The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5 – 9 June 2022, Oslo, Norway

# Modelization of a molten salt thermal energy storage for concentrated solar power.

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**KEY WORDS:** CONCENTRATED *SOLAR POWER, THERMAL ENERGY STORAGE, HEAT AND MASS TRANSFER, COMPUTATIONAL FLUID DYNAMICS*

The need for transitioning towards renewable energies is necessary due to Climate change and the current energy model's unsustainability. Computational methods are a very powerful tool regarding the design and optimization of systems to improve their efficiency and reliability and to reduce cost and environmental impact.

Concentrated Solar Power (CSP) is a renewable energy source that uses sunlight to heat elements at very high temperatures. Solar towers are an important CSP system that consists of a field with multiple mirrors (heliostats) that point to a single region called the receiver. There, a heat transfer fluid (HTF), usually a molten salt, is heated at high temperatures and stored in a hot tank. The HTF is used, when needed, to generate vapor in a steam generator and to produce electricity through a Rankine cycle. The molten salt is then stored in a cold tank waiting for the opportunity of being heated in the receiver again. This is the conventional two-tank energy storage system. However, and to reduce costs, a single tank system is an interesting option: the thermocline system with filler. These accumulators consist of very large structures with filler materials of rocks and sand. Then, when the solar field might not provide energy due to nighttime or adverse climate conditions, the accumulated thermal energy in both the molten salts and the filler material can be used to keep powering the plant.

A new concept has emerged using industrial waste ceramic material that can be used in structured thermocline systems that consist of channels where the HTF flows inside them. The main objective of this work is to simulate this type of thermal energy accumulator under different working conditions and cycles, using advanced numerical methods to solve the heat equation in the solid domain (filler material, tank walls, foundation, etc.), and couple it with the molten salt flow in the channels using unsteady 1D models. The flow in these applications is usually laminar, and then very dependent on the geometry and boundary conditions. Therefore, the possibility of numerically solving the fluid flow in detail using the Navier-Stokes equations will be assessed.

These thermal energy storage systems for CSP have large dimensions. The studied one is roughly 14 meters tall and with a diameter of 40 meters. In addition, this domain has drilled holes of the order of 1cm that act as pipes where the molten salt is flowing. With this geometry, performing a conjugate heat transfer analysis becomes a challenge. A small enough mesh to simulate the geometry of the holes is needed. However, and due to the huge dimensions of the domain, a large number of discretization elements would be needed. Furthermore, the time scale of the problem is in the order of hours/days. Therefore, implicit or semi-implicit numerical schemes are required.

The domain (or part of it) will be simulated with the higher level of accuracy that we can achieve using the parallelization strategy implemented in our in-house code, TermoFluids, and the computational power available. A parametric study of the influence of geometry and working conditions will be presented.