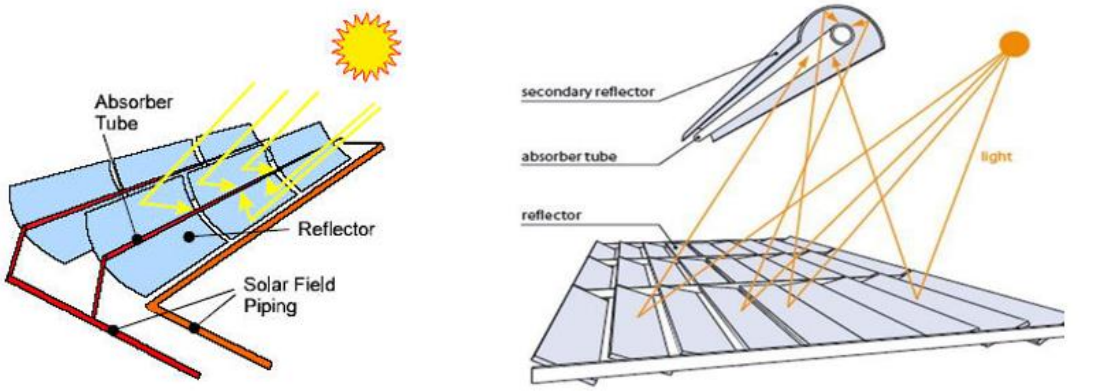
Analysis of Selective Coatings for line-focusing CSP systems

Introduction

The Concentrated Solar Power (CSP) is a promising renewable technology that consists of a solar field, a solar receiver and a power block. The solar field concentrates the solar radiation on the target surface of the solar receiver; the latter transfers the solar energy to a heat transfer fluid producing high temperature heat with the aim to drive a common thermodynamic cycle (power block). Typically, a thermal storage is also included in a CSP plant to generate power in a dispatchable way.

In a line-focusing CSP system the solar radiation is concentrated along a line. The most commercially diffuse line-focusing technology is the parabolic through (Figure 1a), which consists of a series of parabolic mirrors that concentrates the solar radiation on a receiver tube, which is typically encapsulated in a glass cover to reduce the heat losses. An alternative line-focusing technology is the Linear Fresnel Reflector (LFR), which is cheaper but less performing than the parabolic through. The LFR consists of a set of parallel-placed flat or slightly curved mirrors stripes, which focus the solar radiation onto a fixed receiver tube that is equipped with a secondary concentrator (Figure 1b).



https://www.solarpaces.org/how-csp-works/

https://www.semanticscholar.org/paper/Design-and-Analysis-of-Rooftop-Linear-Fresnel-Solar-Gouthamraj-Rani/6771c01a265a0b2e975e29edfd0371057a308cf3

(a) (b)

Figure 1: (a) Parabolic trough and (b) Linear Fresnel systems

Aim of the work

The receiver tube adopted in the line-focusing systems is normally coated with a selective paint, which increases the solar absorptivity while reducing the thermal emissivity. A new surface coating is now developing at ENEA (research center of Casaccia), which aims enhancing the thermal performance of the receiver tube with respect to the current state of the art in terms of surface coatings (see for example [1]).

The aim of the proposed thesis is to:

1. Develop a lumped-parameters numerical model of a parabolic through system using the Modelica language, which should be able to predict the receiver thermal efficiency considering the surface coating properties. The final goal is to evaluate the improvement in the thermal efficiency that can be reached adopting the new coating developed at ENEA.
2. Develop a lumped-parameters numerical model of a LFR system using the Modelica language, which should be able to predict the receiver thermal efficiency considering the surface coating properties. In this case, a CFD study may be required to estimate in a more accurate way the convective and radiative heat losses considering also the presence of the secondary

concentrator. Also for the LFR system, the final goal is to evaluate the improvement in the thermal efficiency that can be reached adopting the new coating developed at ENEA.

A recent reference study conducted on a LFR system is [2]. This thesis is in collaboration with ENEA and it could be combined with an internship at ENEA. In addition, it is possible to arrange a brief period of stay at ENEA during the thesis work

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References

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