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Research Article

Thermo-economic evaluation of solar boiler power plant

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ABSTRACT

Today, the world is turning to use renewable energy to solve the problems of fuel shortage and pollution due to CO_2 emissions from the use of fossil fuels. In this study, parabolic trough solar collectors (PTC) with two types of heat transfer fluids HTF are used to investigate the performance of a retrofitted steam power plant using solar energy. A thermo-economic analysis was performed for a 10 MW simple steam power plant with different boiler pressure from 10 to 100 bar and located in the city of Basra in Iraq which receives high levels of solar radiation. Basra's weather conditions are used to simulate the solar-assisted regenerative system using a parabolic trough collector (PTC). According to the system analysis, it was found that increasing the boiler pressure reduces the area required for the PTC heater for constant power output. For 10 bar operating pressure the required PTC area is 64233,562 m^2 while for 100 bar operating pressure the required PTC area is 42907.59 m^2. Also, it was estimated that the Levelized Cost of Energy (LCOE) decreased with increasing operating pressure. The decrease in LCOE for PV1 heating fluid is 43.25% and the decrease in LCOE is 43.16% for the pressure range from 10 to 100 bar.

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INTRODUCTION

Environmental and energy problems have increased at the beginning of the 21st century, because of the huge use of non-renewable resources such as fossil fuels, and nuclear energy. Due to the use of these materials, global warming and climate change have occurred. In order to avoid continued climatic and energy shortage problems, solar energy was developed to generate electricity.

Benabdellah et al., 2021 [1] studied energy and economic analysis for an 80MW gas turbine and solar plant based on PTC. Hassi R'mel (Algerian Sahara) is where the plant is located and the area is characterized by intense solar radiation. 56 lines, 224 collectors, 183,120 m2 of the solar field area, and synthetic oil (VP-1) were used in the study. The obtained results show that energy efficiency are 56.06% and LCOE was 9.75 ¢/kWh. Wang et al., 2021 [2] studied the economic analysis of (PTC) power plant, for three typical sites, Mojave Desert, Dunhuang, and Quarzazate. This plant has 100-meter-long PTC and 800-meter-long rows connected in a series in the form of eight loops. The temperature at the inlet was 290C and the temperature at the outlet was 550C. According to the economic analysis of the plant, the LCOE (¢ /kWh)

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