Solacoat vs Colorbond Heat Reflectivity

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Background

COOLshield International Pty Ltd produces a heat reflective coating called "Solacoat" for roofs and walls. The company wishes:

i. To evaluate the optical properties (reflectance and emittance) of the "Solacoat" paint
ii. To estimate the relative energy gain of the "Solacoat" though the roofs in buildings

This reports contains several stages of measurements and testing of the "Solacoat" paint as well as simulation.

1. Introduction

Paints with various colours have been used in roofs and walls of buildings aiming to improve the energy efficiency of the buildings. The energy performance of the buildings is influenced by the combined effect of the solar reflectance and thermal emittance. The paints play an important role in effect of back scattering of incident light and at the same time possessing high thermal emittance and provide a lower energy transmitted through the roof structure.

COOLshield International Pty Ltd produces a waterborne acrylic emulsion "Solacoat" white paint. In this project optical and thermal measurements of "Solacoat" paint on metal substrates have been analysed. This involved measurement of the spectral hemispherical reflectance, and infrared thermal emittance and subsequent calculation of the emittance and solar reflectance. The measurements provide the key solar performance characteristics to evaluate energy gain through the roofs.

2. Experiment

Stage I: Optical and Thermal Measurements

The ***"Solacoat" white*** paint was coated on 1) steel substrate and 2) colour bond (of green colour) which gives a ***"cream"*** appearance. Samples of all the paints were cut into 4 x 5 cm for reflectance and emittance measurements. The samples are rough and scattering and require integrating sphere for the optical measurements. The total reflectance of each sample was measured using spectrophotometer with integrating sphere in the solar wavelength range between 300 and 2000 nm. Aluminium mirror was used as a reference. Diffuse reflectance was measured using diffuse spectrophotometer in the 300-900 nm wavelength range using barium sulphate to understand how the light is reflected from the surface of the coating as diffuse or collimated.

Hemispherical thermal emittance of the samples was also measured using Windbourn Emissometer. During the emittance measurements a black hole was taken as a reference

(100% emitter) and polished copper plate as zero emitter. The emittance of copper (0.004) has been considered during the emittance calculation.

From all the measurements integrated luminous, total and diffuse reflectance as well as hemispherical emittance of each paint have been determined.

Stage II: Simulations

Using the results from the optical measurements, a calculation for a "roof structure" consisting of the external material (painted, and unpainted), an air gap and a ceiling material, the U-Value and the relative heat gain through the roof structure have been determined.

3. Results

Total reflectance of the paint coatings in the solar spectrum is shown in Figure 1. The coatings vary in their reflectance value. A high reflectance is observed from the ***"cream"*** and ***"white"*** colour paints. Their reflectance drop sharply at about 400 nm. The reflectance of the white paint tends to decrease with increasing the wavelength of light. The colorbond paint (green) has the lowest reflectance. For comparison the reflectance of the steel-substrate is shown.

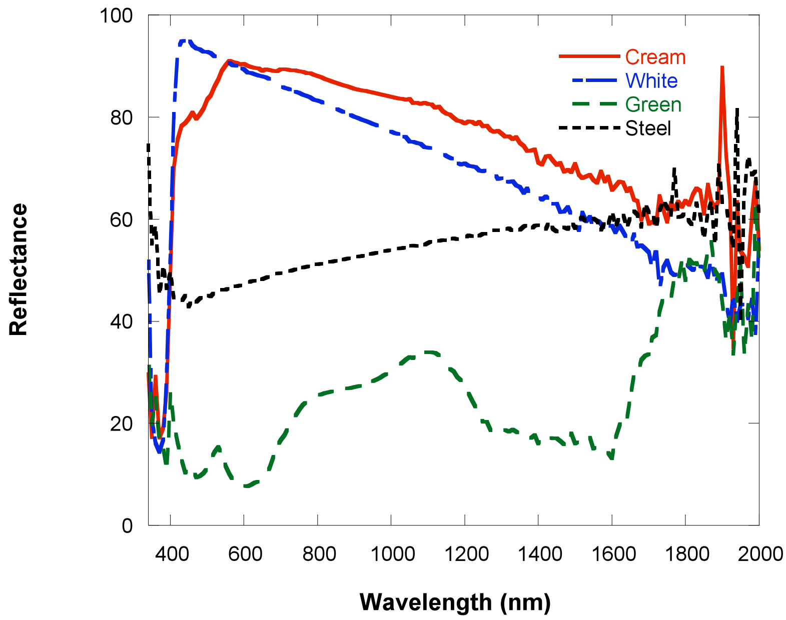

Figure 1 Total reflectance spectra of three paint coatings versus wavelength measured in solar wavelength range

Figure 2 shows diffuse reflectance of all the paints in the wavelength range 300-900 nm. The samples are rough and scattering and thus the reflectance of the paints is mainly diffuse. Thus the diffuse reflectance spectra are found to be similar to the total reflectance shown above (figure 1). The measured diffuse reflectance of the colorbond is relatively higher than the measured total reflectance.

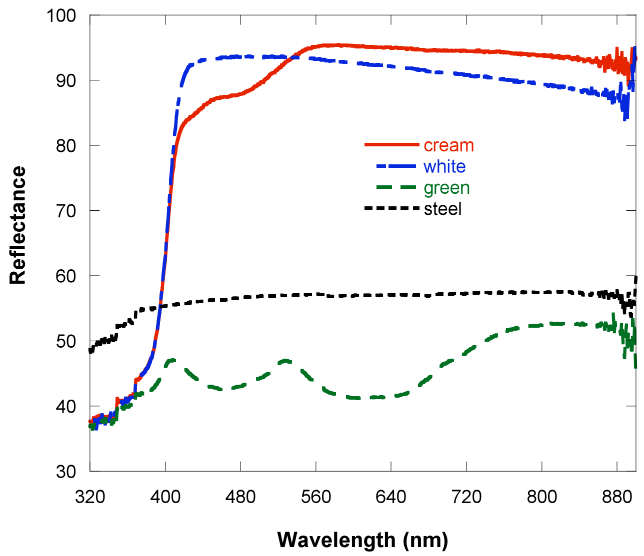

Figure 2 Diffuse reflectance spectra of three paint coatings versus wavelength measured between 300 to 900 nm.

Solar, luminous and diffuse reflectance of the coatings were determined by weighting the reflectance of the paint coatings in the visible wavelength range to the intensity of the corresponding visible spectrum for air mass 1.5. Figure 3 shows solar, luminous and diffuse reflectance of the paint coatings. The ***white/cream*** paint has solar reflectance values approaching 90% whereas the colorbond coating has only solar reflectance of about 20%. The solar reflectance of the steel-substrate is measured to be about 51%.

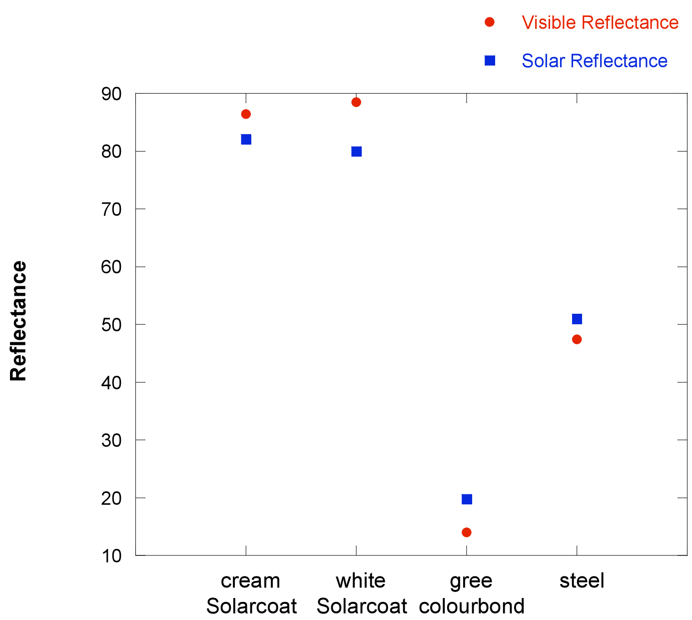

Figure 3 Integrated luminous and total reflectance of white, cream and colorbond paints. The reflectance of each paint is integrated over the visible and solar spectra using AM 1.5.

The thermal emittance of the coatings is shown in Figure 4. The emittance of all the paints ranges only between 88% to 93% whereas the substrate has an emittance of only 16%. The ***cream*** coating has relatively better emittance value compared to the other coatings. It can be seen from table 1 that almost 62% of reflectance variation can be seen between the ***white/cream*** coating and the colorbond coating whereas only a 5% variation in emittance between these paint coatings.

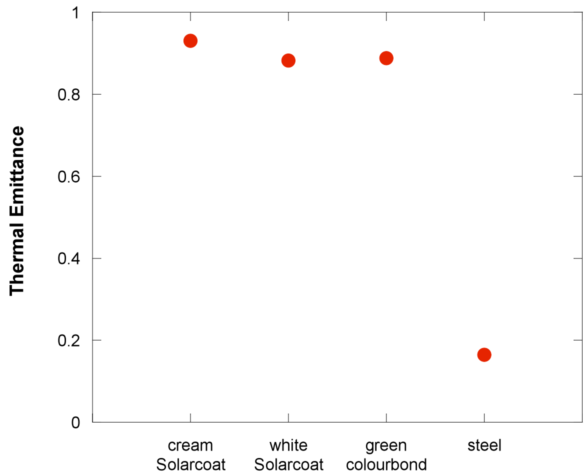

Figure 4 Thermal Emittance of Three paint coatings measured at about 100C. The emittance of steel is also shown.

Using the results from the optical measurements the relative heat gain through the roof structure and U-value have been determined using the window simulation program from Lawrence Berkeley National Laboratory. From the calculation it can be observed that lower relative heat giant has been achieved by painting the metal roof with ***cream/white*** coating. From the calculation, a ***cream/white*** painted steel is found to have lower relative energy gain (22 W/m^2) than two uncoated steel plates with 75 mm insulation (28 W/m^2).

Table 1 Luminous and solar reflectance; emittance and relative heat gain of various paint coatings.

Type of Paint	**Luminous Reflectance (%)**	**Solar Reflectance (%)**	**Diffuse Reflectance (%)**	**Emittance (%)**	**Relative heat gain* W/m^2**	**U $W/m^2/K$**
Cream	86.4	82.1	87.5	93.1	21.9	1.4
White	88.5	80.0	86.9	88.2	23.4	1.4
Colorbond (Green)	14.0	19.8	42.9	88.8	65.7	1.4
Steel	47.4	51.0	54.0	16.4	52.6	1.4
Steel**	47.4	51.0	54.0	16.4	28.3	0.885

* Cream painted steel, 75 mm air gap, steel

** Steel-steel with 75mm Insulation

4. Summary

The solar and luminous reflectance and thermal emittance of “Solacoat” paint prepared by COOLshield International Pty Ltd have been evaluated. The reflectance of the “Solacoat” is considerably higher (about 90%) and rejects most of the incoming solar radiation whereas the colorbond paint coating has only a reflectance value of 20% (absorbing most of the solar radiation). The thermal emittance of both the “Solacoat” and colorbond coatings remain almost similar, ranging between 88% to 93 %. From simulation the relative heat gain of the “Solacoat” cream***/white*** painted steel is found to have lower relative energy gain than the colorbond or uncoated steel roof. A roof material consisting of solarcoat painted steel with a 75 mm air gap and another steel sheet is more efficient at rejecting heat under summary conditions than a roof material consisting of uncoated two steel sheets with 75 mm of glass wool insulation or colorbond painted on of the steel sheets.