Concentrating solar power plants are experiencing an increasing share in the renewable energy generation market. Among them, parabolic trough plants are the most commercially mature technology. These plants still experience many challenges, one of which is the cyclic daily start-up and shut-down procedures. These pose new challenges to industrially mature components like the steam generator system, as frequent load changes might decrease their lifetime considerably due to cyclic thermo-mechanical stress loads. In this context, the header and coil design is a promising configuration to minimize the stresses.

This paper presents a method to design the header and coil heat exchangers of the steam generator, taking into account low-cycle fatigue requirements, by defining minimum allowable heating rates for the evaporator and superheater. Optimal designs were obtained by minimizing the total water pressure drops and purchase equipment costs. A comparison with a sizing routine without accounting for low-cycle fatigue constraints was also conducted. The model was validated against the component data of a 55MWe power plant, with a maximum deviation on the total area estimation of +2.5%. The results suggest that including the heating rate constraints in the design routine substantially affects the optimal design configuration, with a 41% cost increase for a 1bar pressure drop. The optimal design for maximizing the lifetime of the components uses tube outer diameters of 38mm and 50mm and a low number of tubes per layer (4–10) for the superheater.

General information
State: Published
Organisations: Department of Mechanical Engineering, Thermal Energy
Contributors: Ferruzza, D., Kærn, M. R., Haglind, F.
Pages: 793-803
Publication date: 2019
Peer-reviewed: Yes

Publication information
Journal: Applied Energy
Volume: 236
ISSN (Print): 0306-2619
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 8.44 SJR 3.162 SNIP 2.765
Web of Science (2017): Impact factor 7.9
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 7.78 SJR 3.011 SNIP 2.61
Web of Science (2016): Impact factor 7.182
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 6.4 SJR 2.835 SNIP 2.593
Web of Science (2015): Impact factor 5.746
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 6.93 SJR 3.158 SNIP 3.218
Web of Science (2014): Impact factor 5.613
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 6.59 SJR 3.06 SNIP 3.346
Web of Science (2013): Impact factor 5.261
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1