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

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Introduction: Cellular materials are challenging class of materials, able to offer almost unique combination in terms of morphology and material performances. In this work a Cu based foam (see Figure 1) was used as active element in a heat exchanger.

Figure 1. Representative samples of Cu based foam

Definition of the model: for the modeling of the heat exchanger (see Figure 2), different zones were considered:

- ❑ moist air at high temperature, as input;
- ❑ porous medium;
- ❑ air at lower temperature, as output;
- ❑ external tube in brass.

The following physics were considered:

- ❑ heat transfer in solids/fluid;
- ❑ free and porous media flow;
- ❑ transport of diluted species.

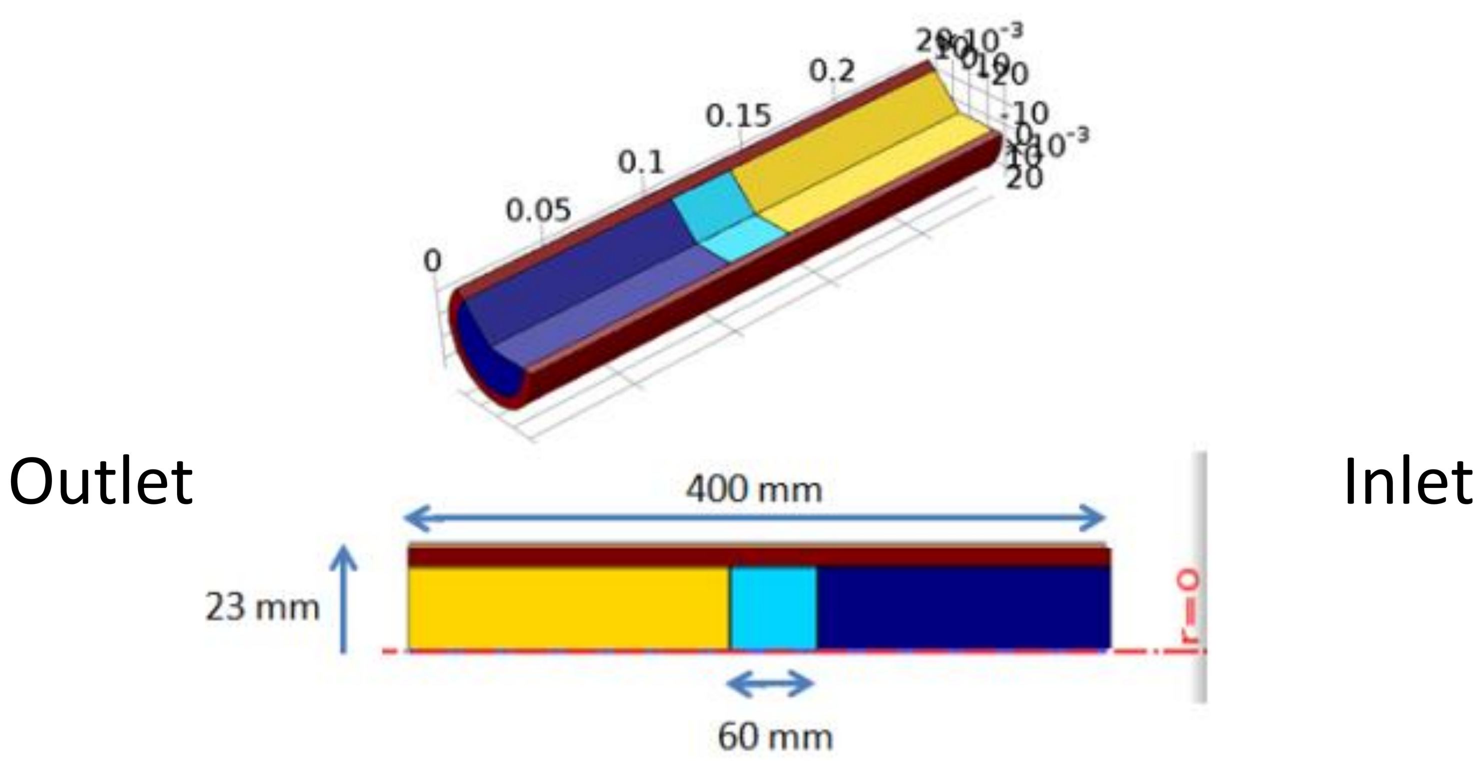

Figure 2. 2D axial-symmetric model of the heat exchanger

The moist air at high temperature (120° C), is modeled as a reactive term, function of the water concentration:

$C = 0.05 * p_{sat}(T_{inlet})/(R * T_{inlet})$ [mol/m³]

where: p_{sat} is the saturation pressure, T_{inlet} is the inlet temperature, R is the universal gas constant.

Results: the foam performances has been evaluated in terms of:

- ❑ fluid velocity;
- ❑ fluid pressure;
- ❑ solid and fluid temperatures;
- ❑ water concentration in the moist air.

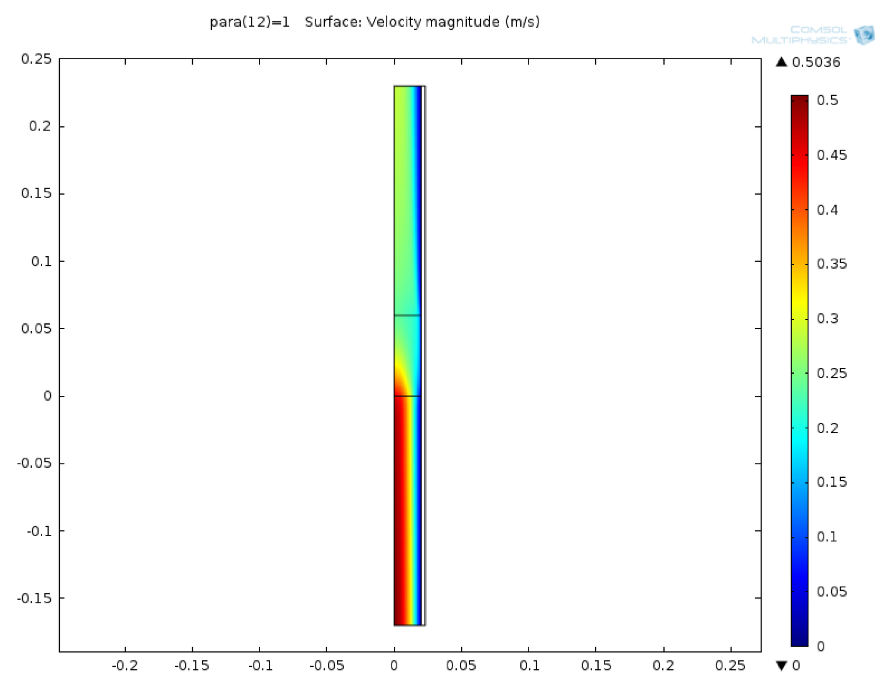

Figure 3. Fluid velocity

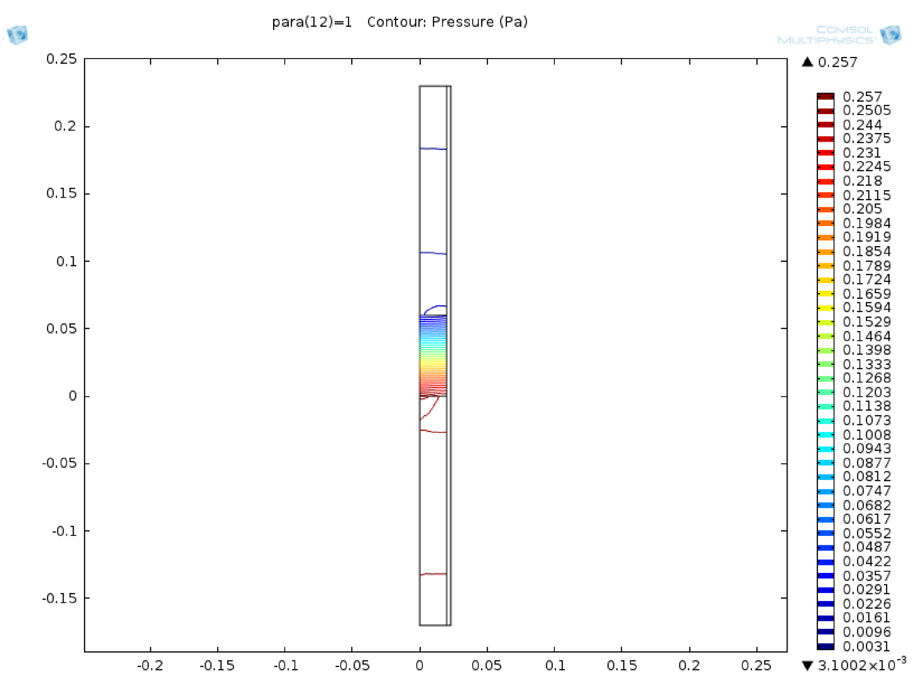

Figure 4. Fluid pressure

The fluid velocity is decreased from 0.5 m/s to 0.25 m/s during its passage through the foam.

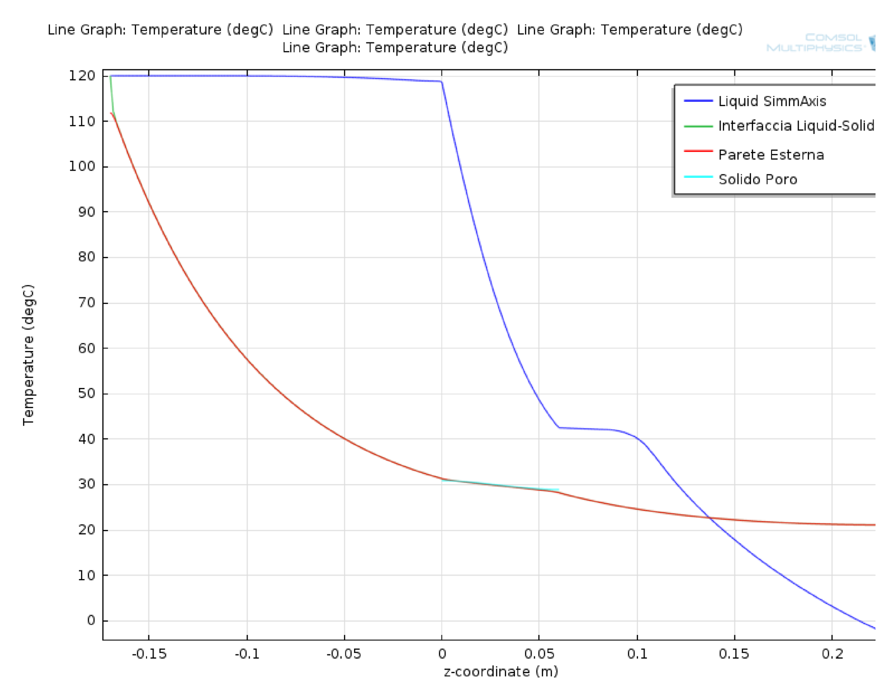

Figure 5. Solid and fluid temperatures

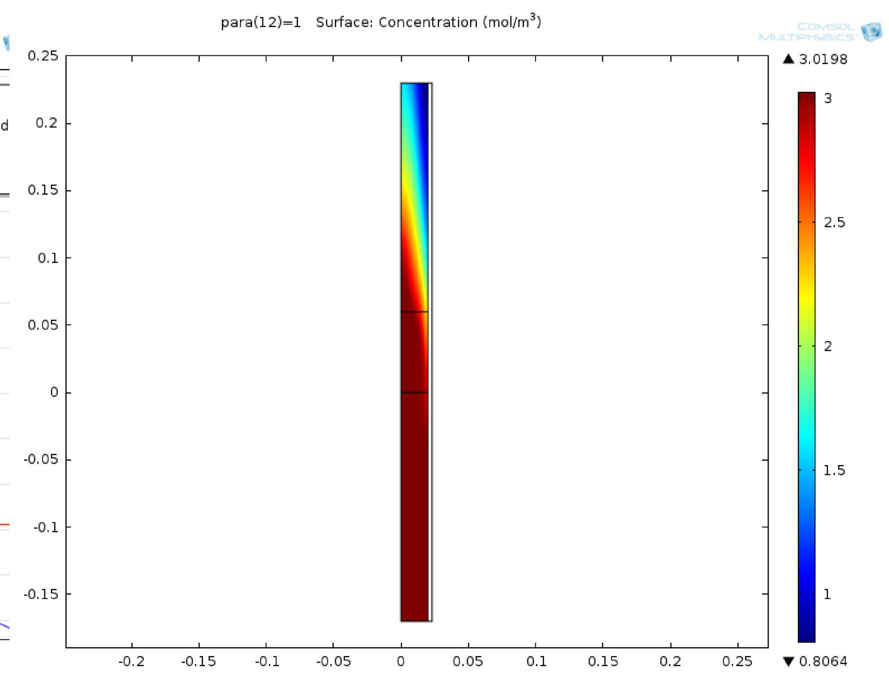

Figure 6. Water concentration

Conclusions: The fluid-dynamic field is strongly modified when the fluid passes through the foam. In fact, more than 60% of the fluid temperature is decreased across the foam.

This confirms how the heat transfer is favorable in the porous medium.

References:

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