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THE SCIENCE OF INSULTEC
HEAT REJECTING MEMBRANE

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The Science of Insultec.

Insultec is a special coating that gives remarkable heat controlling properties to the surface on which it is applied. It enables a building or other enclosure to remain cool even under intense sunlight. In these notes we summarise the scientific evidence for the efficacy of Insultec and we describe the way in which it works. Some understanding of this is needed if full advantage is to be taken of its heat rejecting properties.

Heat Transfer:

Anyone who has studied physics at high school will recall that heat can be transferred by convection, conduction and radiation. Although air is a poor thermal conductor, it allows that transfer by convection. That is why the roofing space above a house is not very good at keeping the building cool in the summer or warm in the winter. Insulating batts, made of fiberglass or similar materials, allow one to combine the poor heat conduction of air with a barrier to convection. In other words, insulating batts have a high thermal resistance.

The thermal resistance depends on the thickness of the barrier and is rated by an R value; for example, $R = 1$ means that 1 square metre of the barrier allows 1 watt of heat transfer to pass from one face to the other when there is a 1°C difference of temperature between them. The higher the R value, the better the insulating properties of the barrier.

Of course, when sunlight falls on the roof of a building, not all of it gets inside. Some is reflected and returns to the atmosphere. The absorptivity of a surface is a measure of the proportion that is not reflected. As the roof becomes hotter, heat starts to radiate outwards. Eventually, a stage is reached when the roof becomes hot enough for the heat entering the building to equal that which is being lost to the surroundings and equilibrium is established.

We see, then, that there are two *passive* ways in which the interior of a building might be kept cool on a hot day. One can either impose a thermal barrier with a high R value or one can enhance the reflection of sunlight and the radiation of heat from the roof. We have noted that insulating batts operate in the first way, while Insultec uses the second method.

Of course, it is well known that poor absorbers are also poor radiators but this rule applies only for light or heat of a particular kind. Thus, it is perfectly possible for a given roofing surface to be a bad absorber of light from the extremely hot sun and a good radiator of heat (so called infrared rays) from the only moderately hot building. What one needs, then, is a surface with selective properties: Insultec provides just such a surface.

Tests On Insultec

The claims that are made for Insultec are supported by a larger number of tests and observations that have been made both in Australia and in other parts of the world. The test fall into three categories:

1. Scientific tests in specialist laboratories that have determined the adsorptive and radiative properties of the coating.
2. Measurement of the reduction of temperature in buildings that have been coated with Insultec.
3. Observations of the improvement in comfort and the reduction in air-conditioning power consumption in buildings that have made use of Insultec. These reports are often quantitative but no less valuable than the more quantitative laboratory tests, since they illustrate the practical performance of the coating.

Measurement of Absorptivity and Emissivity

Measurement of absorptivity and radiating power (also known as emissivity) have been performed in a number of laboratories. Thus , Vipac Engineers and Scientists Ltd. of Port Melbourne have determined the solar absorptivity of Insultec coated steel roofing, and compared it with that of galvanized roofing and various Colorbond roofing colours. Insultec was found to have an absorptivity of no more than 15% compared with 29% for galvanized steel and 25% to 80% for Colorbond steel of various colours from Off White to Heritage Red.

Perhaps the most thorough tests of the basic properties have been carried out by the highly regarded Indian Institute of Technology (IIT) in Bombay. This laboratory found that, for Insultec, the total absorptivity of sunlight under their conditions is 24% compared with an emissivity for heat of 89%. The ratio between the two quantities, which we might call the selectivity factor, is equal to 3.7. By way of contrast, the solar absorptivity of an uncoated surface was as high as 74% and no selective properties can be seen.

Solar Agni International did not specify their conditions of measurement so precisely but, nevertheless, their observations that the selectivity factor for Insultec is equal to 4.6 is not inconsistent with the findings of IIT.

All the above tests indicate that Insultec is a good reflector of sunlight and, at the same time, a good emitter of heat at terrestrial temperatures. In other words, it has ideal selective properties.

Cooling of Buildings

Vipac and IIT have also measured the temperatures reached by Insultec coated surfaces when exposed to strong sunlight. Thus, Vipac found that, with a solar intensity of 782 W/m^2 and with an air temperature of 32°C , an Insultec coated steel sheet reached only 34.2°C whereas a galvanized sheet reached 38°C and Colorbond coated sheets reached 36.8°C to 49.9°C . Even more striking are the results of three separate tests, carried out by IIT using a solar flux of 400 to 684 W/m^2 , in which sheets painted with Insultec reached a mean temperature of 32.5°C , while the unpainted sheets reached a mean temperature of 52.6°C . Similar tests performed by CSTB of Grenoble in air at 23°C , under a solar flux of 1270 W/m^2 gave a rise of temperature of 41.5°C for an Insultec painted sheet and a rise to 56.8°C for an unpainted sheet.

N.J. van Rensburg, consulting engineers, of Durbanville, South Africa, observed the effect of applying Insultec to the roof of a building in a warm climate area. It was found that a temperature of 53°C was reached with a galvanized roof but only 37°C when Insultec was used. Significantly, clean white paint gave a temperature of 42°C , which is 5°C higher than that for Insultec. This substantiates the claim that, while white paint has some beneficial effect in keeping the interior of a building cool on hot days, Insultec is substantially better for this purpose.

The Ministry of Defence in Vietnam is interested in the use of Insultec in a petrol depot. In its trials, it found that a mean temperature of 38.6°C was reached inside a tank coated with Insultec, whereas the mean temperature was 52.9°C for the uncoated tank. The Materials and Chemicals Enterprise in Hanoi City reported that the use of Insultec lowered the temperature other industrial buildings by 10 to 15°C . A similar result was found by Mobil Refining Australia Pty Ltd. who observed a temperature of 33°C for the Insultec treated area of a building and 51°C for an untreated area, the air temperature being 32°C .

In spite of the fact that the above tests were carried out in widely different places and over a range of laboratory conditions, a consistent pattern emerges from the results. The effect of applying Insultec to a metal roof is to lower the temperature under sunlight by about 15°C . The effect is significantly greater than can be achieved with ordinary paints.

Observations by Users.

There have been literally hundreds of users of Insultec, ranging from domestic households up to very large industrial premises. The customers include major Australian companies like BHP, Arnotts, Comalco, and Telstra, instrumentalities of the State and Commonwealth governments and very large overseas bodies. It is the satisfaction expressed by these clients that validates the fact that Insultec works as claimed, in real life situations.

In some cases, users report considerable reduction in air conditioning costs. In others, the need for air conditioning has been eliminated. For example, AE Smith of W.A. reported the lowering of both ceiling space temperatures and air conditioning costs in their Insultec coated buildings.

The NSW Department of Agriculture has noted that the bees in hives that had been painted with Insultec showed no stress, while those in hives painted with other coatings showed a high degree of stress. The South Australian Department of Motor Transport reported that a site laboratory, that became unbearably hot on only moderately warm days, reached only comfortably warm conditions on much hotter days after the application of Insultec.

The above comments represent only a small cross section of the glowing reports from satisfied users of Insultec.

Other Characteristics of Insultec.

It is important to emphasize the differences between Insultec and Insulating batts on the one hand and ordinary paints on the other.

The suppliers of Insultec are often asked to specify an equivalent R value for the product. However, this question is inappropriate since Insultec operates in a completely different way from insulating batts. The latter impede the flow of heat from the roof of a building to the interior whereas Insultec stops the roof from getting hot in the first place. Whether it is better to use Insultec or roofing batts will depend on the local situations. Some calculations performed by Timar Martin, refrigeration and air conditioning engineers, of Toowong, Queensland, have given payback periods of 2.5 (two point five) years for a new uninsulated roof and 2.8 (two point eight) years for an existing uninsulated roof. It must be remembered that the Insultec does not significantly help to keep a building warm in the winter, while insulating batts restrict the flow of heat both inwards and outwards. On the other hand, the fact that Insultec keeps the roof cool, must enhance its life and extend the periods between maintenance.

Insultec coatings are much thicker than ordinary paint coatings. This confers several benefits, quite apart from the rejection of unwanted heat. Taywood Engineering Ltd. of WA have carried out tests that show the high resistance of Insultec coatings to water, carbon dioxide and chloride ion diffusion. The excellent water proofing properties of Insultec have also been confirmed by the Bureau Veritas, the largest building controller in Europe. The relative mechanical strength of Insultec compared with the ordinary paint means that it should have a much greater life.


Of course it must be remembered that, since Insultec is not an ordinary paint, it must be applied strictly in accordance with the specifications. When correctly applied, it confers considerable protection to the underlying material.

Conclusions:

Independent tests have confirmed the efficacy of Insultec in rejecting heat from buildings and that there is a lowering of temperature by as much as 15⁰C below that for an unpainted surface. The tests in the laboratory and on exterior sites are consistent with one another.

The beneficial properties of Insultec are undoubtedly due in the main to its selective low absorptivity for sunlight and high emissivity for heat. It, therefore, operates in a different manner from insulating batts and this must be taken into account in its application.

The mechanical strength and protective properties of Insultec are an added bonus.



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