

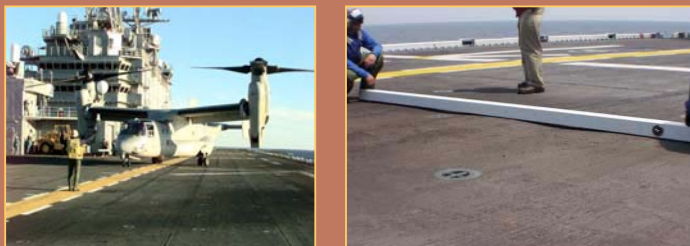
Heat-Reflective Paint for the Decks of Navy Vessels

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Problem

The new V-22 Osprey aircraft has the capability to vertically take off from and land on the deck of an aircraft carrier. During take off and landing, the hot exhaust from the Osprey aircraft engines impinges directly onto the deck of the ship. The deck surfaces were not designed to handle high temperatures and thus warp from the excess heat.

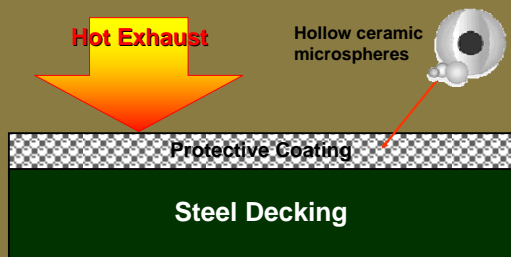


Solution

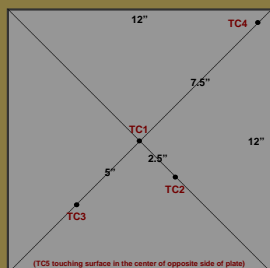
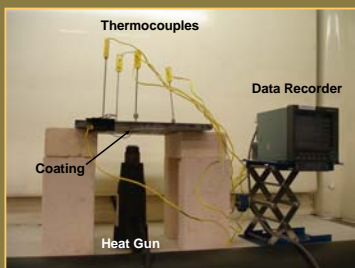
Insulating paints that use special ceramic additives have been developed to improve the energy efficiency of buildings and structures. The decks of naval vessels are coated with paints that include ceramic grit to make them non-skid. It was hypothesized that insulating or conductive additives could be used to replace the non-skid grit and create a paint that could protect the deck from the hot exhaust while maintaining its non-skid properties.

Experimental Approach

Ceramic particles were added to an epoxy-based surface coating to alter the layer's thermal properties, i.e. to reflect, absorb or conduct heat. The ceramic additives investigated included Bionic Bubbles™ which are hollow microspheres derived from fly ash, Insuladd™ particles which are hollow ceramic microspheres invented by NASA, and silicon carbide platelets. The paint was a two-part, water-based epoxy floor coating.



Test specimens were ½ inch thick 12" x 12" steel plates to which paints with different additives were applied. The plates were heated using a heat gun to simulate the exhaust of the aircraft and temperatures on the backside of the painted specimens were measured using thermocouples inserted into holes drilled in the unpainted surface of the plate. The temperature distributions for the plates coated using paints with additives were compared to results for bare metal, paint with no additive, and the standard non-skid deck coating.

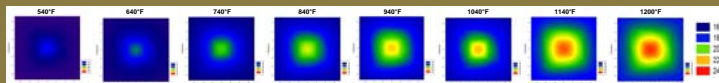


NOTE: Measurements reported in English unit due to link with US Navy. All available data was in English units.

Results

A bare plate was heated to determine baseline temperatures.

Temperature distribution for bare steel plate at different temperatures

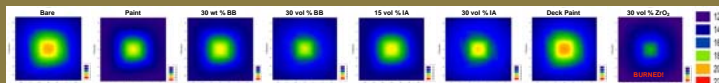


Increasing Temperature

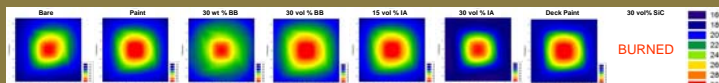
Coated plates were then tested at different temperatures.

Insulating Additives

Temperature distribution @ 540°F for plates with different coatings



Temperature distribution @ 1200°F for plates with different coatings

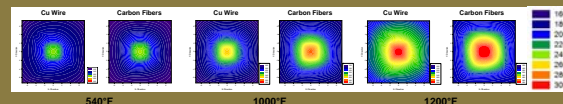


Maximum Temperature of Selected Plates at 1200°F Heat Gun Setting

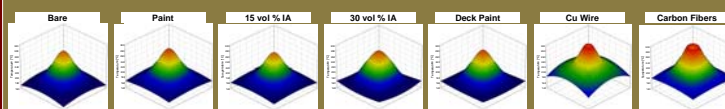
Thermocouple	Bare Plate	Paint	30 wt % BB	30 vol % BB	15 vol % IA	30 vol % IA	Deck Paint	30 vol % SiC
TC1	330	327	302	326	300	322	323	275
TC2	248	246	236	255	229	249	248	230
TC3	204	198	209	210	173	201	187	172
TC4	181	175	177	186	181	175	183	167
TC5	846	840	871	867	673	879	844	661

Conductive Additives

Temperature distribution for plates with different conductive coatings



Performance Comparisons



Summary

The performance of the additives was dependent upon test temperature.

- The Insuladd™ Additive (IA) at 15% by volume performed best at 1200 °F
- The Bionic Bubbles™ at 30% by volume performed best at 540 °F.
- Insulative additives increased the surface temperature of the paint, resulting in some paints burning.
- Conductive additives reduced surface temperature of the paint, but increased the body temperature of the steel. This did reduce the thermal gradient in the steel, which should reduce warping.
- Paints with high concentrations of ceramic additive were soft and fragile.

Conclusions/Recommendations

Solid and hollow ceramic microspheres seem to have promise as additives for producing an insulating deck paint. High concentrations of hollow beads performed well; however, the coating was fragile. The paint with certain additives burned indicating a "hot spot" was created. The grit in the standard deck paint was very faceted and coarse. It is believed that a coarse ceramic particle with the appropriate properties could be produced and used to improve the deck paint. Conductive additives were successful in reducing the thermal gradients, but did increase the temperature of the base steel. The final product might need both insulating and conductive layers, to reject and spread the heat, respectively.

References

Edward L. Davis, Young C. Hwang, and David P. Kihl, *Structural Evaluation of an LHD-Class Amphibious Ship Flight Deck Subjected to Exhaust Gas Heat from a MV-22 Osprey Aircraft*, NSWCCD-65-TR-2006/12, March 2006.