

Erosion Resistance Coatings for Composite Propulsor/Fan Blades

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PROBLEM STATEMENT

Fiber glass reinforced polymers (FRP) are used in building the structural components for ships and aircraft. As a structural part, these materials are very rigid and strong. However, they may not perform well in a cavitation environment, and they can be eroded by sand or water droplets fairly quickly. These deficiencies could be serious for the Ship-to-Shore Connector (SSC) if they choose composite lift fans.

For in-water propulsors, the demand for composite propellers is increasing in both Navy and marine industry. These in-water composite propellers may require cavitation erosion resistance, hydrolysis resistance and barnacle growth resistance.

The lift fan blade assembly on the current LCAC is subject to severe sand and water erosion damages. In addition, the lift fan blade assembly is characterized with limited open space. The limited open space makes repair and service difficult and costly.

Hontek sprayable coatings and moldable resins offer protection against sand erosion, water erosion and cavitation erosion. Hydrolysis resistant coatings are being modified with anti-barnacle properties for use on the in-water propulsors.

WHO CAN BENEFIT?

Composite structures are widely used in marine and aerospace applications. Composite structures may require protective coating when the operational environment encounters cavitation erosion, sand erosion, and rain /water erosion. Hontek advanced coating materials developed will have direct application for commercial manned and unmanned surface vessels used in oceanographic surveying, off-shore oil exploration and on salvage ships.

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Technology developed or used in this contract will find applications in the following fields:

- marine propellers
- aircraft propellers
- LCAC and SSC lift fan blades and propulsion propeller blades
- Engine inlets
- Hydroturbine blades

BASELINE TECHNOLOGY

Goodrich LCAC Molded Sheets are currently used for erosion protection in lift fan blades. The Goodrich Molded Sheets do not offer high erosion protection and do not offer high cavitation resistance. In addition, Goodrich Molded Sheets suffer from poor hydrolysis resistance.

In-air propulsors currently use an elastomeric erosion protection material molded into guards for the leading edge. The two leading edge guards have aluminum backing that support the black elastomeric erosion protection materials.

In-water composite propulsor blades are in developmental stage and are expected to suffer from cavitation erosion. Without protective coatings, the composite propellers may not last long under cavitation erosion environments.

During the Phase I work, all commercial rain erosion resistant coatings and molding resins manufactured by other suppliers failed to offer cavitation erosion resistance. The coatings, used in the thickness range of 16 to 118 mils, were eroded to the substrate in 5 seconds to 7.5 minutes. The carbon composite substrate also showed severe cavitation erosion damages in 6 to 15 minutes.

| Hontek ID-Cavitation | Coatings | Coating Thickness | Test Time @1000 PSI, 1" standoff | Cavitation Test Results |
|-----------------------------|-----------------------------|--------------------------|---|--|
| HB21-004-34B | Commercial carbon composite | 3.0 mm (0.118") | 6 to 15 min | 6 min /1000 psi, 1"; 15 min/1000 psi, 1"; |
| HB21-013-14 | Goodrich PU for LCAC | 1.5 mm (0.060") | 1 min | 1 min / 1000 psi, 1". To glue line/ substrate. |
| HB21-004-36 | Caapcoat FP-200 | 2.0 mm (0.080") | 5 seconds | 5 sec / 1000 psi, 1", punctured through; |
| HB21-004-38 | Task L-101 | 1.1 mm (0.043") | 2 min | 2 min /1000 psi, 1"; To substrate. |
| HB21-004-39 | Chemglaze M331 | 0.4 mm (0.016") | 7.5 min | 7.5 min / 1000 psi, 1"; To substrate. |

TECHNOLOGY DESCRIPTION

Hontek' erosion protection technologies are based on polyurethane elastomers. They are supplied as sprayable coatings or moldable resins. Hontek erosion protection technologies are field repairable: the blades can be repaired without removal. Hontek has

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also designed into their erosion protection products an Early Erosion Indicator, for easy visual cues of erosion damage level.

CURRENT STATE OF DEVELOPMENT

One sprayable coating system, HC05XP1, has been qualified on the Army's Black Hawk helicopters and achieved great success in Iraq and Afghanistan. The field deployment results indicated that sand erosion cause expensive damages on helicopter main rotor blades. During one year deployment with about 600 flight hours in the desert, the main rotor blade replacement rate is about 26.5% in Afghanistan and 30.5% in Iraq. When protected with Hontek coatings and repair kits, the main rotor blade replacement rates are 0% for both Iraq and Afghanistan. Based on the field experiences of 52 Black Hawks, and over 31,000 flight hours, the use of Hontek-coated blades and repair kits has drastically reduce the operating cost of helicopters in the desert. Hontek believes that similar cost savings can be achieved in the Navy platforms.

Several of Hontek coatings have been sprayed on 56 used LCAC lift fan blades. They have been installed onto LCAC lift fan assembly and are in field trial stage.

Molded boots are being developed for use on the in-air propulsion blades.

On-going cavitation erosion tests have shown that Hontek sprayed coatings are capable of providing up to 450 minutes of cavitation erosion resistance before failure, when tested at 1000 psi and 1" standoff distance. This is 450X better than the Goodrich molded sheet, 900X better than Caapcoat FP-200, 225X better than Task L-101, and 60X better than Chemglaze M331.

REFERENCES

Office of Naval Research
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ABOUT THE COMPANY

Hontek Corporation is the technology leader in erosion resistant coatings and molding resins. Founded in 1992 after the Desert Storm war, Hontek has conducted over 17 contracts in erosion protection research for the United States Army, Navy and Air Force. In addition, Hontek also conducts extensive IR&D research projects to develop additional coating technologies.