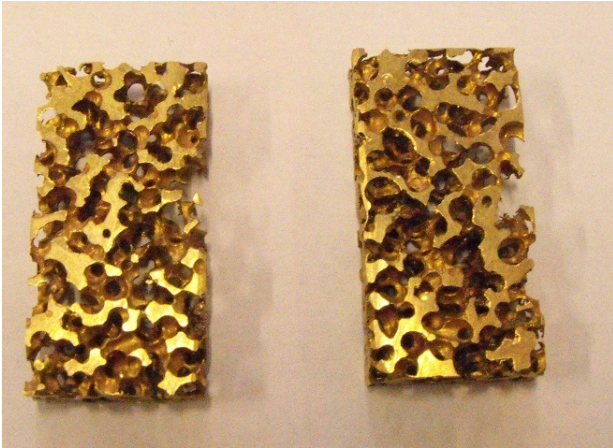
Figure 1: Figure 1: Representative samples of Cu based foam

Figure 2: Figure 2: Schematic of the heat exchanger