ENERGY SIMULATION OF HEATSHIELD COATING ON THE WAY TO GREEN BUILDING FOR A SUSTAINABLE DEVELOPMENT

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Abstract
Sustainable development can be achieved by the adoption of green hierarchy such as reduce-reuse-recycle along with energy efficiency and conservation. Green building can be achieved to some extent by exterior heat insulating coating besides energy efficient equipment and appliances. Here the attempt is to stress on solar passive techniques for optimizing indoor visual and thermal comfort. Green coating helps for reflecting infrared as well as UV(Ultra Violet) radiation, decreasing the room temperature between 5 to 10^{o} C and thus helps in saving energy and preventing global warming.

Keywords
Sustainable development, Green building, Green coating, Heat insulating coating

INTRODUCTION

Sustainable development is defined as 'Meeting the needs of the present generation without compromising the ability of future generations to meet their needs.' Real estate industry is the major polluting and stumbling block on the road to achieve the sustainability. So the focus moves to sustainability on real estate for green building which is not only restricted to energy conservation, but also includes resource usage, impact on the neighbouring environment and working conditions for tenants. One such criteria for a green building is to optimise the energy performance of the building within specified comfort limits which can be achieved to some extent by heat insulating exterior coating.
Green buildings are around 25–30% more energy efficient, with gold-rated buildings as much as obtain 2% of their energy from renewable or green sources. This energy efficiency proves beneficial during peak periods, when energy costs rise due to higher demand.

Requirements for a Green Coating

The coating should be biobased polymers or biobased solvents such as methyl soyate (made from soyaben), mineral spirit, ethyl locate (made from corn esters) & ethylene glycol (EG), which contributes minimum or zero VOCs(Volatile Organic Compounds).
Use of low toxic, solvent-free adhesive & sealants will help in reducing VOCs.
Efforts should to develop & use more and more zero VOCs paint or coating like Intrinsic colors as developed by Bay systems North America (BSNA).Using the products which

are biodegradable, non toxic, water based and cold water compatible will make eco-friendly. Recycling of coat or paint should contain minimum 20% recycled content and recycle of containers will also solve the problem of disposal, emission from residues.

Long term performance & durability is another important feature because of less use of paint or coating which in turn emits less VOCs. For durability thickness plays an important role. Hence, greater is the thickness, grater is the durability.

Quality of pigments, Film build, polymer and sheen are other important factors for durability. The other durability parameters of the coating are:

- It should have anti-microbial growth properties.
- It should have excellent application and finish appearance.
- It should have low odor.

To safeguard our environment following things have to be avoided in the coatings.

- The products that contain dyes, ozone depleting chemicals, heavy metals, formal deride or carcinogens (toxic) should be avoided.
- Solvent based finishes, particle board, adhesives and other products that release volatile chemicals into air should be avoided.

One such green coating is energy efficient coating which helps in reflecting sun's infrared and UV radiation from the substrate by the heat blocking pigments in the paint or coat. This helps in reducing heat transfer and making cooler by which demand of cooling system get reduced as a result energy is being saved and also decreases global warming.

HEAT INSULATING EXTERIOR COATING

It is heat reducing & 'Energy Saving' elastomeric coating here in referred as Heatshield which is composed of acrylic emulsion polymers, microspheres, properly selected and graded inert fillers, light fast and weather durable white pigments, additives and water as medium. It is used as a heat insulating and waterproof coating on building rooftops and exterior walls. It helps in reducing power consumption substantially by reducing the load on air-conditioners and keeps the interiors cool with additional function of waterproofing.

Heatshield contains advanced material of 'Hollow Micro spheres based on Borosilicate Glass as micro bubbles' having remarkable 'Heat Insulation' property. The unique spherical shape of the glass bubble produces stable voids which results in low thermal conductivity and a low dielectric constant. When applied on substrate, the hollow micro spheres form a closely packed structure like 'Air Space' within the dry film layer that serves as insulation medium to resist heat transfer (Figure 1).

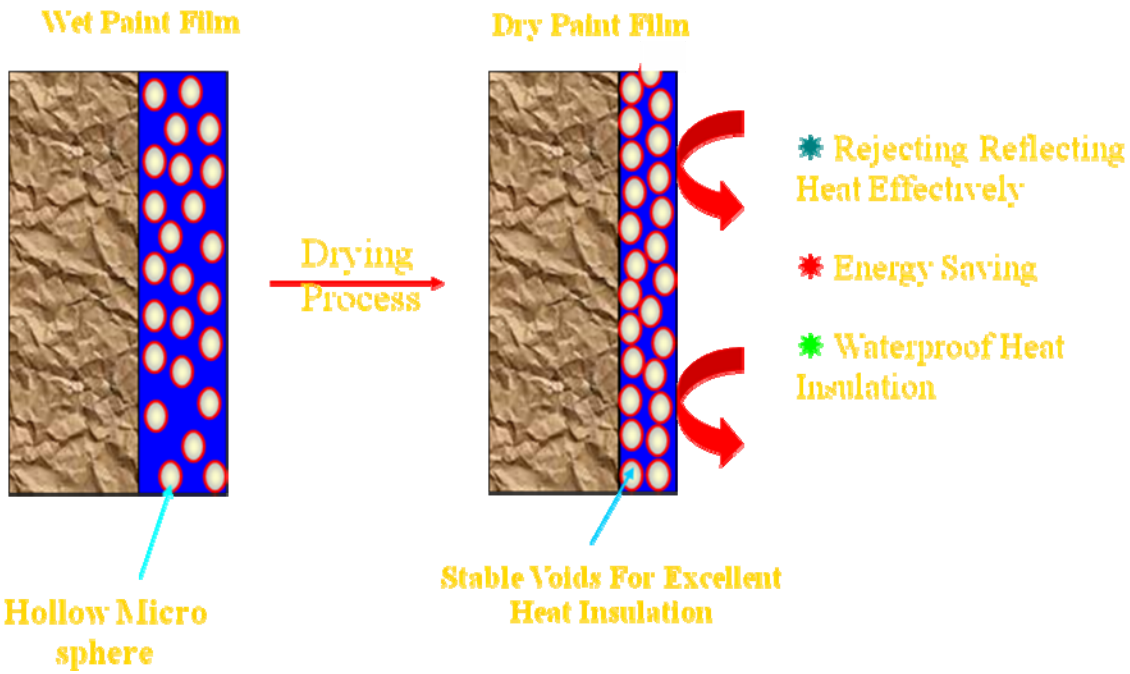

Figure 1.Mechanism of heat insulation of exterior heatshield coating

Heatshield has thus the ability to slow down heat transfer remarkably and keep interiors of externally coated surface of a building cooler by re-radiating most of the solar heat back into the atmosphere.

Areas of Application

- Terraces and rooftops of buildings (Figure 2) - cementitious, asbestos & metal surfaces.
- Exterior walls of buildings(Figure 3)
- Cold storages, computer server rooms, electrical control panel rooms, etc.
- Metal & concrete storage tanks for water, chemicals and fuel in petrochemical industry.

Fig: 2.Coating on a concrete terrace & pipe surface Fig: 3. Coating on a masonry wall

Physical and Chemical Properties

The physical and chemical properties of heatshield coating are as follows:
Appearance: Free flowing, homogeneous & uniform paste.
Colour: White
Solid content (AST M D 1010): > 60%
Specific Gravity: 1.01 – 1.05
Thermal conductivity: 0.029 w/mK(Figure 4)
Elongation (AST M D 412) :200%
Abrasion resistance (AST M D 968): No wear after 450 gm of falling of sand
Wind driven rain resistance (TT C – 555): No moisture penetration after 24 hours.
Tensile strength @ 25^{o}C, (AST M D412): 0.276 N/mm^{2}
Total solar energy rejected: 94%
SRI Value (AST M E–903):83.8%
Accelerated weathering (2000 Hrs) (AST M D 4587): Pass
Mildew resistance (ASTM D 3273-731): No growth
Corrosion resistance (AST M D 610/800): No rust
Relative heat gain: Btu/hr/sq.ft 30
Surface dry: 30 minutes

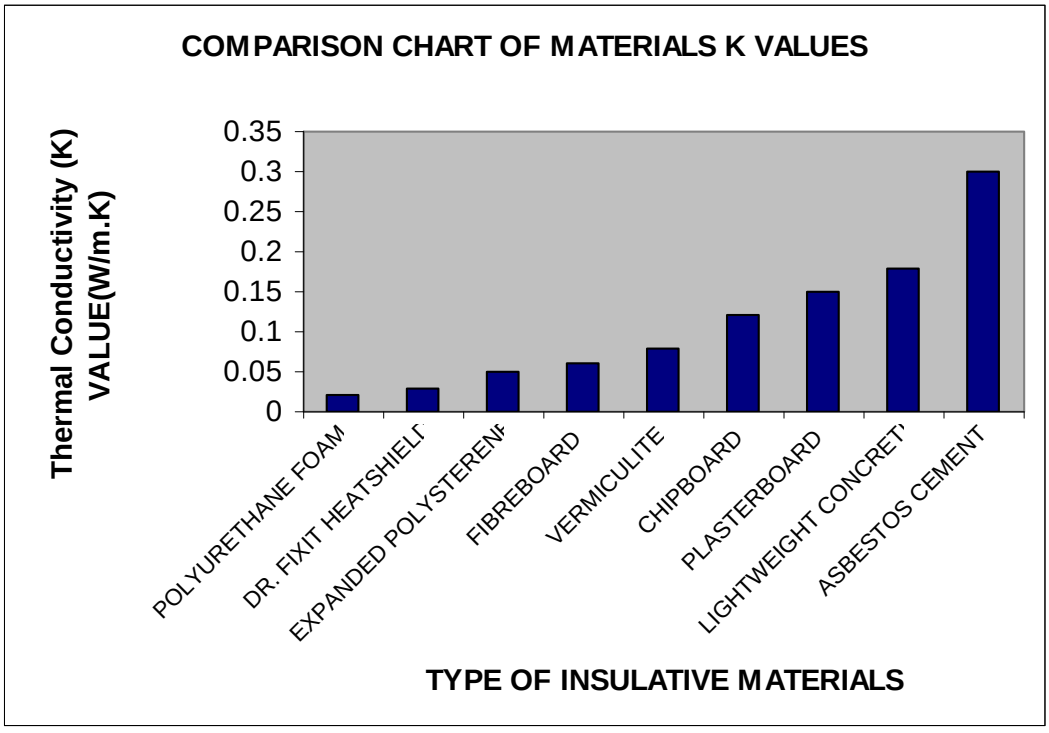

Figure 4.Comparision chart of thermal conductivity of different insulating materials

Features & Benefits

- Heat Insulation - Reduces the conductivity of heat from exterior to interior thus maintains the temperature. Figure 5 and 6 shows the monitoring of temperature

was being made with and without applying Heatshield on a metal surface in the after noon. The difference of temperature was approximately 12 ^{o}C between coated and uncoated surface. However, the same monitoring was made with and without Heatshield coating on concrete surface in the noon where difference of temperature showed only 7 ^{o}C (Figure 7).

- Solar Reflectance - 83.8% solar reflectance (AST M E-903), re-radiated heat back to atmosphere
- U V and IR resistant - Resistance to UV & IR emission protects coating from damage and reduces heat conductivity.
- Microbial resistant – Resistance to algae and fungus growth results into lesser maintenance.
- Toxicity - Non-Toxic & water based system.
- Waterproofing – Excellent waterproofing increases the durability.
- Saving - Reduction in electrical consumption for air-conditioners, saves energy cost(energy simulation studies described at the end).

Figure5. Monitoring of temperature on a coated metal surface

Figure 6. Monitoring of temperature on an uncoated metal surface


Figure 7.Monitoring of temperature on a coated and uncoated concrete surface

Method of Application

On Cementitious Surfaces

Surface Preparation

- Surface to be applied upon must be free from dust, loose materials, paint, oil, or any other material which may impair adhesion.
- Mechanical means such as wire brushing & shot blasting can be used. Finally vacuum cleaning of all loose solids and liquids can be done if required.
- All surface cracks up to 5 mm width should be filled up with resin crack filling material.
- Cracks more than 5 mm and all separation gaps should be filled up with SBR modified mortar.
- If the surface temperature is too high then it should be cooled down using a water hose pipe.

Priming

- All new cement-sand renderings & concrete surfaces should be allowed to age for 6 to 8 weeks before surface coating.
- SSD (Surface Saturated Dry) condition should be attained before priming.
- Priming should be done with a suitable primer usually 2 part primer: 1 part water.
- Finally application of coating should be made with a brush or a roller.

App l i cat i o n

- 3 coats of Heatshield should be applied without any dilution by brush or roller at an interval of 2 hours.
- The coated surface should be allowed to air cure fully for 7 days.

Figure8. Application of heatshield on a concrete surface

On Metal Surfaces

Surface Preparation

- Metal surface should be cleaned to remove existing paint, rust by appropriate mechanical or chemical means.
- New surface should be de-greased and cleaned well

Priming

- The metal surface should be primed with a suitable anti-corrosive primer.
- The priming is not required for new GI sheets.

App l i cat i o n

- 3 coats of Heatshield should be applied without any dilution by brush or roller at an interval of 2 hours.
- The coated surface should be allowed to air cure fully for 7 days

Figure9. Application of heatshield on a metal surface

Precautions & Limitations

- The coating materials should not be diluted.
- It should be always kept as a final coat i.e. no over coating on heatshield should be done.
- All health and safety precautions should be taken during storage and application of the product.

ENERGY SIMULATION STUDIES

For energy calculations for ROI (Return on Investment), following assumptions were made:

An office space with 300 m^3 volume will require air-conditioning of 10 MT capacity.

- Power required for 10 MT capacity is approximately 12.5 KW.
- Energy consumption per hour for same is approximately 15 units per hour.
- Energy consumption for 12 hours is 15 x 12 = 180 units per day.
- Energy consumption for 25 days is 180 x 25 = 4500 units per month(approximately)
- Approx. rate per unit Rs. 3.50, then energy bill for month is 4500 x 3.5 = Rs.15,750/-

To provide protection for 300 m^3 volume space the approximately area required to be coated on rooftop will be 100m^2 and 30 m^2 of exterior wall area on west side as it receives the maximum heat radiation. Thus total area to be protected becomes 130 $m^{2.}$

- Cost of Heatshield coating with 400 micron DFT(Dry Film Thickness) in 3 coats is @ 330/- m^2 and the final cost for 130 m^2 application is 130 x 330 = Rs. 42,900/-
- Considering energy saving of 28% the reduction in energy bill per month will be 15700 x 28 / 100 = Rs. 4410
- Return on investment thus can be obtained approx. in (42900 / 4410) approx. 10 months, but if we consider the monsoon and winter season then the same can be assumed in about 15 months.

The result of this simulation studies can be summarized as follows:

- The studies carried out to test the energy saving in Heatshield had shown that about 28% energy saving in electrical consumption was obtained when Heatshield was applied on roofs and walls. Comparison was done without application of Heatshield. This was because large amount of heat gain from solar radiation received by roof and transmitted into the unit.
- This showed that it can cut electrical bills for air-conditioning substantially.
- The return on initial investment on Heatshield can be earned back within a period of 12 to 15 months.

CONCLUSIONS

Green coating for concrete and masonry surfaces is not a product but a system as a whole for selecting appropriate raw materials, paint or coat, surface preparation, application, cleaning & suitable disposal including life cycle cost to perform certain parameters in terms of VOCs, energy efficiency, performance & durability, recycling & others properties in accordance with the standards of Environmental Protection Agency (EPA) GS-11, Leadership in Energy and Environmental Design (LEED), South West Air Quality Management District (SCAQMD), TERI (The Energy Resources Institute)New Delhi, IGBC (Indian Green Building Council) etc. From energy simulation studies it can be concluded that though the initial costing of heat insulating coating will be higher but return on investment can be obtained within 15 months and at the same time this coating helps in achieving green building to some extent for a sustainable development.

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