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Development of a Test Plant for Parabolic Trough Solar Collectors Characterization

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Abstract : The search for increased efficiency in generation systems has been of great importance in recent years to reduce the impact of greenhouse gas emissions and global warming. For clean energy sources, such as the generation systems that use concentrated solar power technology, this efficiency improvement impacts a lower investment per kW, improving the project's viability. For the specific case of parabolic trough solar concentrators, their performance is strongly linked to their geometric precision of assembly and the individual efficiencies of their main components, such as parabolic mirrors and receiver tubes. Thus, for accurate efficiency analysis, it should be conducted empirically, looking for mounting and operating conditions like those observed in the field. The Brazilian power generation and distribution company Eletrobras Furnas, through the R&D program of the National Agency of Electrical Energy, has developed a plant for testing parabolic trough concentrators located in Aparecida de Goiânia, in the state of Goiás, Brazil. The main objective of this test plant is the characterization of the prototype concentrator that is being developed by the company itself in partnership with Eudora Energia, seeking to optimize it to obtain the same or better efficiency than the concentrators of this type already known commercially. This test plant is a closed pipe system where a pump circulates a heat transfer fluid, also calledHTF, in the concentrator that is being characterized. A flow meter and two temperature transmitters, installed at the inlet and outlet of the concentrator, record the parameters necessary to know the power absorbed by the system and then calculate its efficiency based on the direct solar irradiation available during the test period. After the HTF gains heat in the concentrator, it flows through heat exchangers that allow the acquired energy to be dissipated into the ambient. The goal is to keep the concentrator inlet temperature constant throughout the desired test period. The developed plant performs the tests in an autonomous way, where the operator must enter the HTF flow rate in the control system, the desired concentrator inlet temperature, and the test time. This paper presents the methodology employed for design and operation, as well as the instrumentation needed for the development of a parabolic trough test plant, being a guideline for standardization facilities.

Keywords : parabolic trough, concentrated solar power, CSP, solar power, test plant, energy efficiency, performance characterization, renewable energy
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