SOLSTICE	Name of the PhD: **Thomas FASQUELLE** Title of the PhD thesis/post-doc**: Experimental and numerical study of a thermocline thermal storage integrated in a parabolic trough micro power plant** **Dates (start/end):** 01/10/2014 – 30/09/2017
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Context and objectives

Thermocline technology is a promising solution to decrease cost of thermal energy storage in concentrating solar power (CSP) plants. It consists in the use of one single tank instead of the conventional two-tank technology. Thermocline behavior has been thoroughly been studied in the past years and its behavior is considered well-known. However no study treated of thermocline tanks integrated in CSP plants. Thus, the impact of the varying outlet temperature of the thermocline storage has not been assessed yet. This work aims to fill this lack of knowledge by studying a mini parabolic trough power plant with a thermocline tank as storage (see photos below).

Approach

This work can be divided in three parts:

- The study of the compatibility between the heat transfer fluid of the plant (synthetic oil) and various potential filler materials (cofalit, coal fly ash bricks, alumina) of the storage tank;
- The performance study of each component of the power plant (Solar field, Storage tank and power block) (experimental and numerical);
- The study of the whole power plant, with a focus on the impact of the varying fluid temperature at the outlet of the thermocline (experimental and numerical).

Solar field

Storage tank

Vapour generator

Main results

- The oil thermal aging is accelerated by the presence of solid materials. However, the oil properties are still acceptable for heat transfer fluid application after 500 hours of accelerated tests at 330°C.
- The thermocline model was in good accordance with experimental results from 4 different tanks. The parabolic trough model showed good capability of predicting the dynamic behavior of the receivers.
- The consequences of the thermocline varying outlet temperature can be predicted, and appropriate control strategies can enhance the whole system performances
- With a proper sizing and an appropriate control strategy, thermocline technology induces very low decrease of the solar power plant performance in comparison to the conventional two tank technology (maximum 3-4% of electrical power production difference).

Publications

T. Fasquelle, Q. Falcoz, P. Neveu, J. Walker, G. Flamant, « Compatibility study between synthetic oil and vitrified wastes for direct thermal energy storage », *Waste and Biomass Valorization*, 8(3), 621-631, 2017.

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T. Fasquelle, Q. Falcoz, P. Neveu, J.-F. Hoffmann, A temperature threshold evaluation for thermocline energy storage in concentrated solar power plants, *Applied Energy*, 212, 1153-1164, 2018.

International Conferences

T. Fasquelle, Q. Falcoz, P. Neveu, G. Flamant, J. Walker, « Compatibility tests between Jarytherm DBT synthetic oil and solid materials from wastes », SolarPACES2015, *AIP Conf. Proc*. 1734, 040004 (2016).

T. Esence, T. Fasquelle, A. Bruch, Q. Falcoz, "Experimental investigation of the solid filler influence in thermocline storage systems trough the comparison of two different setups", SolarPACES2017.

T. Fasquelle, Q. Falcoz, P. Neveu, F. Lecat, N. Boullet, G. Flamant, « Operating results of a thermocline thermal energy storage included in a parabolic trough mini power plant », SolarPACES2016, *AIP Conf. Proc.*, Vol 1850, 080010 (2017)

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