Energy Savings by Using Insulating MicrosphereS Ceramic paint

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ABSTRACT

This thesis aimed to test the performance of the heat reflected in the small building which is coated by the insulated paint that has the Microspheres ceramic atom as a main composition and compare with the performance without the paint coating of the small building as well as compare the solar reflectance and heat emission of the gypsum board coated with heat insulated paint which has ceramic atom as a main composition and conventional paint. The performance of the heat reflected in the small building which is coated by the Insulating Microspheres Ceramic Paint is tested in the building which is simulated from general building pattern, constructed with gypsum boards, and installed a 1 Ton size (12000 BTU) air conditioner inside. The surface temperatures are recorded from different 11 points of small building, including both inside and outside of the middle point of the walls and the roof (10 points) and the center point of the room inside the building, for different temperature measurement in each position. The K type thermocouple is installed for surface temperature detection on each wall and roof and, then, the temperature data is recorded by DATA LOGGER. In addition, the electric energy loss per day (kWh/day) in air conditioner is recorded to compare the energy saving value of the air conditioner under 2 conditions. Total test period of both conditions is 14 days on February. Each day takes 10 hours for testing (07.00 am – 05.00 pm). The solar reflectance and heat emission measurement found that the gypsum board coated with heat Insulating Microspheres Ceramic Paint can provides the maximum of solar reflectance and heat emission, 94.7% and 0.89 respectively. When compare with another board, the solar reflectance of the heat Insulating Microspheres Ceramic Paint coating gypsum board are 7.4% and 55.2% more than the gypsum board coated with conventional paint and the uncoated respectively. Likewise, the heat emission of the heat Insulating Microspheres Ceramic Paint coating gypsum board are 0.06 and 0.04 more than the gypsum board coated with conventional paint and the uncoated respectively. The heat performance measurement of small building coated with heat Insulating Microspheres Ceramic Paint with ceramic particles as main ingredient found that the average room and ceiling temperatures, both inside and outside, of the coated building are lower than the uncoated building. These caused by the coated building can reflect almost 100% of sunlight energy, when it incidents into the building, as well emit the heat. The coated building can save the electric energy at 28.3% of the uncoated building electric energy consumption. Therefore, building coating with this paint is one of the methods to save the energy consumption of air condition system because it can reduce the heat energy transferred through the building and the load of air conditioner.

Keywords: *Microspheres Ceramic, Data Logger, Insulate Paint, Solar Reflectance, Thermal Performance*

1. INTRODUCTION

Energy is a very important key factor for the movement of the economic and the nation development. Nowadays, the energy consumption is extremely increasing in Thailand. Its share in the total energy use is at the 3rd rank after the transport and industrial sectors. The residential energy consumption has been increasing continuously and energy efficiency concern because increased air temperatures raise air-conditioning loads in buildings, for cooling and greater personal comfort, in turn raising energy consumption, peak energy demand and energy prices. However, the energy are unnecessarily used and used ineffectively. These cause higher energy production cost with no decreasing trend. Therefore, the government has stipulated many regulations and policies for the most effective energy consumption, also avoided unnecessary consumption of electricity and fuel, set up campaigns for effective use as well as energy saving, etc. There are many methods to save the energy. One of the methods which play the important role is to save the energy from residential consumption. In general, the energy loss in residential houses will be expensed for lighting and air conditioning. Especially from air conditioning, the lost will be over 50% of total electricity consumption of the building [1]. Thus, one possible economic solution to reduce the cost of energy is the reduction of energy consumption of air condition system of the building by minimizing the loss. The loss of energy in air condition system will be varied which depends on the heat load in that room at that moment. One important heat load that has much influence is the heat load which radiated from the sunlight and convected via the roof and the walls. Therefore, if the heat load which convected to the building is reduced, the energy consumption of the air condition will be reduced. One of the popular methods is to use the insulators coating materials which has low heat absorption coefficient and reflect the sun or infrared radiate. The tested material and tested building coated with low heat absorption insulators can reflect 72% of the sunlight and can save energy at 125 kWh per year (8.4 kWh/m^2) [2]. In addition, After the comparison of the building coating with insulators and the evaporative cooling method, it was found that the building coating can save a little less energy than the evaporative cooling method but it has much less investment cost [3,4]. Another method is to use the material which has hollow micro spheres to coat the tested building which can reflect the radiation from sunlight and reduce the heat load in the building [5,6,7].

With this reason, if we applied the low heat absorption, radiation reflection, hollow micro spheres and insulated materials as major paint composition, it was expected that the distribution of heat and heat radiated into the building will be reduced, thus, prevent the energy loss of air condition system in the building. From the research, it was found that ceramics atom has those mentioned properties. This thesis aimed to test the performance of the heat reflected in the small building which is coated by the insulated paint that has the ceramic atom as a main composition and compare with the performance without the paint coating of the small building as well as compare the properties of heat reflection of insulated paint which has ceramic atom as a main composition and conventional paint.

2. METHODOLOGY

This chapter will describe the principles and the methods used in the thesis. The procedures for this research will be divided into 2 parts are the solar reflectance testing of the heat insulating microspheres ceramic paint which has ceramic particles as main composition and the heat performance testing of small building coated with the heat insulating microspheres ceramic paint. These procedures are as follows:

2.1 The Solar Reflectance testing of the Heat Insulated Paint which has Ceramic Particles as Main Composition

Institute for Scientific and Technological Research and Services, King's Mongkut's University of Technology Thonburi measured the solar reflectance and heat emission comparison between the uncoated gypsum board (no paint) and heat insulated paint gypsum board and conventional paint coated gypsum board with the Shimadzu UV-3100 (UV-VIS-NIR Recording Spectrophotometer) follow as the solar reflectance according to JIS R 3106 standard method and the AE emissometer, respectively.

2.2 The Heat Performance testing of Small Building Coated with the Heat Insulated which has Ceramic Particles as Main Composition

This experiment is heat performance measurement for 2 small building with 4 m x 4 m x 2 m dimensions. Each building was simulated from general building pattern, constructed with gypsum boards, and installed a 1 Ton size (12000 BTU) air conditioner as shows in figure 1. This experiment was tested by comparison the heat performance of uncoated walls (no painted) with heat insulated paint coated walls (heat insulating microspheres ceramic paint). The surface temperatures were recorded from differential 11 points of small building, including both inside and outside of the middle point of the whole walls (10 points, to calculate the difference between in side and outside) and the center point of the room inside the building (1 point). Figure 2 is the K type thermocouple installed for surface temperature detection on each wall. These temperature data were recorded by DATA LOGGER as shows in figure 3. In addition, the electric energy loss per day (kWh/day) of the air conditioners was recorded to compare the energy saving value of the air conditioners under this 2 conditions. Total test period of both conditions is 14 days on February. Each day takes 10 hours for testing (07.00 am - 05.00 pm). This test has scope to compare the different heat transfer into the building at the same pattern, the same size, and the same construction materials, this test was simulated for consideration the heat results that transfer through the gypsum only. Because of the limited of building construction for study the heat transfer via bricks or cement like actual building requires a lot of budget.

Fig. 1 Small building for the heat performance testing.

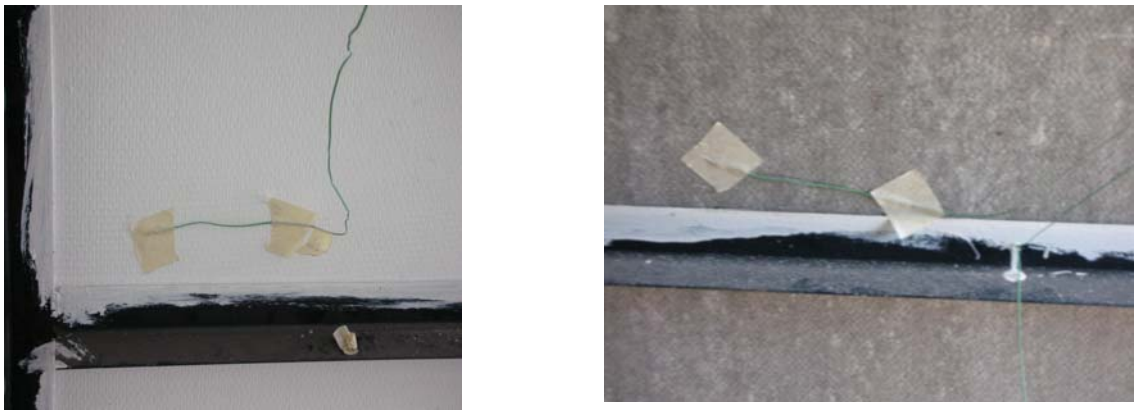

Fig. 2 K type thermocouple installation for the wall surface temperature measurement.

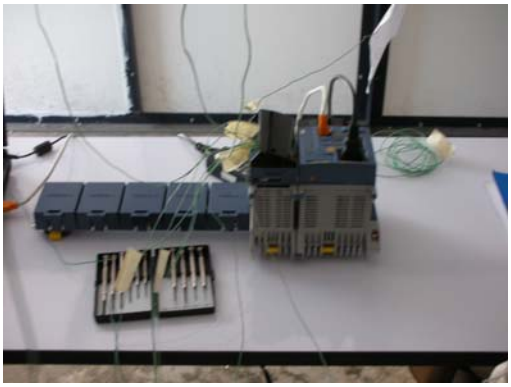

Fig. 3 DATA LOGGER for temperature data record.

2.2.1 Energy saving performance indicator in small building

Saving energy performance indicator in small building analysis under 3 conditions; no paint, paint with conventional paint, and paint with Beger cool, can consider from kilowatts-hour value from air conditioner cooling system consumption. Both of all conditions can be obtained from electric meter that installed on the building. Saving energy is defined as

$$E_{begercool} - E_{No-coating}$$

or measured in the percentage as

$$\frac{E_{begercool} - E_{No-coating}}{E_{No-coating}} \times 100$$

Where $E_{No-coating}$ is electric energy obtained from electric meter of no paint building, kw-h, and

$E_{begercool}$ is electric energy obtained from electric meter of Berger cool coating building.

3. RESULT AND DISCUSSION

The results in this chapter will be divided into 2 parts; the solar reflectance measurement of the heat insulated paint with ceramic particles as main ingredient (heat insulating micro spheres ceramic paint) part, and the heat performance measurement of small building coated with heat insulated paint with ceramic particles as main ingredient part. These results are as follows:

3.1 The Solar Reflectance and Heat Emission Measurement of the Heat Insulated Paint with Ceramic Particles as Main Ingredient

The solar reflectance and heat emission measurement of heat insulated paint coating and uncoated gypsum boards found that the gypsum board coated with heat insulated paint can provides the maximum of solar reflectance and heat emission, 94.7% and 0.89 respectively, as shows in table 1. When compare with another board, the solar reflectance of the heat insulated paint coating gypsum board are 7.4% and 55.2% more than the gypsum board coated with conventional paint and the uncoated respectively. Likewise, the heat emission of the heat insulated paint coating gypsum board are 0.06 and 0.04 more than the gypsum board coated with conventional paint and the uncoated respectively. These results show the heat insulated paint can reflect almost 100% of sunlight energy, when it incidents into the gypsum board, as well emit the heat. Therefore, building coating with this paint is one of the methods to save the energy consumption of air condition system because it can reduce the heat energy transferred through the building and the load of air conditioner.

Table 1 The solar reflectance and heat emission comparison between paint and no paint gypsum boards

Sample	Solar Reflectance (%)	Emission
Insulating microspheres ceramic paint	94.7	0.89
Conventional Paint	87.3	0.83
No Painted Sample	39.5	0.85

3.2 The Heat Performance Measurement of Small Building Coated with Heat Insulated Paint with Ceramic Particles as Main Ingredient

Total period test of the heat performance measurement of small building coated with heat insulated paint with ceramic particles as main ingredient is 14 days, divided into 10 sunny days and 4 cloudy days, as follows:

3.2.1 Sunny Days

The room temperature comparison of building which the heat insulated paint coating and uncoated, as shows in figure 5, found that the room temperature of the coated building is less than another. The average temperature (all over 10 days) of the coated building is 26.1 ^{o}C, while the uncoated building temperature is 27.1 ^{o}C.

Figure 6 is the ceiling surface temperatures comparison of building which the heat insulated paint coating and uncoated. The ceiling temperatures, both inside and outside, of the coated building are less than another for all over testing. The average inside ceiling temperature (all over 10 days) of the coated building is 34.1 ^{o}C and the outside ceiling temperature is 36.9 ^{o}C, while the average inside and outside ceiling temperature of the uncoated building are 41.6 ^{o}C and 44.0 ^{o}C.

The coated building can reflect almost 100% of sunlight energy, when it incidents into the building, as well emit the heat. With these reasons, the average room and ceiling surface temperatures of the coated building is less than the uncoated.

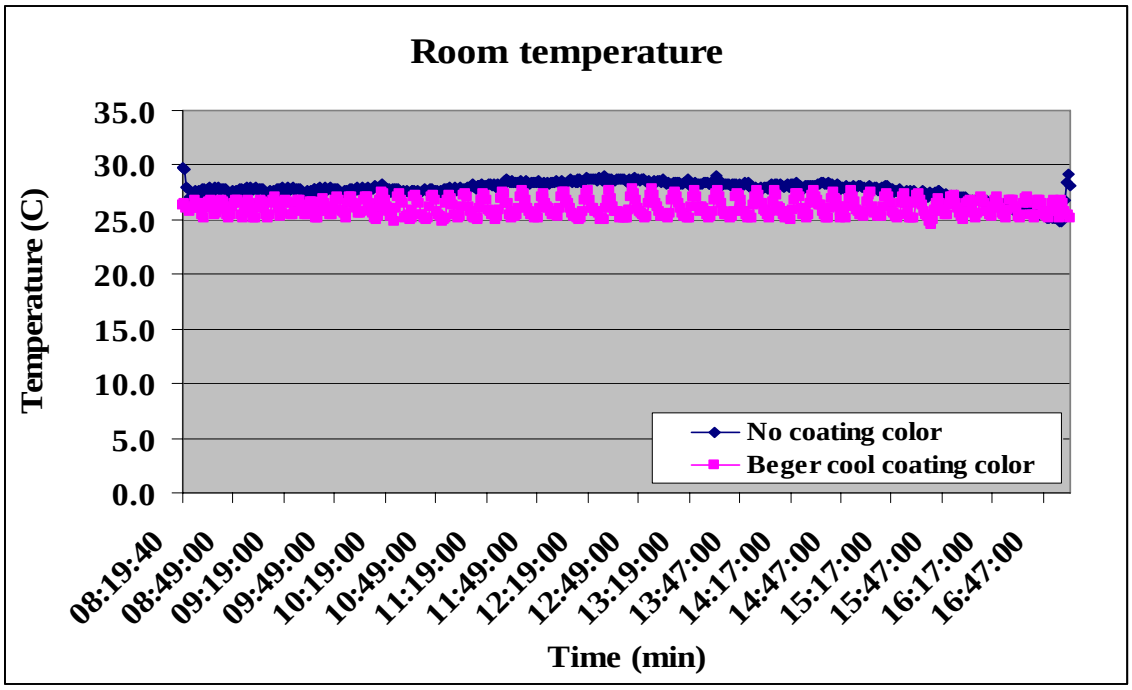

Fig. 5 The room temperature comparison to the building which the heat insulated paint coating and uncoated at 33 ^{o}C environment temperature.

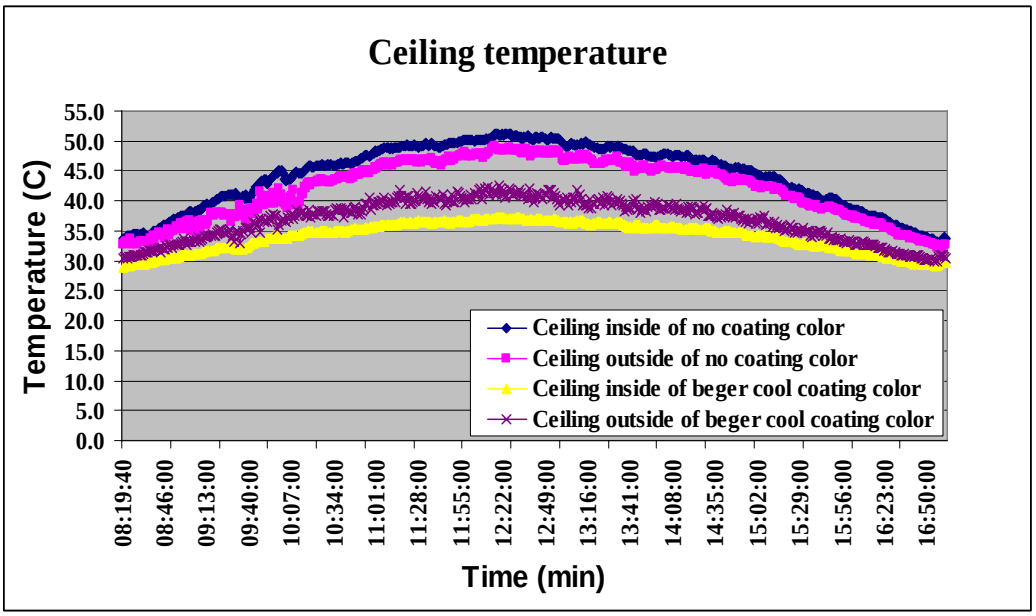

Fig. 6 The comparison of the ceiling surface temperature of building which the heat insulated paint coating and uncoated at 33 ^{o}C environment temperature.

The electric energy consumptions, both before and after testing, of building which the heat insulated paint coating are compared with the uncoated building, as shows in table 2. The heat insulated paint coating building uses the electric energy less than the uncoated building obviously. The coated building can save the electric energy at 28.3% of the uncoated building consumption.

Table 2 The electric energy consumption comparison of building which the heat insulated paint coating and the uncoated building

	Before testing (kw.h)	After testing (kw.h)	Difference (kw.h)
No paint building	90.4	99.6	9.2
Building coated with the heat insulated paint	56.2	62.8	6.6

3.2.1 Cloudy Days

The room temperature comparison, as shows in Fig. 7, of building which the heat insulated paint coating and uncoated found that the room temperature of the coated building is less than another. The average temperature (all over 4 days) of the coated building is 25.5 ^{o}C, while the uncoated building temperature is 27.4 ^{o}C.

Fig. 8 is the ceiling surface temperatures comparison of building which the heat insulated paint coating and uncoated. The ceiling temperatures, both inside and outside, of the coated building are less than another for all over testing. The average inside ceiling temperature (all over 4 days) of the coated building is 34.1 ^{o}C and the outside ceiling temperature is 38.6 ^{o}C, while the average inside and outside ceiling temperature of the uncoated building are 42.5 ^{o}C and 43.9 ^{o}C. The testing is tested on the cloudy days. This result in, sometimes, the average surface ceiling temperatures, both inside and outside the building, are not stable and lower than measured on sunny days. The reasons that the average room and surface ceiling temperatures of the building which the heat insulated coating are less than another are described in 3.2.1 section above.

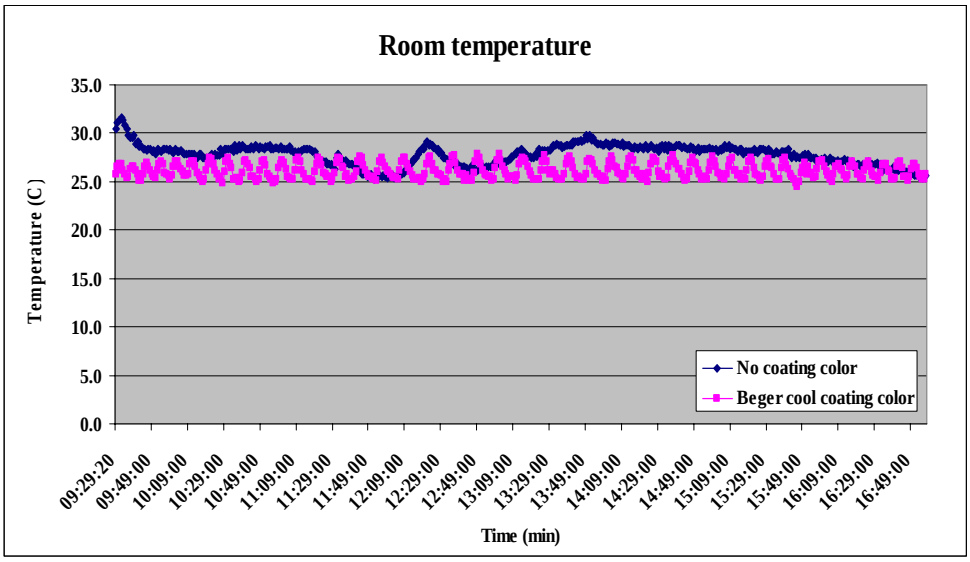

Fig. 7 The room temperature comparison of the building which the heat insulated paint coating and uncoated at 33 ^{o}C environment temperature.

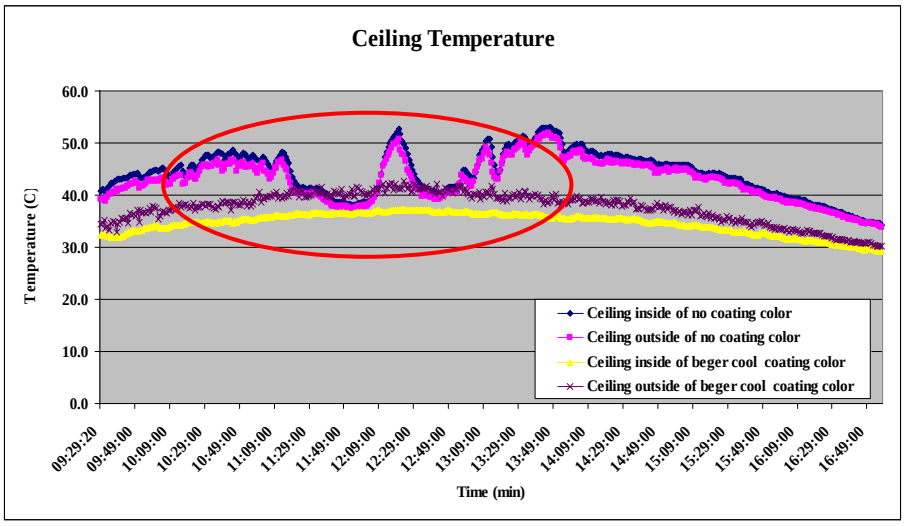

Fig. 8 The comparison of the ceiling surface temperature of building which the heat insulated paint coating and uncoated at 33 ^{o}C environment temperature.

The electric energy consumptions, both before and after testing, of building which the heat insulated paint coating are compared with the uncoated building, as shows in table 3. The heat insulated paint coating building uses the electric energy less than the uncoated building obviously. The coated building can save the electric energy at 26.0% of the uncoated building consumption.

Table 3 The electric energy consumption comparison of building which the heat insulated paint coating and the uncoated building

	Before testing (kw.h)	After testing (kw.h)	Difference (kw.h)
No paint building	100.6	108.3	7.7
Building coated with the heat insulated paint	64.1	69.8	5.77

4. CONCLUSION

Because of the energy consumption is extremely increasing in Thailand and the energy are unnecessarily used and used ineffectively, therefore, the government has stipulated many regulations and policies for the most effective energy consumption, also avoided unnecessary consumption of electricity and fuel, set up campaigns for effective use as well as energy saving, etc. There are many methods to save the energy. One of the popular methods is to use the heat insulated paint with ceramic particles as main ingredient coat the building. This paint can reduce the heat energy transferred through the building results in the load of air conditioner reduction because the building can reflect almost 100% of sunlight energy, when it incidents into the building, as well emit the heat. The coated building can save the electric energy at 28.3% of the uncoated building electric energy consumption. The heat performance measurement of small building coated with heat insulated paint with ceramic particles as main ingredient found that the average room and ceiling temperatures, both inside and outside, of the coated building are lower than the uncoated building. When compare with another board, the solar reflectance of the heat insulated paint coating gypsum board are 7.4% and 55.2% more than the gypsum board coated with conventional paint and the uncoated respectively. Likewise, the heat emission of the heat insulated paint coating gypsum board are 0.06 and 0.04 more than the gypsum board coated with conventional paint and the uncoated respectively. Thus, the heat insulated paint with ceramic particles as main ingredient coating the building is one of the methods to reduce the heat load which convected to the building and the energy consumption of the air condition, results in the reduction of the energy cost.

References

[1] Vachara Mungvititkul. Energy saving process and technique in building and industrial factory. Energy reserve center of Thailand. 2004

[2] H. Akbari. Measured energy savings from the application of reflective roofs in two small non-residential buildings. Energy.2003. Vol 28. 953-967

[3] N.M. Nahar, P. Sharma and M.M. Purohit. Performance of different passive techniques for cooling of buildings in arid regions. Building and Environment. 2003. Vol 38. 109-116

[4] N.M. Nahar, P. Sharma and M.M. Purohit. Studies on solar passive cooling techniques for arid areas. Energy Conversion & Management. 1999. Vol 40. 89-95

[5] G.B. Smith, A. Gentle, P.D. Swift, A. Earp and N. Mronga. Coloured paints based on iron oxide and silicon oxide coated flakes of aluminium as the pigment, for energy efficient paint: optical and thermal experiments. Solar Energy Materials & Solar Cells. 2003. Vol 79. 179-197

[6] G.B. Smith, A. Gentle, P. Swift, A. Earp and N. Mronga. Coloured paints based on coated flakes of metal as the pigment, for enhanced solar reflectance and cooler interiors: description and theory. Solar Energy Materials & Solar Cells. 2003. Vol 79. 163-177

[7] A. Dombrovsky, H. Randrianalisoa and D.Baillis. Infrared radiative properties of polymer coatings containing hollow microspheres. International Journal of Heat and Mass Transfer. 2006