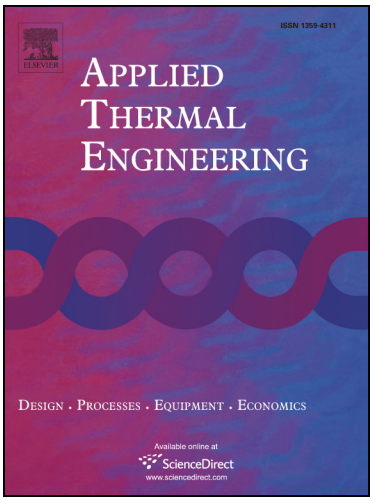

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Thermal load and bending analysis of heat collection element of direct-steam-generation parabolic-trough solar power plant

Lu LI[1], Jie SUN[2*] and Yinshi LI[1*]

[1]Key Laboratory of Thermo-Fluid Science and Engineering of MOE, School of Energy and Power Engineering, Xi'an Jiaotong University, Xi'an, Shaanxi 710049, China

[2]School of Chemical Engineering and Technology, Xi'an Jiaotong University, Xi'an, Shaanxi 710049, China

Abstract

The reliability of heat collection element (HCE) in parabolic trough collector (PTC) system is of importance to the solar thermal energy harvesting. The present work proposes the 2D-finite volume method (FVM) and 3D-finite element volume (FEM) coupled model to conduct the thermal load and bending analysis of the HCE of direct-steam-generation (DSG) PTC solar power plant. The emphasis is focused on the evaporation and superheating stages of a DSG loop in re-circulation mode due to the presence of the phase-change process and the relatively lower heat transfer performance, respectively. It is found that the thermal deflection is far less than 1 cm for a 4-m HCE in the evaporation stage. However, in the superheating stage with *DNI*=1000 Wm^{-2} (*DNI* being the direct normal irradiance), the circumferential temperature difference and the deflection of a 4-m HCE can reach up to 48 ^{o}C and 2.16 cm, respectively. It should be pointed out, based on the present work, that the non-uniform heating and local overheating issues exist in the evaporation and superheating stages, respectively, the latter of which seems more serious and potentially causes damage.

Keywords: Concentrating solar power (CSP); Direct steam generation (DSG); Heat collection element (HCE); Thermal bending

*Authors to whom correspondence should be addressed. Electronic mails: thisissj@hotmail.com (JS), ysli@mail.xjtu.edu.cn (YSL)