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[54] **NEW PROCESS FOR IMPROVING THE RESISTANCE OF SURFACES AGAINST EROSION**

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[56] **References Cited**

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[57] **ABSTRACT**

There is disclosed a process for improving the resistance of the surface of a substrate against erosion and wear. The process includes coating the substrate with a coating consisting of fibers in a plastic matrix, the fibers being selected from materials wherein at least the surfaces thereof are coated with boron, boron carbide, or silicon carbide. At least a portion of the plastic matrix is removed from the surface, thereby exposing some of the embedded fibers. The surface is then coated with a polyurethane material containing a quantity of particulate material wherein at least the surfaces thereof are of boron, boron carbide, or silicon carbide.

7 Claims, No Drawings

NEW PROCESS FOR IMPROVING THE RESISTANCE OF SURFACES AGAINST EROSION

BACKGROUND OF THE INVENTION

The present invention relates to a process for applying an erosion resistant coating to a substrate.

The durability of many pieces of industrial equipment, such as compressor blades or helicopter blades, is dependent to a large extent on the erosion of the equipment by friction or by impact of finely divided solid or liquid particles. As there is no way to avoid this friction or particulate impact during use of the equipment, some means is needed to protect the equipment against such erosion.

The present invention is directed to a process for improving the resistance to erosion of surfaces either metallic or non metallic, which are subjected to friction or particulate impact. The process of the present invention comprises coating the surfaces or portions of surfaces subjected to erosion with at least one layer of a composite coating material containing fibers dispersed in a plastic binding agent. The surfaces of the fibers are either boron, boron carbide, or silicon carbide. After the fiber-containing coating material is applied, the surface is sandblasted to remove the plastic binding material, and a coating of polyurethane containing particles having a surface of boron, boron carbide, or silicon carbide is applied.

Thus, according to the present invention, the surface to be protected is first coated with one or more layers of threads or fibers contained in an organic resin. These threads or fibers have boron, boron carbide, or silicon carbide surfaces. In this coating the threads or fibers may be oriented in a preferred direction; in the case where more than one layer is used, the orientation may differ from one layer to the next.

The amount of threads or fibers contained in the coating composition may range from 30 percent to 70 percent by volume.

The orientation of the threads in the coating is determined by the degree and orientation of the flexion, traction, or torsion stresses which the pieces may receive in use, as such oriented threads may advantageously enhance the resistance to stress of the entire piece.

Previously, in order to apply the coating of the present invention to a substrate, two methods could be used. Where the substrate had a non-metallic surface, such as the case of a glass or carbon laminate, the coating would be effected at the time the laminate was molded. In the case of a metallic substrate, the coating would be first molded and then attached to the metal surface by means of a suitable adhesive.

However, the coating resulting from the above-described methods generally proves to be inadequate in preventing erosion due to the wear of the organic resin forming the matrix between the fibers of the coating. The method of the present invention alleviates this problem by removing the organic matrix between the fibers and then applying a second coating containing fine particles.

One or more layers of a first coating composition are applied to the surface to be protected. This coating composition comprises an organic plastic matrix containing from 30 percent to 70 percent by volume of threads or fibers having a coating of boron, boron carbide, or silicon carbide. After this coating is applied, it is preeroded by dry or humid sandblasting with the aid of an abrasive such as alumina of low granulometry. This treatment preferably eliminates the organic matrix, leaving a coating solely of the threads or fibers.

Next, a second coating is applied; this second coating comprises an elastomeric binder and a charge of 15 to 60 percent fine particles intrinsically resistant to erosion. This charge is based on micronized powders having a boron, boron carbide, or silicon carbide surface. A silicon carbide surface is preferred.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The example given below describes a process for protecting a compressor blade composed of carbon fibers in an epoxide resin matrix against erosion. In the manufacture of such a blade, a technology is used which employs the stacking of the unidirectional layers of carbon fibers pre-impregnated with epoxide resin. Certain of these layers have angles of intersection provided to obtain a satisfactory modulus in flexion and torsion with respect to the longitudinal axis of the blade. The stack of the plurality of layers is placed in a closed mold and then heated under pressure up to the polymerization temperature of the epoxide resin.

According to the present invention, the outer carbon layers of the above-described compressor blade are replaced by one or more unidirectional layers of boron or silicon carbide threads, which may have angles of intersection provided so as either to not change or to improve the characteristics of the blade. After the base is polymerized and machined, the blade is sandblasted dry with alumina. This sandblasting operation eliminates on the surface and between each thread the epoxide resin whose behavior to erosion is poor.

A finishing coating is then applied. In this case it is a polyurethane based paint charged with a micronized silicon carbide powder. The paint penetrates the interstices between the threads of boron or boron carbide and enables a final smooth surface to be obtained having adequate aerodynamic characteristics.

The process of the present invention may also be used to make helicopter blades. The blades are coated with threads or fibers suspended in a matrix, which coating is treated by sandblasting and then overcoated as in the process described above.

We claim:

1. A process for applying an improved erosion resistance coating to a substrate comprising coating the substrate with a composition comprising a plastic material containing fibers having a surface of a material selected from the group consisting of boron, boron carbide, and silicon carbide; sandblasting said coating; thereafter coating the surface thus obtained with a coating of polyurethane containing micronized particles having a surface of a material selected from the group consisting of boron, boron carbide, and silicon carbide.

2. The process of claim **1** wherein at least a portion of the matrix is removed by sand blasting.

3. The process of claim **1** wherein the plastic material is an epoxide resin.

4. The process of claim **1** wherein the fibers in the plastic material comprise 30 to 70% by volume of said composition.

5. The process of claim **1** wherein the micronized particles in the polyurethane coating comprise 15 to

60% by volume of the polyurethane coating composition.

6. The process of claim 1 wherein the plastic material when being applied to said substrate is an unpolymerized polymer and the coating is polymerized after being applied.

7. The process of claim 6 wherein at least a portion of the matrix is removed by sand blasting.

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