Bachelor or Master Thesis

Optimal Heat Flux Distribution on the Surface of Molten Salt Receivers in Solar Tower Power Plants

Course of study: Mathematics, Computer Science, Computational Engineering
Kind of thesis: Programming, Simulation, and Optimization
Programming language: C++ and others
Start: January 2019

Topic

In this project we are looking at solar tower power plants. The principle of concentrating solar thermal power plants seems to be very simple: Large mirrors are used to concentrate rays of sunlight on an receiver where a fluid (e.g. molten salt) is being heated up. The heat of the fluid is exchanged into steam which powers a turbine to generate electricity.

Solar tower power plant PS10, Spain.

During operation, the focal spots of heliostats are distributed on the receiver's surface, such that the conversion from optical to thermal power is optimal. This distribution highly depends on the flow medium and the receiver technology, e.g. for open volumetric air receivers a homogeneous distribution is optimal, while for direct steam generating receivers the distribution should increase to the center of the receiver. A detailed model of the receiver would help to find an optimized flux distribution on the receiver surface.

Preliminary work

A simple receiver model exists, which describes the heat transfer from the tubes into the fluid.

Tasks

Within this project, a dynamic model of molten salt receivers is investigated. The desired heat distribution on the receivers' surface is optimized under changing solar irradiation conditions. This approach is finally tested in a feasibility study.
The following tasks have to be solved:

- Literature review on modeling the heat transfer and transient flow in receiver systems.
- Develop a thermal model to describe the heat transfer at the molten salt driven receiver considering all relevant physical effects.
- Implement the model while using ANSYS Fluent for the simulation of the numerical part.
- Extend this model with a control strategy which controls the mass flow, such that a desired outlet temperature is reached.
- Consider safety and lifetime limits that must be taken into account in receiver model, e.g. receiver outer tube temperature, salt film temperature (degradation), tube stress, etc.
- Couple the model with an optimizer to find out an optimal heat flux distribution on the receivers' surface. The goal is to reach as much mass flow as possible (at the desired temperature).
- Investigate the optimal heat flux distribution in the frame of a feasibility study for a virtual solar tower power plant (e.g. PS10 in Spain).

Contact This project is offered by the *Steinbuch Centre for Computing* and the *Computational Science & Mathematical Methods* research group headed by Prof. Dr. Martin Frank. The project will be co-supervised by Dr. Daniela Piccioni Koch and Dr. Pascal Richter. For further questions please contact us via email:

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