Identification of optimum molten salts for use as heat transfer fluids in parabolic trough CSP plants. A techno-economic comparative optimization

Parabolic trough power plants using thermal oil as heat transfer fluid are the most mature concentrating solar power technology and state of the art. To further increase their efficiency and lower costs, molten salts can be used as heat transfer fluid. This results in higher operating temperature differences for improved cycle efficiencies and enables direct thermal energy storage at lower costs due to omission of the oil-to-salt heat exchanger and the need for smaller storage sizes. As a variety of salts are available to choose from, this study uses a multi-objective optimization to identify the most suitable heat transfer fluid for three locations in South Africa, Spain and Chile. The lowest values for the levelized costs of electricity (LCOE) can be found in Chile using Solar Salt as heat transfer fluid (75.0 $/MWhe). Generally, Solar Salt offers the lowest LCOE values followed by thermal oil and Hitec. The results also suggest that the choice of the heat transfer fluid is dependent on the direct normal irradiance (DNI) at each location. Thermal oil is competitive with Solar Salt in small systems at locations with low DNI values, whereas Hitec can be cheaper than thermal oil in large systems at locations with high DNI. Furthermore, it is also investigated at which freeze alert temperature set point the activation of the freeze protection system is optimal. The results indicate that this temperature should be chosen close to the solar field inlet temperature for small systems, while it can be lowered significantly for large systems to reduce electricity consumption from the freeze protection system.

General information
Publication status: Published
Organisations: Department of Mechanical Engineering, Thermal Energy, University of Stellenbosch, KTH - Royal Institute of Technology
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Publication date: 2018
Peer-reviewed: Yes

Publication information
Journal: Aip Conference Proceedings
Volume: 2033
Issue number: 1
Article number: 030012
ISSN (Print): 0094-243X
Ratings:
BFI (2018): BFI-level 1
Scopus rating (2018): CiteScore 0.37 SJR 0.182 SNIP 0.385
Original language: English
DOIs: 10.1063/1.5067028
Source: Findit
Source ID: 2441436557
Research output: Contribution to journal › Conference article – Annual report year: 2018 › Research › peer-review