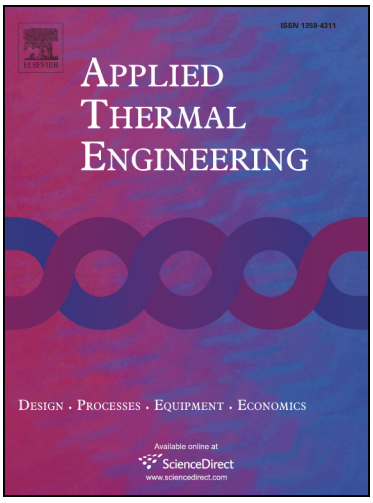

Research Paper

Optical and thermal analysis of a linear Fresnel reflector operating with thermal oil, molten salt and liquid sodium

Evangelos Bellos, Christos Tzivanidis, Angelos Papadopoulos

PII: S1359-4311(17)36968-5
DOI: https://doi.org/10.1016/j.applthermaleng.2018.01.038
Reference: ATE 11692

To appear in: *Applied Thermal Engineering*

Received Date: 31 October 2017
Revised Date: 10 December 2017
Accepted Date: 10 January 2018

Please cite this article as: E. Bellos, C. Tzivanidis, A. Papadopoulos, Optical and thermal analysis of a linear Fresnel reflector operating with thermal oil, molten salt and liquid sodium, *Applied Thermal Engineering* (2018), doi: https://doi.org/10.1016/j.applthermaleng.2018.01.038

Optical and thermal analysis of a linear Fresnel reflector operating with thermal oil, molten salt and liquid sodium

Evangelos Bellos, Christos Tzivanidis, Angelos Papadopoulos

Thermal Department, School of Mechanical Engineering, National Technical University of Athens, Zografou, Heroon Polytechniou 9, 15780 Athens, Greece.

Corresponding author: Evangelos Bellos (bellose@central.ntua.gr, tel: +302107722340)

Abstract

Linear Fresnel collectors are promising technologies for the exploitation of solar irradiation in medium and high temperatures. In this study, a linear Fresnel collector with flat primary mirrors and a parabolic shape secondary reflector is investigated. The location of the secondary reflector is simply optimized and then the collector is investigated under different incident angles (transversal and longitudinal). The next step is the thermal analysis of the collector with three different working fluids: thermal oil, molten salt and liquid sodium. The analysis is performed for temperatures up to 900 K with liquid sodium in order to examine the collector up to its stagnation temperature. Both the optical and thermal analysis are conducted with SolidWorks Flow Simulation. According to the final results, the exergy performance of the collector is maximized at 700 K and it is 30.20% with liquid sodium and 30.05% with molten salt. Generally, liquid sodium was found to be the best candidate according to performance criteria, with molten salt and thermal oil to follow. The high heat transfer coefficient is the reason for the superior performance of the liquid sodium. Moreover, the pumping work is maximized for operation with molten salt.

Keywords

Linear Fresnel Reflector, Thermal analysis, Optical analysis, Molten salt, Liquid Sodium

1. Introduction

Solar energy exploitation is one of the major ways to face the global environmental problems and to create sustainable energy systems [1-3]. Concentrating solar power (CSP) is a promising method for producing high amounts of electricity in locations with adequate solar beam potential. Parabolic trough collectors (PTCs), linear Fresnel reflectors (LFRs), solar tower and solar dishes are the most developed concentrating technologies capable of producing useful heat in medium and high-temperature levels [4-5].

Linear Fresnel reflectors present a series of advantages, compared to the other concentrating technologies and especially the PTC. LFRs are low-cost technologies [6-7] which can operate without great mechanical difficulties. The absorber is not rotated and it is stable, the fact makes the operation easier. Moreover, the concentration ratio of LFR can be easily increased by adding extra reflectors close to