Experiment No. (4)

((Estimation of the amounts of solar radiation on)) horizontal surfaces

The purpose of the experiment:

Calculation of the hourly values of direct, diffuse and total solar radiation .on horizontal surfaces

Experience theory:

a. The amount of direct solar radiation falling on a unit of horizontal surfaces can be calculated from the equation:

$$S_b = S_p t^m Sin \quad a.....(1)$$

Wheras :

S_b Hourly value of direct solar radiation $Watt/m^2$

S_p solar constant $1260 watt/m^2 =$

t : air transparency $0.7 =$

m Optical path of radiation $\frac{1}{Sin\alpha} =$

$:\alpha$ Sun elevation angle (degrees)

and to calculate $Sin \ \alpha$ The following equation is used:

$$Sin \quad \alpha = Sin\Phi Sin\delta \div Cos\Phi Cos\delta Cos\omega.....(2)$$

Whereas:

Φ : Latitude of the place in degrees.

: The angle of inclination of the sun in degrees.$\boldsymbol{\delta}$

: The hour angle in degrees.$\boldsymbol{\omega}$

Table (1) shows the values of δ for the days of the year.

b. The diffuse solar radiation falling on horizontal surfaces can be calculated from the equation:

$$S_d = \gamma\left(\beta S_p Sin\ \alpha - S_b\right).....(3)$$

Whereas $0.5 = \gamma$

, $0.91 = \beta$

It represented the absorption of solar radiation by water vapor, carbon dioxide, ozone and the rest of the atmospheric components.

C. The amount of total radiation falling on a unit of horizontal surfaces can be obtained from:

$$S_t = S_b \div S_d .....(4)$$

Required:

1- Calculate ω From the equation:

$$\omega = \pm(12 - T)\frac{360}{24}$$

T : The number of hours before or solar noon and the negative sign of the solar noon time.

2- Find value δ From Table 1 for the desired day.

3- Calculate $Sin\ \alpha$ for all values ω Calculate the value and then ***m***

From the equation:

$$m = \frac{1}{Sin\ \alpha}$$

4- Calculate the values of S_d, S_b of the two equations(1,3) then calculate S_t From equation (4).

5- Arrange your calculations in a table as follows (Baghdad Latitude.

$\Phi = 33.3^{\circ}$)

6- Draw a graph between the values of solar radiation and the hours of the day and then discuss this graph.

Table (1)

Declination for each day of the year

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1	-23.07	-17.28	-7.78	4.36	14.93	22.02	23.20	18.20	8.51	-2.95	-14.26	-21.74
2	-22.99	-17.00	-7.40	4.75	15.24	22.15	23.13	17.94	8.14	-3.33	-14.58	-21.90
3	-22.90	-16.71	-7.02	5.13	15.54	22.29	23.06	17.69	7.78	-3.72	-14.90	-22.05
4	-22.80	-16.41	-6.63	5.51	15.83	22.41	22.98	17.42	7.41	-4.11	-15.22	-22.19
5	-22.70	-16.11	-6.25	5.89	16.12	22.53	22.89	17.16	7.04	-4.50	-15.53	-22.32
6	-22.59	-15.81	-5.86	6.27	16.41	22.64	22.80	16.89	6.67	-4.88	-15.83	-22.45
7	-22.47	-15.50	-5.47	6.65	16.69	22.74	22.70	16.61	6.30	-5.27	-16.13	-22.57
8	-22.34	-15.18	-5.08	7.03	16.96	22.84	22.59	16.33	5.93	-5.65	-16.43	-22.68
9	-22.21	-14.87	-4.69	7.40	17.24	22.93	22.48	16.05	5.55	-6.03	-16.72	-22.79
10	-22.07	-14.54	-4.30	7.77	17.50	23.01	22.36	15.76	5.17	-6.41	-17.01	-22.88
11	-21.92	-14.22	-3.90	8.14	17.77	23.09	22.23	15.46	4.80	-6.79	-17.29	-22.98
12	-21.76	-13.89	-3.51	8.51	18.02	23.16	22.10	15.17	4.42	-7.17	-17.57	-23.06
13	-21.60	-13.55	-3.12	8.87	18.28	23.23	21.96	14.87	4.03	-7.55	-17.84	-23.13
14	-21.43	-13.22	-2.72	9.24	18.52	23.28	21.81	14.56	3.65	-7.92	-18.11	-23.20
15	-21.25	-12.87	-2.33	9.60	18.77	23.33	21.66	14.25	3.27	-8.30	-18.37	-23.26
16	-21.07	-12.53	-1.93	9.95	19.00	23.38	21.50	13.94	2.88	-8.67	-18.62	-23.31
17	-20.88	-12.18	-1.54	10.31	19.23	23.41	21.34	13.62	2.50	-9.04	-18.87	-23.36
18	-20.68	-11.83	-1.14	10.66	19.46	23.44	21.17	13.30	2.11	-9.40	-19.12	-23.39
19	-20.48	-11.47	-0.74	11.01	19.68	23.47	20.99	12.98	1.72	-9.77	-19.36	-23.42
20	-20.27	-11.12	-0.35	11.35	19.90	23.48	20.81	12.66	1.34	-10.13	-19.59	-23.44
21	-20.05	-10.76	0.05	11.70	20.10	23.49	20.63	12.33	0.95	-10.49	-19.82	-23.46
22	-19.83	-10.39	0.44	12.04	20.31	23.49	20.43	11.99	0.56	-10.85	-20.04	-23.46
23	-19.60	-10.03	0.84	12.37	20.51	23.49	20.23	11.66	0.17	-11.21	-20.25	-23.46
24	-19.37	-9.66	1.23	12.71	20.70	23.47	20.03	11.32	-0.22	-11.56	-20.46	-23.45
25	-19.13	-9.29	1.63	13.04	20.88	23.46	19.82	10.98	-0.61	-11.91	-20.67	-23.43
26	-18.88	-8.91	2.02	13.36	21.07	23.43	19.60	10.63	-1.00	-12.25	-20.86	-23.40
27	-18.63	-8.54	2.41	13.68	21.24	23.40	19.38	10.28	-1.39	-12.60	-21.05	-23.37
28	-18.37	-8.16	2.80	14.00	21.41	23.36	19.15	9.93	-1.78	-12.94	-21.23	-23.33
29	-18.11	0.0	3.19	14.32	21.57	23.31	18.92	9.58	-2.17	-13.27	-21.41	-23.28
30	-17.84	0.0	3.58	14.63	21.73	23.26	18.68	9.22	-2.56	-13.61	-21.58	-23.22
31	-17.56	0.0	3.97	0.0	21.87	0.0	18.44	8.87	0.0	-13.94	0.0	-23.16