Metallized plastic sheeting for use in cold climate survival

P. Marcus[1]

Introduction

Metallized surfaces have been used for many years to reflect infra-red radiation and thus prevent heat loss. Plastic sheeting with a fine deposit of aluminium was developed in the mid 60s in the USA to fulfil the requirements of the cryogenics industries and space research organizations for a flexible 'super insulator'. Aluminium is spattered on to a polyester 'Melinex' or 'Mylar' sheet in vacuo in the form of minute discrete particles thus reducing lateral conduction of heat. Plastic of only 5 microns thickness is sufficiently tough for many uses. Metallized plastic sheeting (MPS) has been used by the US National Aeronautics and Space Administration in the construction of 'moon suits'. In this application many layers of plastic separated by spacing material are used resulting in excellent insulating properties in the vacuum of space, where radiation is the most important avenue of heat exchange.

More recently, many manufacturers in America and Europe have suggested the use of single or double layer MPS (often referred to as 'space blankets') for survival purposes. Impressive advertising claims are made and these have resulted in an unusually high level of interest amongst potential users. It is claimed that thin MPS, which can be packed into a very small volume, especially by vacuum techniques, is sufficiently strong to use as an emergency shelter for cold/wet/windy environments and that, since the metallized surface reflects heat lost from the body by radiation, the insulation afforded by a thin bag of this material is significantly greater than by others such as polythene. MPS is also said to reflect radar waves and so to be a valuable aid to location of survivors.

MPS for survival purposes is manufactured in light and heavyweight forms. The lightweight 'space blanket' is a single thin layer of Melinex, of silver appearance on the metallized side and usually coloured bright orange on the other. If the reverse side is not coloured, it too has a silver appearance since Melinex is transparent. Melinex absorbs infra-red radiation so the material's special insulating properties are lost if the non-metallized surface is placed next to the body and the coloured sheeting is to be preferred as an aid to identification of sides. The lightweight sheeting is often made up into an exposure- or casualty-bag by taping. The heavyweight version is usually smaller and is not commercially supplied in bag form. It consists of two layers of MPS sandwiching a scrim of man-made fibre and sealed around the edges. It often incorporates eyelets for the attachment of guy ropes when used as a shelter.

Tests of MPS

There is a considerable body of opinion that blankets or exposure bags made of MPS would be of great value for protection from the cold, wet and windy environment and many civilian mountaineering and rescue organizations and private individuals have equipped themselves with this material. Laboratory and

1 RAF Institute of Aviation Medicine, Farnborough, Hampshire.

field trials of heavy and lightweight MPS were undertaken to evaluate these items for cold climate survival. The tests were carried out in 4 phases:

Field assessments. Heavy and lightweight MPS were used in the field to achieve familiarity with handling the materials and to confirm their advantages and disadvantages. The sheeting was put to a variety of 'protection' and 'location' uses on short survival exercises in the UK during the autumn.

While the heavyweight blanket was of some value in providing shelter, and reflections from its silvered side could be seen for some distance against various terrains, neither it, nor the lightweight material, afforded any special advantages compared with other materials commonly used for protection in the cold and wet environment such as polythene or woven nylon. The lightweight MPS was found to be insufficiently robust. When punctured by stones or twigs the holes produced quickly tore.

Wind tunnel assessments. The importance of high air movements in chilling the body in the cold is well recognized. Lightweight and heavyweight MPS blankets and lightweight bags were compared with bags of polythene and 'rip-stop' nylon in high wind speed conditions in a climatic chamber. They were used by 'survivors' as emergency shelters and in protecting an 'unconscious casualty'.

Sheets, of any material, were found to be unmanageable at wind speeds above approximately 20mph. It was only with extreme difficulty that they could be wrapped around an inert 'casualty'. Flapping soon produced gaps in the covers and the wind rapidly carried them away. The exposure bags were easier to handle but, when made of lightweight MPS, quickly disintegrated at wind speeds above 20mph. Bags of 0.12mm polythene and of 1oz 'rip-stop' nylon withstood wind speeds of nearly 40mph even when holed intentionally.

Cold chamber assessments. A comparison of the insulating properties of polythene and lightweight MPS bags was carried out in a climatic chamber. Eight young subjects of average body build lay at rest wearing winter clothing for one hour in bags of 4 different materials at 2 different air temperatures. Their skin temperatures were measured continuously during their exposures.

Climatic conditions were chosen to represent those occurring in the field. Half of the experiments were performed at an air temperature of $-25 \pm 1°C$ in still air, to simulate the environment of an unheated 'snow-hole' shelter in Northern Scandinavia. The same cooling rate was produced at an air temperature of $-8 \pm 1°C$ with a wind speed of about 10mph to simulate conditions on Northern European hills during the winter. (Initially, it was hoped to carry out half the experiments at 0°C with a higher wind speed, but when wind tunnel studies demonstrated the fragility of the polyester sheeting it was realized that this would be impossible.) Four sets of bags of dimensions 90cm x 195cm were made up by taping sheets of the test materials. Bags were constructed in semi-opaque polythene sheeting 0.12mm thick, clear polyester sheeting 17 microns thick (Melinex, ICI Limited) and 17 micron polyester with aluminium vacuum-deposited on one side (Vacuum Reflex Limited), with the aluminized side towards the body and also away from the body.

Statistical analysis showed no significant difference in skin temperature

decrement between the 4 bags in either of the 2 climatic conditions. It was found that condensation formed on the inner surface of the bags early in each exposure and soon froze, particularly at the lower air temperature.

Radar reflectivity studies. An RAF Nimrod aircraft and a rescue launch compared the radar returns at varying ranges at sea from one multi-seat dinghy with lightweight or heavyweight MPS draped over its canopy and one without.

The Nimrod's radar and the launch's equipment detected the rafts with and without MPS at the same range. In the case of the aircraft faint contact was made at about 5 miles and in that of the pinnace at 100 yards. Sea conditions were fairly calm during this test and the operators knew the positions of the dinghies in advance.

Discussion

Thin MPS has been found to have significant disadvantages in the field in comparison with traditional material. In particular it is easily punctured and damaged by strong wind. The heavyweight sheeting is more robust but of little value as small blankets. It would be better in bag form but even so, the cold chamber studies show that MPS offers no better insulation under representative environmental conditions than common alternatives such as polythene bags, which are considerably cheaper. Theoretically, reflection of the infra-red radiation emitted from the skin should be advantageous but, except in a vacuum, the main avenue of heat loss from the body is by convection, and radiation forms a very small proportion of the total. When condensation forms on a metallic surface its infra-red reflecting properties are lost. The body perspires continuously even in a cold environment and water vapour is contained in expired air. At sub-zero air temperatures hoar frost forms on the inside of an exposure bag and further prevents infra-red reflection.

Many rescue aircraft use radar routinely in searching for survivors at sea and a properly designed reflector will aid detection. The study reported shows that MPS is unfortunately of no value in this respect.

Many factors need to be considered in the choice of a material for environmental protection in survival. The seeming advantages of some new appliance or technique may not be borne out by objective testing, which may also demonstrate its hidden disadvantages. Survival aids should be subjected to close scrutiny under controlled laboratory conditions before over-enthusiastic acceptance.

It may be concluded that:

Heavyweight MPS is of some value as water and wind protection but other materials (such as polythene or 'rip-stop' nylon) are equally effective, cheaper and more robust.

'Blankets' are of little use in the cold and windy environment and bags are preferable.

Lightweight MPS is too fragile for most survival purposes.

Reflection of the body's infra-red radiation by an MPS exposure bag is soon prevented by condensation on the aluminium surface and, at sub-zero temperatures, by frosting. In this situation MPS offers no advantage over cheaper and stronger alternatives.

MPS is of no value as a radar location aid in survival.