European Conference on Smart & Functional Coatings

September 2013, Torino, Italy

NEW FORMULATION OF PAINT AIMED TO IMPROVE REFLECTION OF INFRARED RADIATION FOR ENERGY EFFICIENCY OF BUILDING

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Abstract

The growing demand for energy consumption reduction presents opportunities, in building field, and provides the impetus for innovation such as the use of solar-reflective coatings to reflect a significant amount of solar radiation from colored surfaces in order to keep these surfaces cooler. This paper will present the improvement of IR-reflecting properties of paints formulated by using reflective pigments and additives.

Introduction

The sun energy reaches Earth as UV, visible and infrared radiation. The last one is largely responsible for heat build-up. When the sun electromagnetic radiation strikes a surface, it is partially absorbed and transferred into heat causing a temperature rise in the surface [1]. In order to reduce the temperature of the exterior surface of buildings, and then the amount of heat transferred into indoor space, solar reflective coatings were investigated [2].
The aim of the present work is to show the improvement of IR-reflecting properties of paints formulated by using reflective pigments and fillers. Currently, both organic and inorganic IR-reflective additives are available [3]. The differences in the optical and thermal performance among them, as well as their compatibility with the others raw materials, in the formulations, were analyzed.

Experimental

White and coloured paints, using standard and IR-reflective pigments, were formulated and compared.
UV-VIS-NIR spectroscopy properties were examined by Lambda 9 PerkinElmer spectrometer equipped with integrating sphere. The total solar reflectance (TRS) was calculated by using the ASTM method E903-96 and by using the reference tables, for solar irradiance, from ASTM G173-03.
An additional original test was developed to evaluate the effect of reflective paints on indoor temperature of buildings. Aluminum painted panels were exposed to infrared quartz twin tube short wave emitter at the distance of 10 cm for 1 h; a thermocouple was attached to the back side of the aluminum panel and the temperature versus time was plotted.
In addition, thermographic images were recorded by using an infrared camera.

Results and Discussion

Absorption of radiation causes heat build-up, whether the radiation is visible or NIR; so that the evaluation of solar reflectance of pigmented films requires knowledge about its reflectance over the entire solar spectral range. In Figure 1, an example of different reflectances caused by different pigments is reported. In particular, a white paint (White, grey curve), a black paint with standard black pigment (Std Black, blue curve), and a black paint with solar-reflective pigment (IR Black, black curve), are shown.

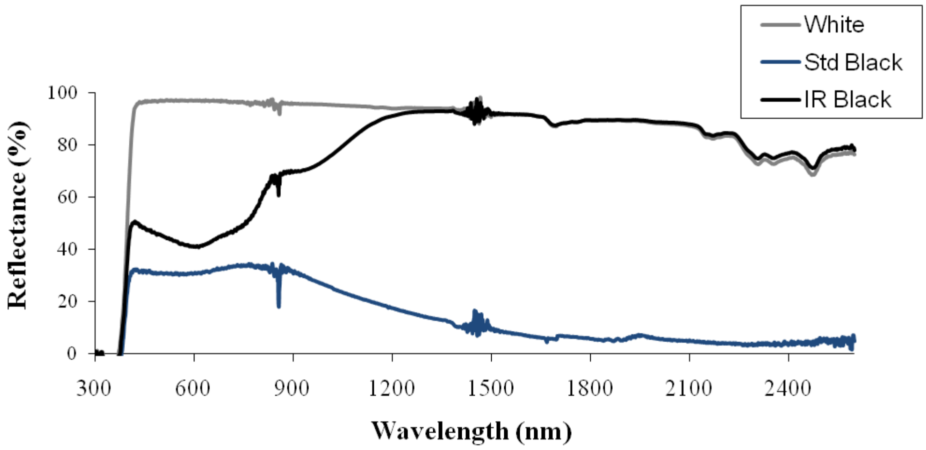

Figure 1. Spectral reflectance of three kinds of paint: White, Standard Black and IR-reflective Black.

A considerably high reflectance of the solar irradiance is achieved in the case of IR Black pigment. Indeed, the black IR-reflective paint shows behaviour close to the traditional black in the visible range, due to the dark colour of the paint, while, by increasing the wavelength, behaviour close to the traditional white paint is obtained.

In order to correlate the TRS variation with the variation of surface temperature, thermal tests were carried out. The coating containing NIR reflective pigment has a much lower surface temperature, *i.e.* -13°C, in comparison to the similar coating containing traditional black pigment exposed to the same conditions. The advantage of reduced heat build-up can be correlated with decreased energy consumption.

Conclusions

IR-reflective pigments and fillers, provide the improvement of solar reflectance properties compared to ordinary paint and coatings. The use of solar heat reflective paints is an inexpensive solution that can contribute to the reduction of cooling loads in air-conditioned buildings. Indeed, thermographic measurements, in simulating summer time conditions, show the decrease of the painted surface temperatures, leading to the improvement of indoor comfort.

References

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