J. Sci. Soc. Thailand, 10 (1984) 57 - 62

CALCULATIONS OF LONG - WAVE SPECTRAL ATMOSPHERIC EMISSIVITIES FOR BANGKOK, SONGKHLA AND UBON RATCHATHANEE

PIYAWAT BOON - LONG

Department of Mechanical Engineering, Chiang Mai University, Chiang Mai, Thailand

(Received 8 August 1983)

Abstract

Spectral atmospheric emissivity in the wavelength range 5 - 35 μm has been calculated for three cities in Thailand : Bangkok, Songkhla and Ubon Ratchathanee. This is in addition to the work previously published for Chiang Mai (Boonlong, P. (1981) J. Sci.Soc. Thailand *7, 147 - 153). The method used was based on an approximate monochromatic emissivity equation, and published upper - air data for the three cities. Results show that the lowest spectral emissivity in the transparency window (8.5 - 12 μm) occurs in February, ranging from 0.49 at Ubon Ratchathanee to 0.66 at Bangkok. A sample of calculated outward radiation fluxes from four radiators at the three cities is also presented and discussed.*

Results of calculations of long - wave spectral emissivity of the atmosphere of Chiang Mai were presented in a previous paper[1]. Here, spectral atmospheric emissivity calculations for three other cities in Thailand (Bangkok, Songkhla and Ubon Ratchathanee) are added. These four cities were the only weather stations for which published upper air data were available. The spectral atmospheric emissivity obtained is of interest in the calculations of radiative heat loss from a surface at ground level, for example a nocturnal radiator.

The resulting emissivities for the three cities are shown in Tables 1 - 3. The results previously calculated for Chiang Mai are shown in Table 4, for completeness. It can be seen that, even though the *total* hemispherical emissivities of the atmosphere for the four cities are not much different in any given month, the *spectral* hemispherical emissivities differred markedly in the 8.5 - 12.0 μm range. In general, the atmospheric emissivities are lowest at Chiang Mai and Ubon Ratchathanee, and highest at Bangkok and Songkhla, both of which are coastal cities.

Outward radiation fluxes calculated from the atmospheric emissivities are shown in Fig. 1 and 2. In these two figures, only radiation fluxes in the two extreme months - January and July - for the four cities are shown as samples. A maximum flux of approximately 50 Wm^{-2} was found at Chiang Mai in January, while the lowest flux was about 20 Wm^{-2} at Bangkok and Songkhla. This was from an ideal radiator at ambient temperature. As the radiator temperature drops, radiation flux from the surface would decrease. The rate of decrease would vary with type of radiator, but the ideal radiator

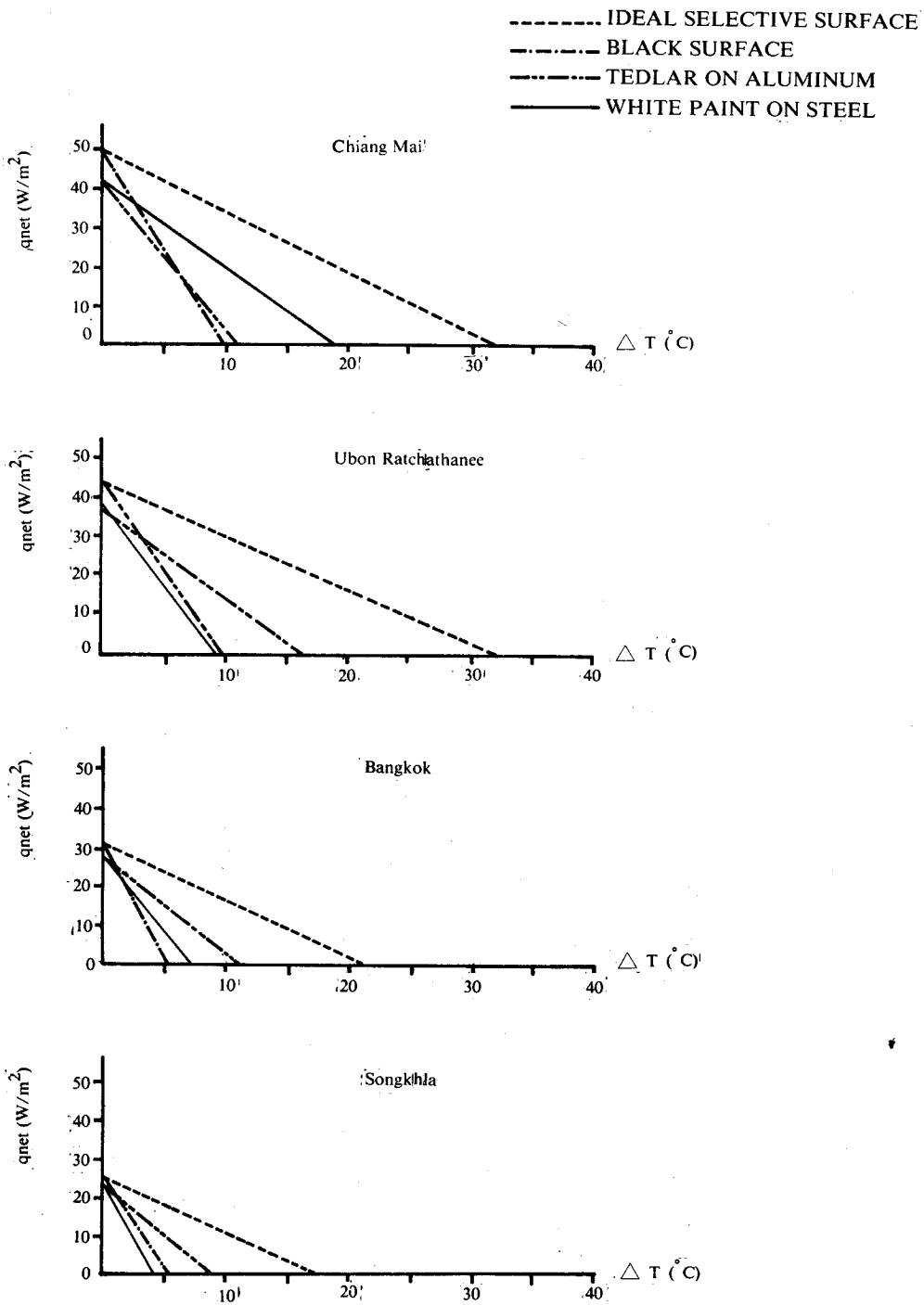

Fig. 1 Radiative Cooling Rates in January as a Function of Temperature Difference between Ambient and Radiator.

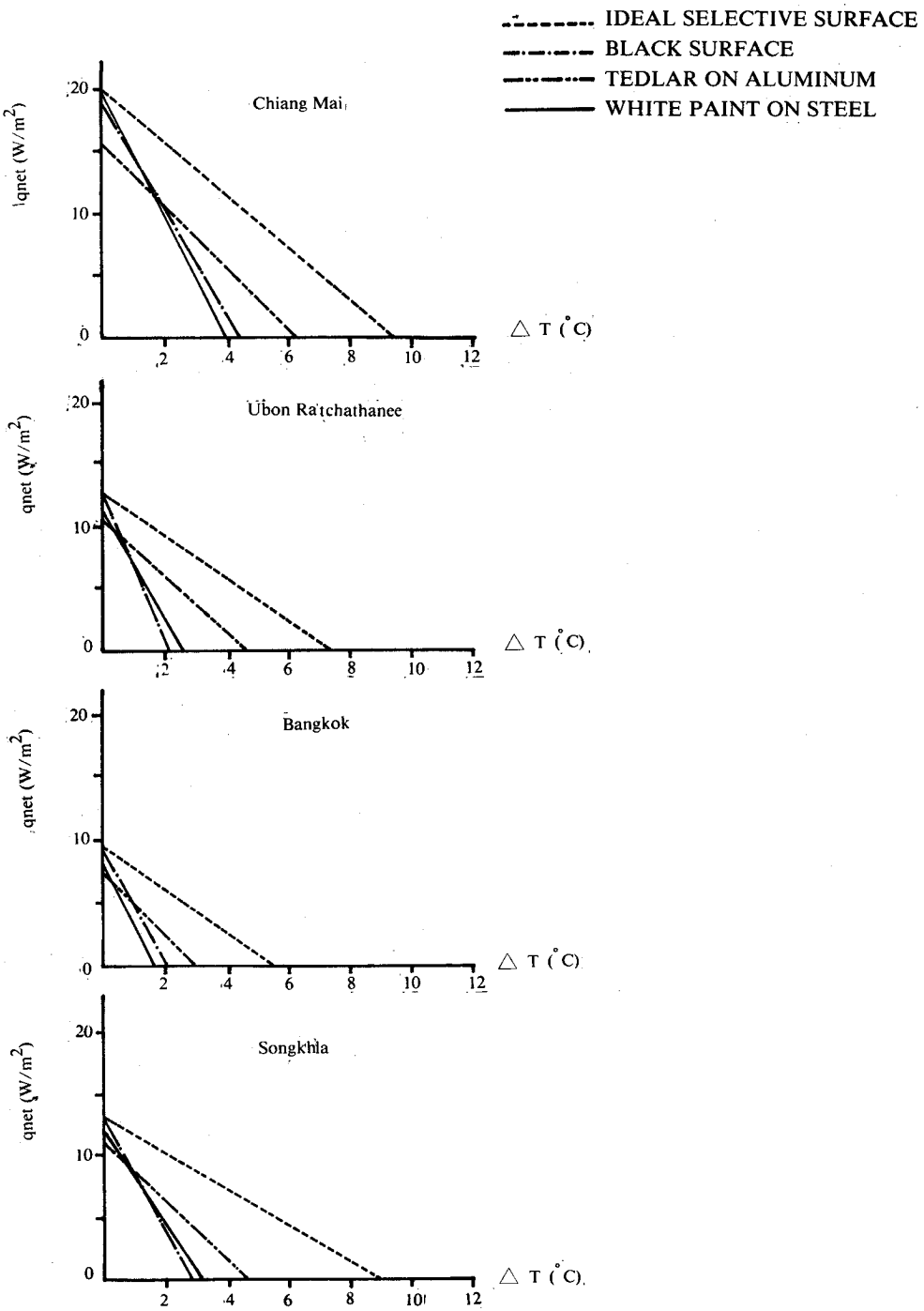

Fig. 2 Radiative Cooling Rates in July as a Function of Temperature Difference between Ambient and Radiator.

would always show the highest net outward radiation. It should also be noted that these curves are based on the assumption of zero conductive heat gain into the radiator; with heat conduction into the surface, the equilibrium radiator temperature would be higher.

It must be emphasized that the calculations presented here were based on monthly - averaged meteorological data taken at 7 a.m., and an assumption of clear skies only. Therefore, the results are strictly valid under those conditions. The presence of clouds, especially during the rainy season, would be an important factor which would singnificantly increase atmospheric emissivity, and therefore lower the outward radiation fluxes that could be obtained. A more realistic estimate would have to take these could effects into consideration.

TABLE 1

CALCULATED SPECTRAL ATMOSPHERIC EMISSIVITY FOR BANGKOK.

Month	Monthly - Averaged Temperature (C)	Spectral Hemispherical Emissivity 8.5-12.0 μm	Total Hemispherical Emissivity
January	21.9	0.68	0.92
February	22.8	0.66	0.92
March	25.5	0.74	0.93
April	25.6	0.84	0.96
May	26.0	0.91	0.97
June	25.9	0.91	0.98
July	25.8	0.91	0.97
August	25.3	0.92	0.98
September	25.3	0.90	0.97
October	24.7	0.87	0.97
November	22.9	0.74	0.94
December	22.6	0.76	0.94

Note Spectral emissivity at wavelengths 5 - 8.5 μm and 12 - 35 μm is unity.

TABLE 2

CALCULATED SPECTRAL ATMOSPHERIC EMISSIVITY FOR UBON RATCHATHANEE.

Month	Monthly - Averaged Temperature (C)	Spectral Hemispherical Emissivity 8.5-12.0 μm	Total Hemispherical Emissivity
January	19.1	0.54	0.89
February	21.2	0.49	0.88
March	24.7	0.61	0.90
April	24.7	0.68	0.92
May	26.0	0.75	0.94
June	25.2	0.88	0.97
July	25.2	0.83	0.96
August	25.0	0.88	0.97
September	25.1	0.83	0.95
October	23.4	0.74	0.93
November	20.5	0.61	0.91
December	20.4	0.59	0.90

Note Spectral emissivity at wavelengths 5 - 8.5 μm and 12 - 35 μm is unity.

TABLE 3

CALCULATED SPECTRAL ATMOSPHERIC EMISSIVITY FOR SONGKHLA.

Month	Monthly - Averaged Temperature (C)	Spectral Hemispherical Emissivity 8.5-12.0 μm	Total Hemispherical Emissivity
January	24.8	0.75	0.94
February	23.9	0.63	0.91
March	24.1	0.70	0.93
April	25.3	0.83	0.95
May	24.9	0.89	0.97
June	24.9	0.87	0.97
July	24.0	0.83	0.95
August	24.2	0.85	0.96
September	23.9	0.84	0.96
October	24.2	0.88	0.97
November	24.2	0.89	0.97
December	24.7	0.77	0.94

Note Spectral emissivity at wavelengths 5 - 8.5 μm and 12 - 35 μm is unity.

TABLE 4

CALCULATED SPECTRAL ATMOSPHERIC EMISSIVITY FOR CHIANG MAI.

Month	Monthly - Averaged Temperature (C)	Spectral Hemispherical Emissivity 8.5-12.0 μm	Total Hemispherical Emissivity
January	14.1	0.42	0.87
February	14.4	0.42	0.86
March	17.9	0.43	0.87
April	21.7	0.61	0.91
May	23.6	0.75	0.94
June	24.4	0.81	0.95
July	23.9	0.81	0.95
August	23.7	0.78	0.94
September	23.4	0.75	0.94
October	22.1	0.70	0.93
November	19.7	0.60	0.90
December	17.7	0.49	0.88

Note Spectral emissivity wavelengths 5 - 8.5 μm and 12 - 35 μm is unity.

Reference

1. Boon - long, P. (1981) Calculations of Long - Wave Spectral Atmospheric Emissivities and Potential of Selective Radiation Cooling for Chiang Mai, Thailand. *J. Sci. Soc. Thailand* 7, 147 - 153.

บทคัดย่อ

บทความนี้ เสนอผลของการคำนวณหา spectral emissivity ในช่วงคลื่นยาวของบรรยากาศในบริเวณกรุงเทพมหานคร อุบลราชธานี สงขลา และเชียงใหม่ โดยอาศัยข้อมูลการตรวจอากาศชั้นบนของกรมอุตุนิยมวิทยา เมื่อปี 1970 ผลการคำนวณพบว่า spectral emissivity ในช่วง 8.5 - 12 μm มีค่าต่ำสุดในเดือนกุมภาพันธ์ โดยมีค่าตั้งแต่ 0.39 ที่เมืองอุบลราชธานี ถึง 0.66 ที่กรุงเทพมหานคร ได้แสดงตัวอย่างของผลการคำนวณอัตราการแผ่รังสีสุทธิจากผิวแผ่รังสีชนิดต่าง ๆ ไว้ด้วย