Solar heat reflective coatings – an effective energy-saving coating

In the fifth of his series of six articles on coatings, Prof. A S Khanna, Retd. IIT Bombay, Chairman SSPC India, puts the spotlight on solar heat reflective coatings. These form a low cost, self-application alternative which can reduce temperatures when applied to houses, factories, warehouses, and on public transportation, helping to reduce global warming.

Fig. 1: An example showing the cooling effect of 12 °C on a steel shed roof in Vijaywada.

Background

Every year, thousands of people die due to intense heat in summer. A huge amount of energy is consumed in bringing tolerable temperature within homes by using air-conditioners (AC), coolers and other local cooling methods. It has been found that at an ambient temperature of ~40 °C, the rooftop temperature will reach to about 65 °C at the peak summer day, between 12 to 2.00 pm. The consumption of electricity under these conditions is very high. A 10 °C decrease in the temperature of the room can bring down electricity cost by at least 50%. A rough calculation has shown that for a city having 10 lakh rooftop houses of approximately 1000 sq. foot with a 1.5 ton AC, running only for 10 hours a day, can bring down electricity savings equivalent to a cost reduction of about 480 crores if the room temperature be reduced by 10 °C.

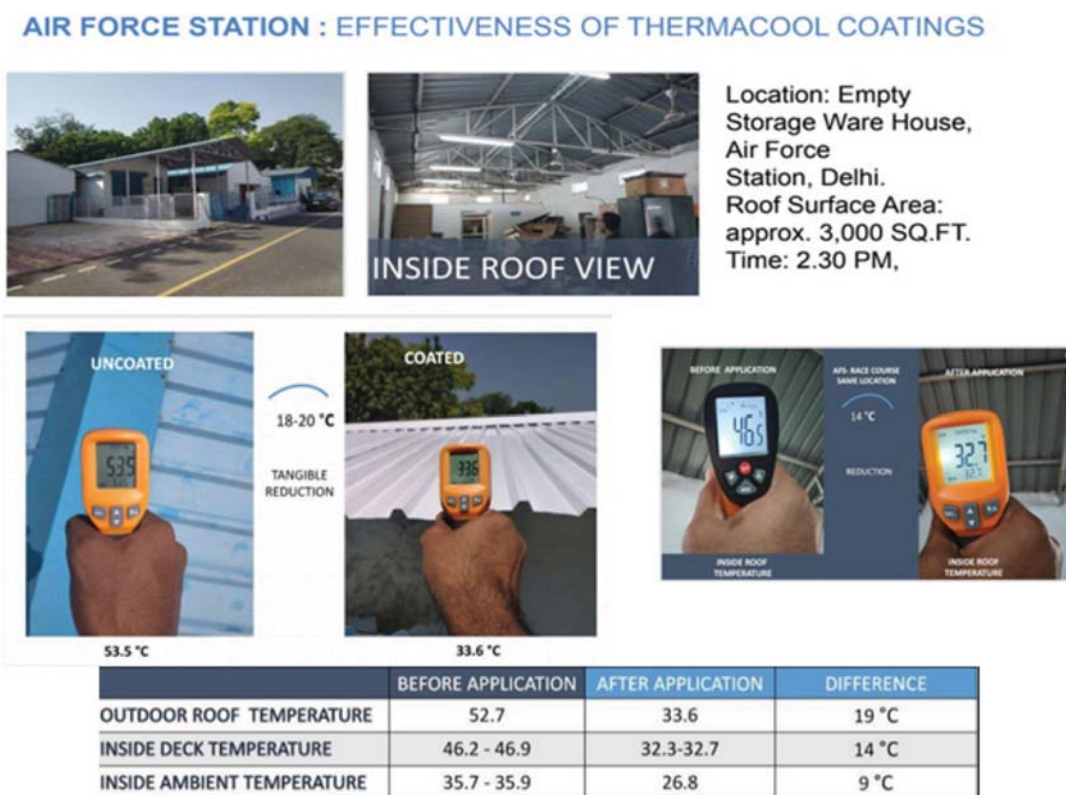
This can be achieved by using solar heat reflecting cool roof coatings (SHRC). A cool roof coating can be created on the rooftop of a house which can bring down the ceiling temperature by as much as 20 °C. The concept of cool roof coating here is to make use of certain special pigments which reflect more than 89% of near infrared radiations from sun, which constitute 52% of the total sun radiations. Successful coatings were made which on application on rooftop can help bring the temperature of rooftop by 18-20 °C, and the temperature in the room by 6-9 °C. Similarly, cool roof coatings for steel surfaces are developed which reduce the temperature by 6-9.5 °C.

Global warming

Last two decades have seen severe climate changes with number of tsunamis, hurricanes, wildfires, cloud bursting, volcano eruption, glacier melting and severe cold and hot conditions in specific regions across the globe. What could be the one reason for these severe changes in climate? The one possible answer is the global warming, which has risen by just one degree in the last few decades. Now imagine, what worst could happen when the global temperature, as predicted would cross 2 °C in the coming decade or two. Recollecting the reasons behind this rise in global warming is the burning of fossil fuels in power generation, and vehicular pollution. That is why the effort is to control this temperature by reducing the use of coal and oil in power plants and using electric vehicles to reduce pollution. World-wide, the action has started and India is not far behind in this effort. India's goal of power generation using alternative energy methods, especially wind and solar is increasing at a very fast pace and we are much ahead in achieving our targets.

So what can be done, what is being done and what are the future possibilities to reduce global warming. One clear pathway is the use of alternate methods of power generation. Nuclear and hydroelectric are in use for decades and are helping the reduction of coal use in power production. In addition, there is increasing use of wind turbines and solar power plants which are creating a positive dent in controlling global warming. However, in this article we are introducing a simple and cost-effective method to help control global warming. If this concept is accepted collectively and implemented with a proper government policy, it can create a great dent

in reducing global warming. This method is the use of a simple architecture coating on rooftops of houses, industrial establishments, water tanks, automotive transport vehicles and tractor tailors. This architectural coating helps in reflecting heat from the roofs using infrared (IR) absorbing additives in the architecture coating. It can be noted that the solar radiation has 52% of IR radiations which are responsible for concentrating heat on the roofs. Using these IR sensitive/absorbing additives, they absorb them, followed by their immediate reflection. This technology is therefore termed solar heat reflecting technology. Solar heat reflecting coatings (SHRC), applied on rooftop of buildings, and industrial establishments, made of concrete, steel or any other artificial roofing material. If implemented properly, it has an annual market of Rs. 2500 Cr and can reduce substantial carbon footprints in terms of thousands of tons per annum.



	BEFORE APPLICATION	AFTER APPLICATION	DIFFERENCE
OUTDOOR ROOF TEMPERATURE	52.7	33.6	19 °C
INSIDE DECK TEMPERATURE	46.2 - 46.9	32.3-32.7	14 °C
INSIDE AMBIENT TEMPERATURE	35.7 - 35.9	26.8	9 °C

Fig. 2: A drop in temperature of 18-20 °C of the roof temperature at an ambient temperature of 34 °C with a 9 °C drop in the temperature of the room.

Solar heat reflective coatings

Solar radiation mainly consists of ultraviolet, visible and infrared (IR) radiation. It is IR radiation, especially near IR (from 750-1250 nm) which brings maximum heat to the roof. Hence any technology for cool roof must eliminate this portion of IR radiation. This therefore can be achieved by modifying the formulation of conventional architectural coatings by introducing IR absorbing pigments. A right composition of these pigments with suitable size can absorb most of this radiation, followed by its immediate reflection. Other two factors which help in the cooling are white colour and presence of insulation additives. The Thermacool Heat Reflective coating has all such ingredients and is an effective coating to reduce heat. It is a patented technology, developed at IIT Bombay and has been well tested using several proof of concepts in industrial sheds, railway transportation and housing. Possible applications of the SHRC coatings are many and varied, including simple concrete housings, schools, factories, hospitals buildings, industrial sheds and warehouses, railway and bus transportation, rooftop water tanks and many more. The approximate market of SHRC has been found to be Rs. 2500 Cr per annum.

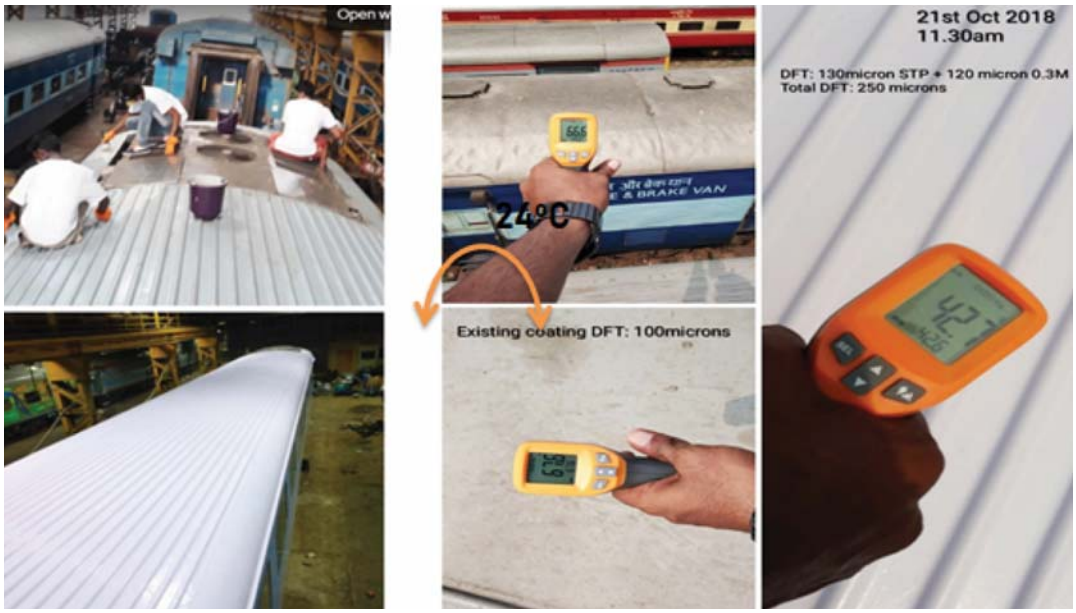


Fig. 3: The application of SHRC coating on the roof of an air-conditioned railway compartment reduced the temperature by 24 °C which can substantially reduce the electricity consumption of the AC.

Proof of concepts

Let us now review some of the results of proof of concepts on many industrial and utility buildings. The first example is the huge drop in temperature of a TVS industrial shed made of coil coated steel in Vijaywada, an industrial southern city in India. Figure. 1 clearly demonstrates a drop of 12 °C after application of this coating on the steel rooftop and 11 °C drop in the

Table 1: The properties and applications of various solar heat reflective coatings.

PRODUCT LISTS					
Core Products	**Type**	**1K/2K (Coating thickness)**	**Application on Surface**	**Service Life**	**Remark**
Thermacool 0.3C	Water based (Acrylic based)	1K 69 (100 to 120 µm)	Concrete Roof (Cov.35 SqFt)	5 Years	Provided a suitable Concrete primer/ leakproof primer is applied
Thermacool 0.3M	Solvent Based (PU based)	2K (100-120 µm)	Steel/Galvanized (Cov.35 SqFt)	8 Years	Provided the existing surface is pre-coated rust/ crack free or has a suitable primer
Thermacool 0.3M FR	Solvent Based (PU based with fire resistant properties)	2K (100-120 µm)	Steel/Galvanized (Cov.35 SqFt)	8 Years	Provided the existing surface is pre-coated rust/ crack free or has a suitable primer
Addin Products	**Type**	**1K/2K (Coating thickness)**	**Application on Surface**	**Service Life**	**Remark**
Thermacool 0.3M (AR)	Solvent Based (PU based)	2K (100 to 120 µm)	Steel/Galvanized (Cov.35 SqFt)	5 Years	Provided a suitable Concrete primer/leakproof primer is applied
Thermacool 0.3M (AK)	Solvent Based (Alkyd based)	1K (100-120 µm)	Steel/Galvanized (Cov.35 SqFt)	2-3 Years	Provided the existing surface is pre-coated rust/ crack free or has a suitable primer
Thermacool 0.3M(W)	Water Based (PUD)	1K (100-120 µm)	Steel/Galvanized (Cov.35 SqFt)	4-5 Years	Provided the existing surface is pre-coated rust/ crack free or has a suitable primer
Base Coats/Primers	**Type**	**1K/2K (Coating thickness)**	**Application on Surface**	**Remark**	
Thermacool STP	Expoxy based Corrosion Resistant ST primer	2K (80 to 100 µm)	Galvanized Steel/ pre- coated steel	Must be applied on bare or deteriorating pre-coated steel surface before application of Solar reflecting coating	
Thermacool WP 51 Clear	Water proof primer	1K	Concrete	Must be applied on cracked/leaking roofs	
Thermacool WP 51 White	Pigmented Waterproofing Primer	1K	Concrete	Must be applied on cracked/leaking roofs	

temperature of ceiling which is a substantial decrease for the comfort of employees, working under the shed.

Figure 2 is the most pertinent example to illustrate the use of such coatings. A drop of 18-20 °C was noticed on the steel rooftop at an ambient temperature of 34 °C outside. This resulted the temperature in the room as 26 °C, a drop of almost 9 °C in temperature from outside.

The next example is that of railways and bus transportation where a substantial cost reduction of electricity consumption can be achieved by coating rooftops using SHRC. Figure 3 shows the results of applying SHRC to the coach roof of the Shatabadi Express. Meanwhile, longer life and fuel savings can be achieved for AC buses (Figure 4).

The coatings supplied by Thermogreen Cool Coat Pvt. Limited are simple and are in two categories, one for concrete roofs which are acrylic based and are Griha certified eco-friendly category with a durability of five years. The coatings that are applied on steel roofs are polyurethane base and are solvent base with a durability of eight years. A list of various products available along with suitable primer and a modified fire-retardant coating are given in Table 1.

Energy saving and reduction in global warming

Finally, it can be shown how much electricity savings can be made on running domestic ACs which would result in monthly savings in the electricity bill cost and annual savings in carbon footprint. The results are summarised taking the example of a rooftop house of 1000 sqf with an AC of 1.5 tons running for 10 hours a day. Application of this SHRC coating will save 7 units of electricity per day equivalent to about Rs. 314 savings per month and a savings in the carbon footprint of 9 million tons per annum assuming approximately 6 million ACs in a city.

Higher-quality images can be viewed via the online version of this article, available on the VWIME Featured Stories gallery at https://tinyurl.com/xxxxxxxxx

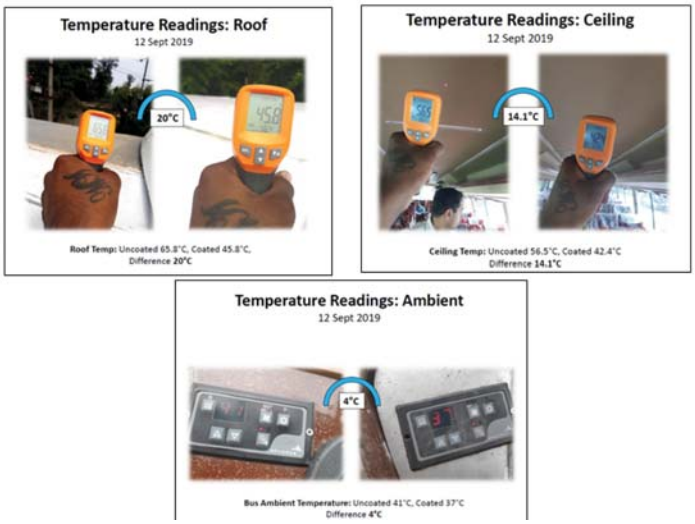


Fig. 4: Example showing how the application of SHRC led to a 20 °C decrease in the roof temperature, a 14 °C fall in the ceiling temperature and a 4 °C reduction in the ambient temperature inside the bus. This reduces fuel consumption needed to run the AC.

Conclusion

In order to reduce global warming, several measures have already been taken. Alternative methods of producing power such as nuclear, and hydro-electric are being used for decades. The renewable source of electricity production methods now being followed are wind and solar. In the past decade, wind and solar have created a measurable effect on reducing carbon footprints. However, use of solar heat reflective coatings is a low-cost, self-application alternative which can be applied in houses, factories, warehouses, railways and AC buses. A combined effect will definitely help reducing global warming.

About the Author

Dr. A S Khanna, a retired Professor from Indian Institute of Technology, Bombay, after 27 years of teaching and research, guiding 27 Ph.D's, 125 Masters and creating research expertise in High Temperature Corrosion, Coatings, Surface Engineering, Corrosion of concrete structures and nano-coatings. He has won several International Awards such as Humboldt Fellowship from Germany, Royal Norwegian Fellowship from Norway, Fellow of Japan Key Centre and worked as visiting Professor in Germany and France. He has written three books and edited four books. He has published more than 300 papers in several International and National Journals with more than 4500 citations. He is a coating expert and is associated with Hindustan Zinc for several assignments related to galvanization and its applications, Sterling & Wilson for selection of sites for solar power plants, oil & gas industry for consolation on coatings for underground pipelines and offshore structures.
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