	Name of the PhD candidate: **Léa PENAZZI** Title of the thesis : **Optimization of high temperature porous exchangers with a parameterized reduced model by a Symbolic Monte-Carlo method in 3D complex geometry** Dates (start/end): 01-10-2017/ 31-10-2020
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Context and objectives

Reducing our reliance on fossil fuels and restricting CO_2 emissions belong to major challenges of the last decades. Optimizing the efficiency of heat exchangers and increasing the electricity production with concentrated solar power can achieve these goals. The main purpose of this work is to increase the yield of heat exchangers, especially solar receivers, by intensifying thermal transfers coupled to a flow in a complex geometry. More specifically, the idea is to develop a methodology to obtain an accurate reduced model. This model will be employed in optimizing high temperature porous exchangers with a complex geometry such as solar volumetric receivers with atmospheric air and transient exchanger-storage medium for thermochemical cycles.

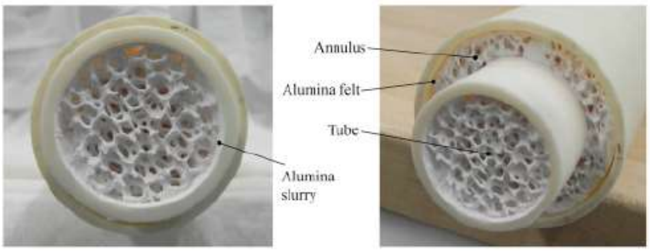

Figure 1: Tubular exchangers garnished with alumina foam

Approach

This methodology will be based on the Monte Carlo method. This statistic method enables to compute local measures such as temperature, flux or a thermal image. The Monte Carlo method is a computational method for the resolution of integrals and is applied here to the resolution of coupled heat transfers (conduction, convection and radiation) in a complex geometry. This method has the asset of being insensitive to the problem dimensions and the complexity of the geometry without the burden of meshing. However, a linearization of transfers in regards to the temperature is required that is an acceptable assumption in the applications considered.
A specific method of Monte Carlo will be used, the so-called « Symbolic » Monte Carlo method. This approach was the subject of few publications and aims at producing a scale model (such as a function) that delivers very fast and accurate simulation of the exchanger. The scale model links the optimization objectives to relevant design parameters while including coupled heat transfers in complex geometry. The procedure will be as follow. First, a Monte Carlo computation will occurs in order to obtain the result in a functional form depending on boundary conditions or physical properties. Hence, the computed function may take the form of a polynomial used to compute the outcome by changing these parameters (boundary conditions or physical properties). This function will substitute a Monte Carlo calculation in the resolution of coupled transfers in complex geometry and will enable a fast computation of any magnitude. This speed of execution will be able to be used in global optimization algorithms that need lots of function evaluations. This method will be used to optimize high

temperature porous exchangers in ceramic and in particular, exchanger-storage medium in thermochemical cycles.

Main results

A literature survey is carried out, meanwhile codes to simulate conductive heat transfer in a wall and the use of symbolic Monte Carlo are developed to obtain a scale model.
The 1D conductive heat transfer problem in a wall leads to a functional form of the right-wall face temperature, with parameters such as boundary conditions (temperatures) and physical properties (thermal conductivity, convective heat transfer coefficient, wall thickness etc.). The function is linear in regards to variable parameters. This case can be broadened to more complex situations, for instance, a porous media in a 3D complex geometry, or a convective and radiation coupling, an unsteady problem etc.
Besides, one of the assets of this functional is that the error bar related to the computed result, is also a functional of our parameters of interest. And this form helps understanding the influence of parameters and their preponderance. Hence, the algorithm is simple but can be generalized to more complex situations with ease.