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## Estimation of solar radiation and optimum tilt angles for south-facing surface in Nakhon Pathom and Chiang Mai stations

In this research, optimum tilt angles for south-facing surface obtaining the highest solar energy in Nakhon Pathom (13.82 N, 100.04 E) and Chiang Mai (18.78 N, 98.98 E) stations were estimated for monthly, seasonal and annual basis. The solar radiation incident the inclined surface consists of beam radiation, sky diffuse radiation and reflected radiation. Liu & Jordan (1962) model and Iqbal (1983) model were selected to calculate sky diffuse radiation on tilted surfaces using diffuse radiation on horizontal surface and reflected radiation on tilted surface. Beam radiation on tilted surface was calculated from beam radiation on horizontal surface and beam conversion factor. The solar radiation on horizontal surface measured at the two stations were used for over a period of 5 years (2014-2018). The daily total solar radiation (in MJ/m<sup>2</sup>-day) for an inclined surface is calculated every 0.2 degrees from 0-90 degrees. The total solar radiation on tilted surface based on monthly, seasonal and annual optimum tilt angles at Chiang Mai and Nakhon Pathom stations were performed. For the analysis results, annual optimum tilt angle for Chiang Mai and Nakhon Pathom stations was found as 18.9 and 14.5 degrees, respectively. Estimated gains in annual average solar radiation based on monthly, seasonal and annual optimum tilt angles in comparison to a horizontal surface were 11.95%, 10.53% and 6.11% for Chiang Mai, and 6.20%, 5.42% and 1.98% for Nakhon Pathom, respectively. The solar energy losses of 1.27% and 5.22% (for Chiang Mai) and 0.74% and 3.98% (for Nakhon Pathom) were occurred when compared the solar energy on the seasonal and annual optimum tilt angle surfaces, respectively, with that on the monthly optimum tilt angle surface. Therefore, from the result, the inclined surface should be tilted on monthly or seasonal optimum tilt angle for better utilization of solar energy.

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