Modeling of Linear Concentrating Solar Power using Direct Steam Generation with Parabolic-Trough

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Concentrating Solar Power (CSP) is a renewable electricity generation technology that uses sun's Direct Normal Irradiation (DNI) to generate electricity through a conversion from thermal energy to mechanical work with the help of a thermodynamic cycle. In its latest Technology Roadmap report (OECD/IEA 2014), the International Energy Agency estimates that with appropriate R&D support, the contribution of CSP to the global electricity production could reach 11% in 2050.

Among the several CSP technologies, parabolic-trough uses linear concentration to collect heat with a fluid flowing inside an absorber tube located at the focal line of a parabolic mirror. The process of using water as the heat transfer fluid in the tubes and generating steam for a direct use as the working fluid of the thermodynamic cycle is referred as Direct Steam Generation (DSG). It offers several advantages and has potential cost reductions effects, compared to technologies using other heat transfer fluids and heat exchangers (Eck et al. 2008; Feldhoff et al. 2009). The combination of the natural transient condition of solar irradiation and the dynamics induced by the presence of a two-phase flow inside the absorber tubes results in a behavior of the steam generation system that is strongly dynamic. Modeling this behavior at the system scale is useful for the sizing and design of both the solar field and its control system.

This papers deals with the Modelica /Dymola modeling of linear Concentrating Solar Power in a parabolic-trough experimental loop using direct steam generation. An extensive description of the parabolic collector and the absorber tube models is proposed. First results of the simulation of a clear sky day, with the aim of validating the models, is proposed. Experimental data from the CIEMAT-PSA DISS loop in Almeria, Spain, is used. Good behavior agreement is found between experiment and model, although adjustments to the model need to be done to make its accuracy satisfactory.

References

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