Dynamic Analysis of Extraordinary Operations of MS Central Receiver

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Introduction

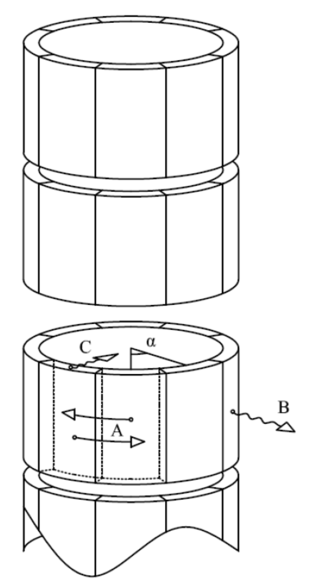
A model of a central receiver has been implemented in the dynamic simulation software ISAAC Dynamics. The model is capable of simulating **draining** and **filling** procedures of the molten salt inside the pipes, in addition to standard procedures

The basic element of the receiver, the **pipe**, is modeled in ISAAC Dynamics and is subjected to a set of tests and the results are compared to those obtained by DLR

The results generated by ISAAC Dynamics are compared to the those obtained from a CFD analysis carried on by DLR

In addition, a basic receiver system will be drained and filled showing some interesting results about these operations in a Central Receiver System

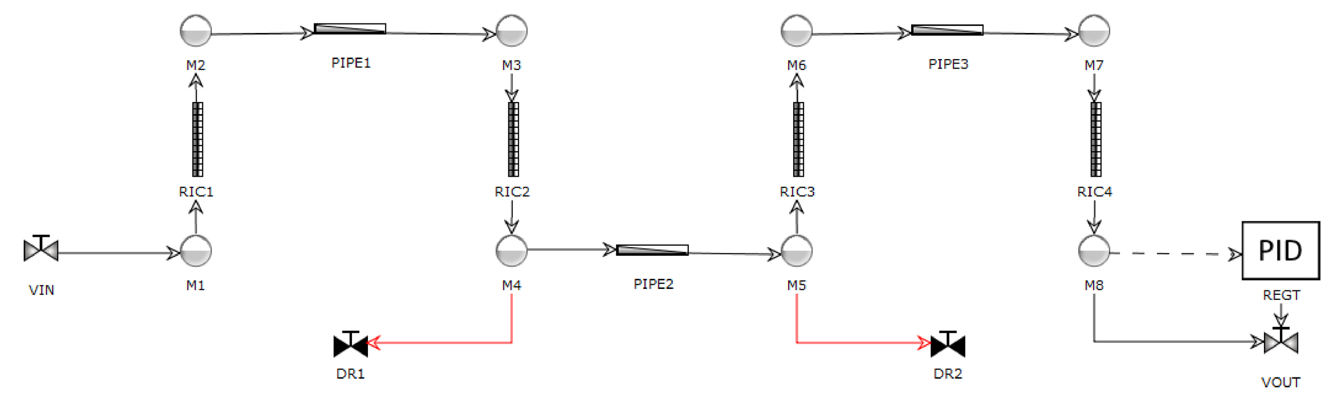
Tube model and ISAAC Dynamics receiver model



Longitudinal Contributes : it takes into account heat transferred by conduction between each cell and the other. For the first and the last cell it is also possible to consider conduction contributions with the upstream and downstream metallic components.

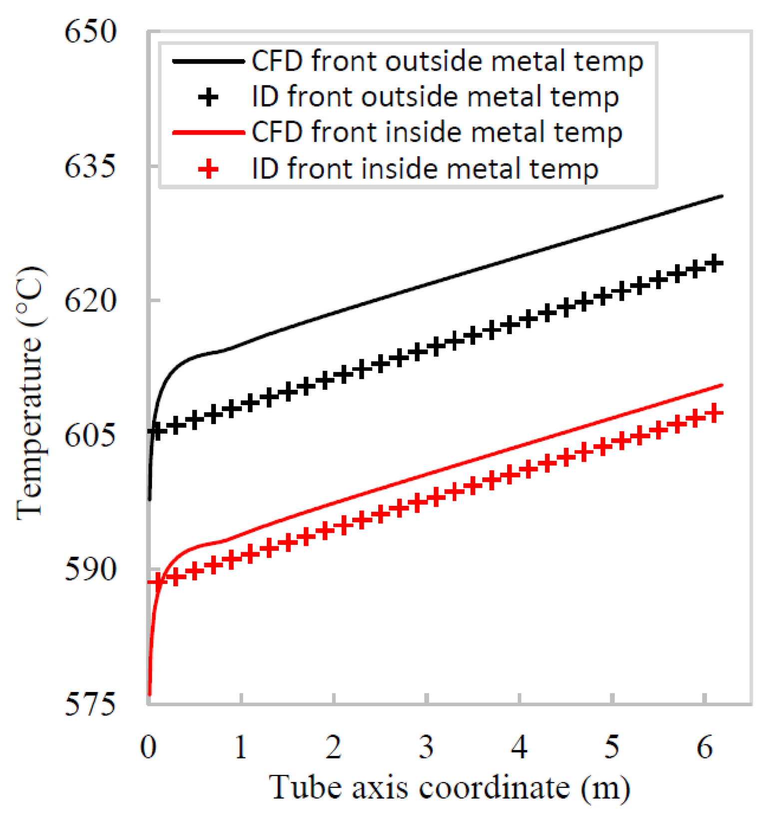
Circumferential (NC cells): it takes into account the heat transferred by conduction between adjacent circumferential cells.

Radial (NR cells): it takes into account heat transferred by conduction among adjacent inner cells. The zero-cell (inner cell) exchanges convective thermal power with the molten salt and the last radial cell (outer cell) considers heat losses toward the environment via convective and radiative exchange. It also includes the external radiation set by the user to simulate the DNI under examination.

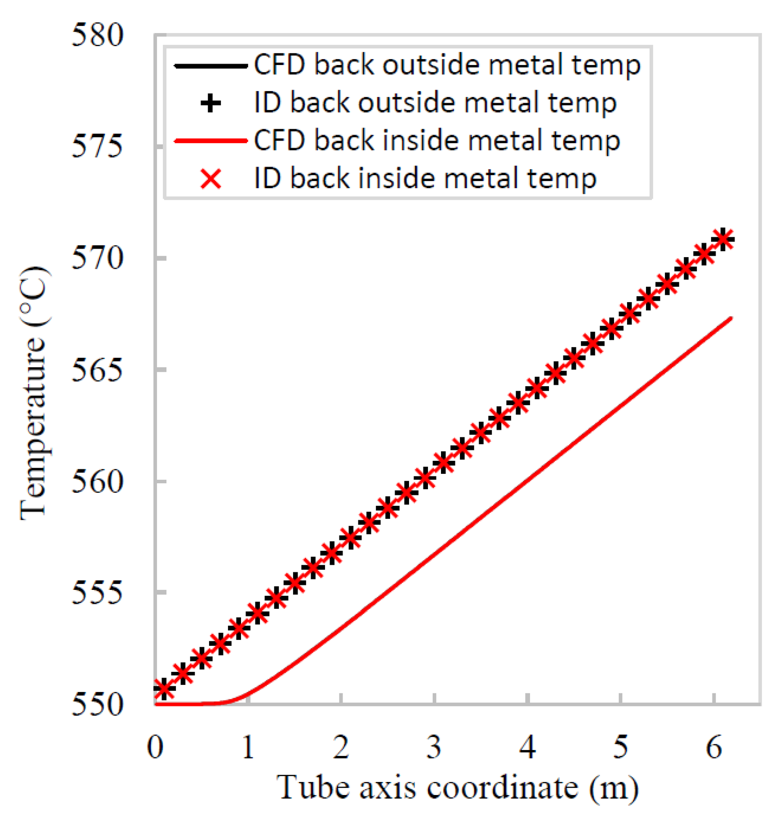


A basic model of a receiver system has been built in ISAAC Dynamics in order to test in a more complex system the behavior of the pipe previously analyzed. A simple regulation system consisting in a single PID varies the valve VOUT lift in order to change the MS flow rate and obtain a MS outlet temperature of 550 °C

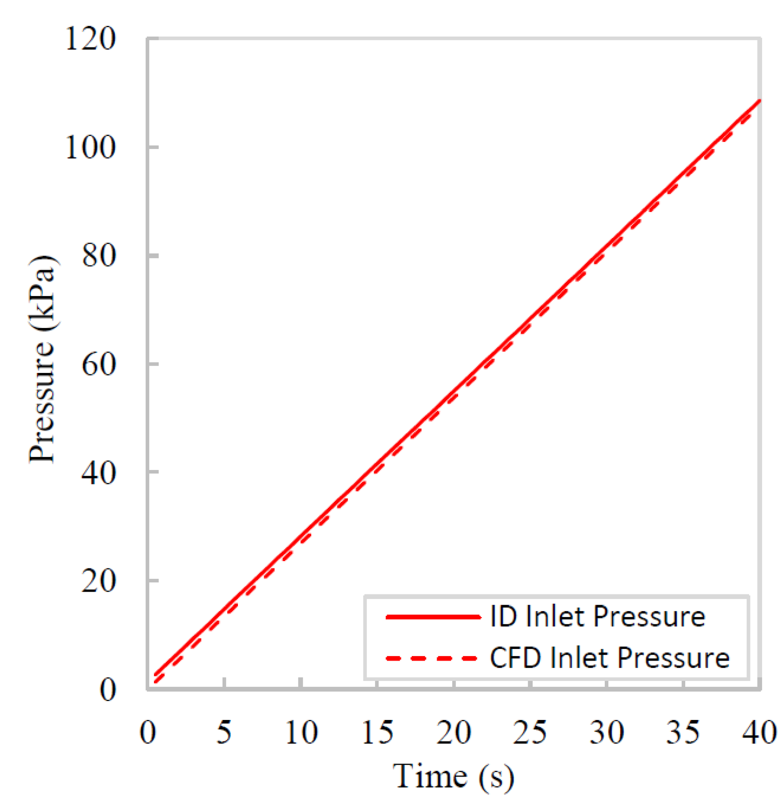
Comparison of the results for the ISAAC Dynamics tube model and the CFD analysis



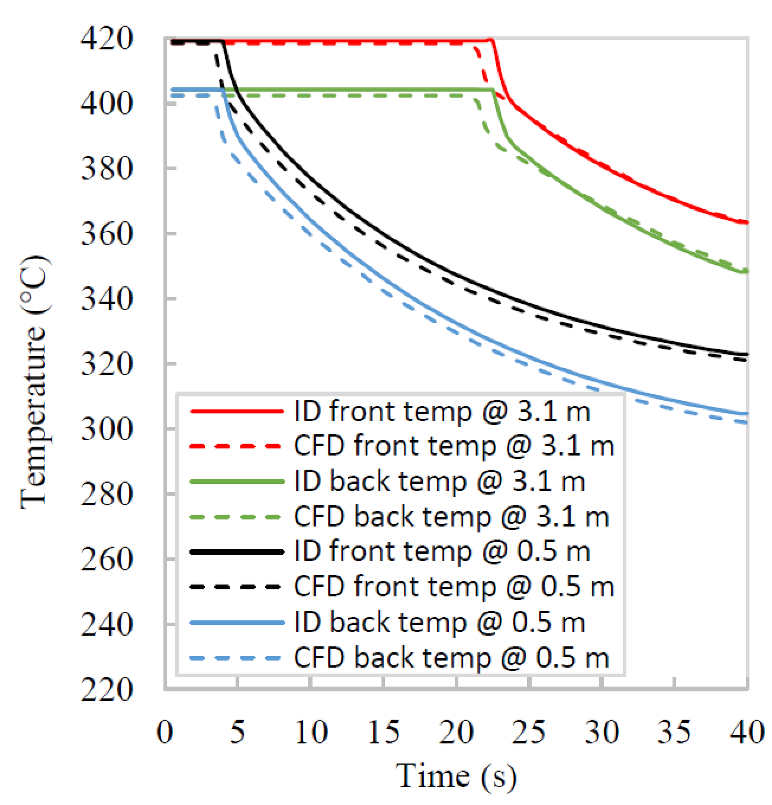
Metal internal and external temperatures in the front side of the tube with a constant flow rate of MS (steady state) as a function of the axis coordinate



Metal internal and external temperatures in the back side of the tube with a constant flow rate of MS (steady state) as a function of the axis coordinate

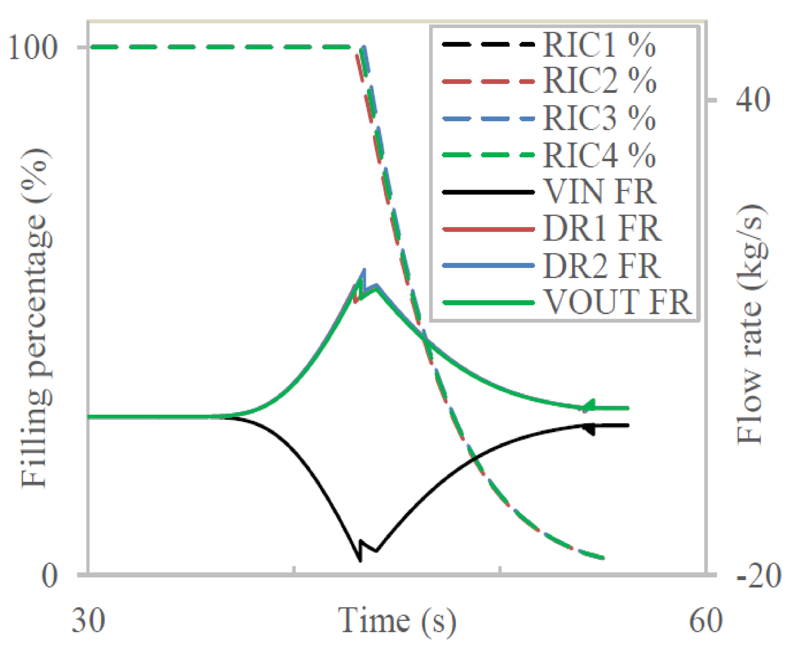


Pressure at the tube inlet necessary to guarantee a constant flow rate during the filling procedure as a function of the simulation time

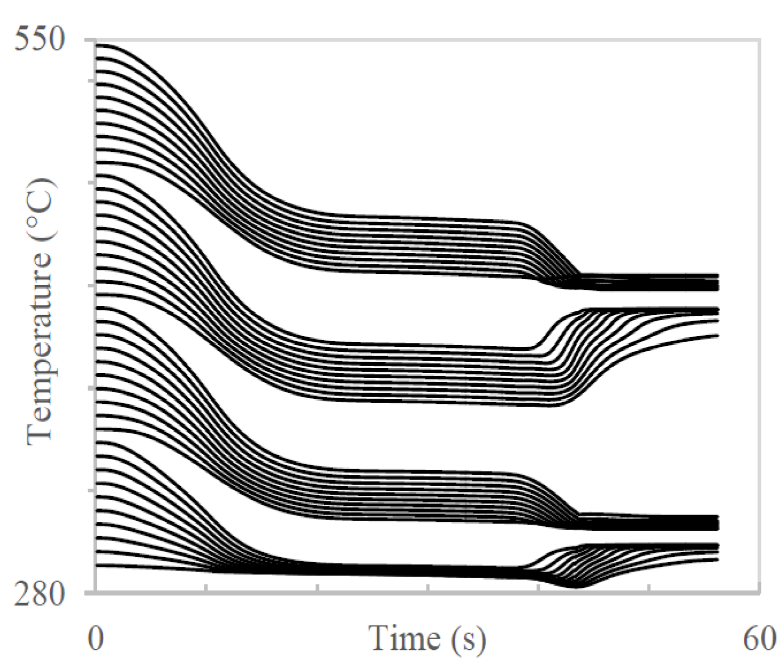


Metal internal and external temperatures in the back and front sides of the tube during the filling procedure at different axis coordinates

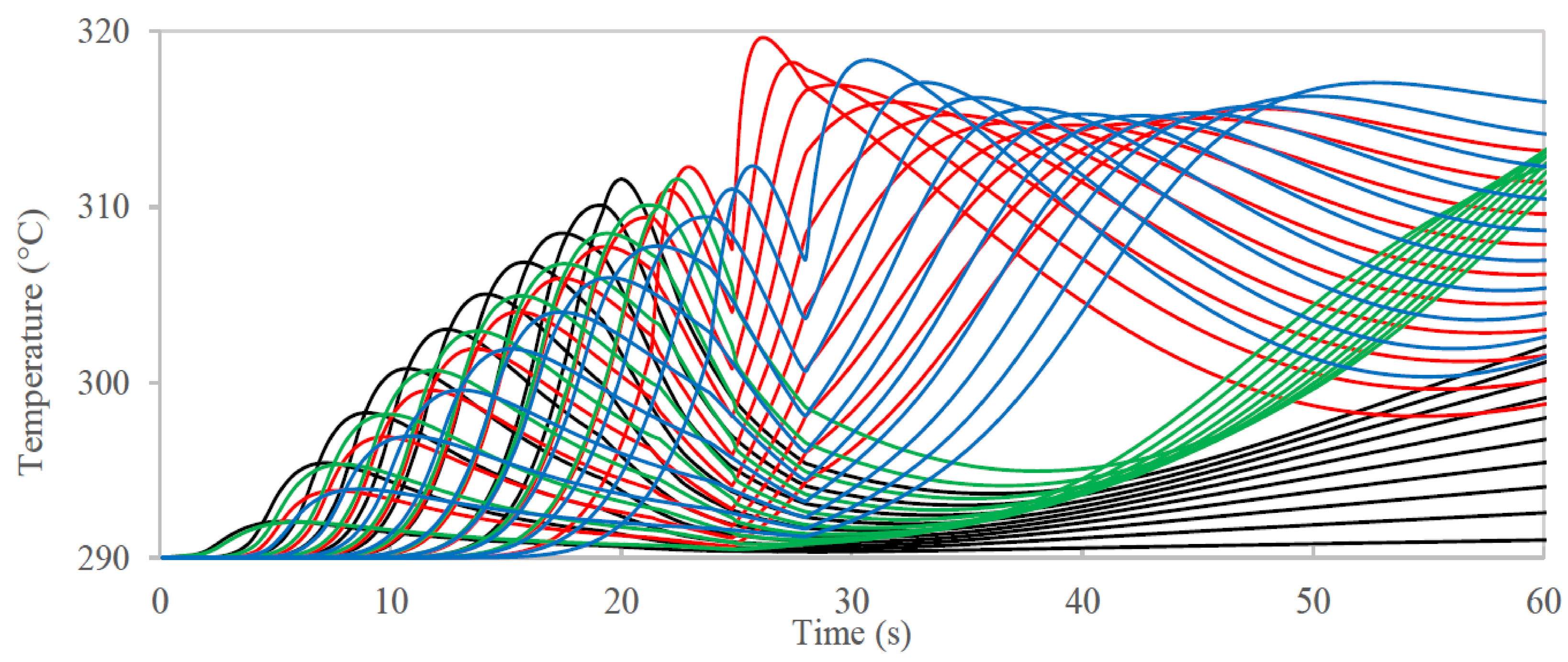
Drainage and filling of the complete receiver system



Panel filling percentages and draining valve flow rates during the drainage procedure of the receiver.



MS temperatures for the four panels (each panel is divided into many longitudinal cells) during the drainage of the receiver



MS temperatures for the four panels (black 1st, red 2nd, blue 3rd and green 4th) during the filling procedure (until the 25th second) and switch to normal circulation (each panel is divided into many longitudinal cells)

Conclusion

The model of the pipe developed in the simulation platform ISAAC has been validated by means of a detailed comparison of the simulation data obtained by the DLR with their CFD analysis and with their model built in Dymola. The comparison has shown a very accurate agreement providing a validation of the pipe model. The same pipe model has been used to generate a basic receiver system allowing one to obtain a large range of interesting simulation data that could be used in order to analyze, optimize and eventually predict the actual physical behavior of a real receiver system in a Central Tower Power Plant.

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