Solar Resource Estimation

- Calculate the angle made by beam radiation with the normal to a solar flat plate collector on September 1 at 1000h (LAT). The collector is located at Kozhikode and is tilted at an angle of 15^{o} with the horizontal and the surface azimuth angle is 30^{o}.

- $\cos\theta = \sin\phi(\sin\delta\cos\beta + \cos\delta\cos\gamma\cos\omega\sin\beta) + \cos\phi(\cos\delta\cos\omega\cos\beta - \sin\delta\cos\gamma\sin\beta) + \cos\delta\sin\gamma\sin\omega\sin\beta$
- $\phi = 11^o15'$ for Kozhikode
- $\beta = 15^o$
- $\gamma = 30^o$
- $\omega = 15^o[12 - LAT] = 15^o[12 - 10] = 30^o$
- n = 243 (September 1)

$$\delta = 23.45 sin\left[\frac{360}{365}(284 + n)\right]$$ $\delta = 8.02^o$

$\theta = 24.55^o$

- Estimate the monthly average daily global radiation (in kJ/m^2.day) falling on a horizontal surface at Kozhikode during September. The monthly average sunshine hours is 5.1.

$$\frac{\overline{H_g}}{\overline{H_0}} = a + b\left(\frac{\bar{S}}{\overline{S_{max}}}\right)$$

- For Kozhikode: a = 0.27, b = 0.43

$$H_0 = \frac{24}{\pi} I_{sc}\left(1 + 0.033cos\frac{360n}{365}\right)(\omega_s sin\phi sin\delta + cos\phi cos\delta sin\omega_s)$$

- I_{sc} = 1367 W/m^2

$\omega_s = \cos^{-1}(-\tan\phi \tan\delta) = 90.5^o$

$S_{max} = (2/15)\,\omega_s = 12.07$ h

$$\overline{H}_g = 16711.3 \quad kJ/m^2.day$$

- Calculate the radiation flux incident on the collector of a solar air heater located at Kolkata (22°39′N, 88°27′E) on March 21 during 1000-1100 h (IST). The collector is placed facing south with a tilt of 22°. Assume ground reflectivity to be 0.2. Comment on the validity of your result.

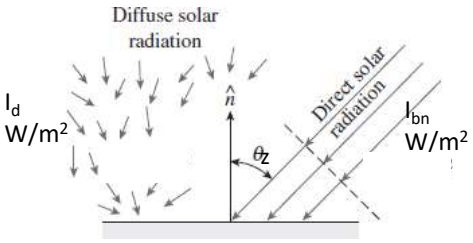
Hourly Global, Beam and Diffuse Radiation Under Cloudless Skies

- $I_g = I_b + I_d$
- $I_g = I_{bn} \cos\theta_z + I_d$

$$I_{bn} = \mathbf{A}\exp\{-\mathbf{B}/\cos\theta_z\}$$

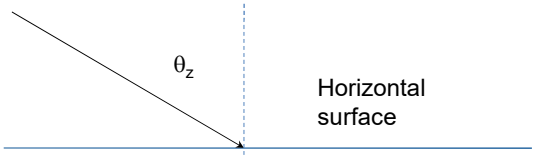
$$I_d = \mathbf{C} I_{bn}$$

$\mathbf{A} = 1136\ \text{W/m}^2$, $\mathbf{B} = 0.165$, $\mathbf{C} = 0.121$ for September

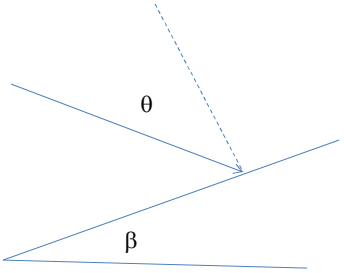


Calculation of incident flux on tilted surface

- Measuring instruments give the value of solar radiation falling on a horizontal surface
- But solar collectors are placed tilted to the horizontal plane
- We use tilt factor for the estimation of flux on tilted surfaces
- Beam radiation tilt factor: The ratio of beam radiation flux falling on a tilted surface to that falling on a horizontal surface



$I_b = I_{bn} \cos\theta_z$



$I_{bT} = I_{bn} \cos\theta$

Beam radiation tilt factor
$r_b = \cos\theta/\cos\theta_z$

Diffuse radiation tilt factor
$r_d = (1+\cos\beta)/2$

Reflected radiation tilt factor, $r_r = \rho(1-\cos\beta)/2$

Flux on tilted surface, $I_T = I_b r_b + I_d r_d + (I_b + I_d) r_r$