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Global, direct and diffuse solar radiation on horizontal and tilted surfaces in Jeddah, Saudi Arabia

A.A. El-Sebaïi *, F.S. Al-Hazmi, A.A. Al-Ghamdi, S.J. Yaghmour

Physics Department, Faculty of Science, King Abdul Aziz University, P.O. Box 80203, Jeddah 21589, Saudi Arabia

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ABSTRACT

The measured data of global and diffuse solar radiation on a horizontal surface, the number of bright sunshine hours, mean daily ambient temperature, maximum and minimum ambient temperatures, relative humidity and amount of cloud cover for Jeddah (lat. $21^{\circ}42'37''\text{N}$, long. $39^{\circ}11'12''\text{E}$), Saudi Arabia, during the period (1996–2007) are analyzed. The monthly averages of daily values for these meteorological variables have been calculated. The data are then divided into two sets. The sub-data set I (1996–2004) are employed to develop empirical correlations between the monthly average of daily global solar radiation fraction (H/H_0) and the various weather parameters. The sub-data set II (2005–2007) are then used to evaluate the derived correlations. Furthermore, the total solar radiation on horizontal surfaces is separated into the beam and diffuses components. Empirical correlations for estimating the diffuse solar radiation incident on horizontal surfaces have been proposed. The total solar radiation incident on a tilted surface facing south H_t with different tilt angles is then calculated using both Liu and Jordan isotropic model and Klucher's anisotropic model. It is inferred that the isotropic model is able to estimate H_t more accurate than the anisotropic one. At the optimum tilt angle, the maximum value of H_t is obtained as ~ 36 (MJ/m^2 day) during January. Comparisons with 22 years average data of NASA SSE Model showed that the proposed correlations are able to predict the total annual energy on horizontal and tilted surfaces in Jeddah with a reasonable accuracy. It is also found that at Jeddah, the solar energy devices have to be tilted to face south with a tilt angle equals the latitude of the place in order to achieve the best performance all year round.