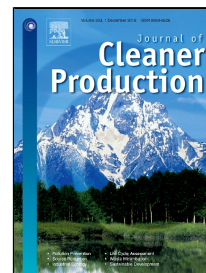


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Development of Empirical Models for Estimation of Global Solar Radiation Exergy in India

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Abstract

In this work, exergy of incoming solar radiation is estimated using empirical models. Long-term meteorological data (1986-2000) consisting of monthly mean diffuse and global solar radiation on a horizontal plane, ambient temperature and sunshine hours for 23 selected stations were available from Indian Meteorological Department (Pune), India. Exergy of direct and diffuse radiations was calculated using Petela model and summed to obtain exergy of global solar radiation. Beam and diffuse exergy efficiencies were in the range of 0.9286-0.9365 and 0.7189-0.7499 respectively. Estimated global exergy efficiencies were found in the range of 0.7700-0.8912. Empirical models were developed by correlating global solar exergy (in the form of global exergy efficiency and global exergy efficiency factor) in terms of clearness index and relative sunshine period. Four categories of single predictor models were defined with each consisting of eight models. Statistical analysis was used to compare and evaluate the accuracy of the models. Further, Global Performance Indicator was calculated and used to rank the models within the individual categories of models as well as the overall group of the 32 developed models. Overall assessment proved that power model with the clearness index is the best one for estimation of global exergy efficiency factor.

Keywords: Solar Radiation; Exergy; Clearness Index; Sunshine Period; India.

1. Introduction

1.1 Solar Radiation Description

Exploration of new technologies for effective utilization of renewable energy for power generation has huge implications in the present scenario where rising levels of pollution and global temperature post a serious threat to the environment. Solar energy is exploited in a great range of applications due to its free of cost availability. Sun sustains numerous life forms on earth, support agricultural processes, and influences the climate of the region and local weather conditions. Solar energy is a vital renewable energy source that is deemed to considerably reduce the dependence on conventional fuels in the near future [1]. The climate conditions are influenced by the incoming solar irradiation in every location. Abundant availability of solar radiation in a region can be beneficial for solar energy based devices and equipment.

Fig. 1 illustrates solar radiation and its components. The emitted energy from the sun surface in the form of radiations travels the space between the sun and the atmosphere of the earth (known as extraterrestrial radiations). The annual average radiation outside the earth's

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