THE VITREOUS ENAMEL COATINGS AND HIS USE IN THE MECHANICAL ENGINEERING

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Abstract

Corrosion resistance is an important aspect of material selection for applications in the chemical, food, and petroleum industries, as well as in manufacturing operations. In addition to various possible chemical reactions from the elements and compounds present, environmental oxidation and corrosion of components and structures is a major concern.

Resistance to corrosion depends on the particular environment, as well as the composition of the material. Corrosive media may be chemicals (acids, alkali, and salts), the environment (oxygen, pollution, and acid rain), and water (fresh or salts). Nonferrous metals, stainless steels, and nonmetallic materials generally have high corrosion resistance. Steels and cast irons generally have poor resistance and must be protected by various coatings and surface treatments.

One of the types of the coating which can be successfully used in the environment low and high temperature corrosion is the vitreous enamel coat provide the sufficient prevention of the metallic material.

1. PORCELAIN ENAMELING AND CERAMIC COATING

Metals may be coated with a variety of glassy (vitreous) coatings to provide corrosion and electrical resistance and for service at elevated temperatures. These coatings are usually classified as porcelain enamels and generally include enamels and ceramics. The word enamel is also used for glossy paints, indicating a smooth, hard coating.

Porcelain enamels are glassy inorganic coating consisting of various metal oxides. Enameling involves fusing the coating material on the substrate by the heating them both to 425-1000 °C to liquefy the oxides. Depending on their composition, enamels have varying resistances to alkali, acids, detergents, cleansers, and water—and come in different colors.

Typical applications for porcelain enameling are household appliances, plumbing fixtures, chemical processing equipment, signs, cookware, and jewelry. Porcelain enamels are also used as protective coatings on jet-engine components. The coating may be applied by dipping, spraying, or electrodeposition, and thicknesses are usually 0.05 - 0.6 mm. Metals that are coated are typically steels, cast iron, and aluminum.

Ceramic coatings such as aluminum oxide or zirconium oxide are applied with the use of binders, to the substrate at room temperature.

1.1. Oxide ceramics

Alumina. Also called corundum or emery (Aluminum oxide, Al₂O₃) is the most widely used oxide ceramic, either in pure form as a raw material to be mixed with other oxides. Their properties are improved by minor additions of other ceramics, such as titanium oxide and titanium carbide. Structures containing various alumina and other oxides and are used as refractory materials for high-temperature applications. The mechanical and physicall
properties of alumina are particularly suitable for applications such as electrical and thermal insulation and as cutting tools and abrasives.

_Zirconia_ (Zirconium oxide, ZrO\(_2\)) has good toughness, resistance to thermal shock, wear, and corrosion, low thermal conductivity, and low friction coefficient.

2. CERAMIC COATINGS FOR HIGH TEMPERATURE APPLICATIONS

Characteristics such as wear resistance and thermal and electrical insulation, particularly at elevated temperatures, can be imparted on products by ceramic coatings rather than imparting these properties to the base metals or materials themselves. Selecting materials with such bulk properties can be expensive or may not meet the structural strength requirements in a particular application. Thus, for example, a wear-resistance component does not have to be made completely from a wear-resistant material, since the properties of only a thin layer on the component’s surface are relevant for wear. Consequently, coatings have important applications. The table below shows various ceramic coatings and typical applications at elevated temperatures. These coatings may be applied either singly or in layers.

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>TYPE OF CERAMIC</th>
<th>APPLICATIONS</th>
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<tbody>
<tr>
<td>Electrical insulation</td>
<td>Aluminium oxide</td>
<td>Brazing fixtures, induction coils, general electrical applications.</td>
</tr>
<tr>
<td>Thermal insulation</td>
<td>Zirconium oxide</td>
<td>Compressor blades, and seals for gas turbine, valves, fan blades, pistons, and combustion heads for automotive engines.</td>
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<tr>
<td>Wear resistance</td>
<td>Chromium oxide</td>
<td>Compressor rods for the petroleum industry, pumps, plastic extruder barrels, turbine shafts, seals.</td>
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<tr>
<td></td>
<td>Aluminium oxide</td>
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3. DEFECTS - „FISH SCALE“

The most problems by the enamelling of steel are the hydrogen defects. The hydrogen sources can be:
- the proces of metallurgy by the steel making
- the moisture in the atmosphere
- the ingrediance used by the milling of enamel
- the chemical treatment of surface before enamelling

For good quality of the enamel vitreous coat is necessary perfect bond between the metal and the vitreous enamel and resist against rise of defect of type fish scale (Fig.1), which produce of the release of hydrogen from the substrat. Formation hydrogen from moisture in course burning and his diffusion to steel is schematic drawing on Fig.2. The process results during cooling enamel in the places of microscopic inhomogeneities f.e. micro-cavity in steel. In the places forms the center of molecular hydrogen, which with his pressure can cause shelling the vitreous enamel. This process runs on the phase interface very slowly and can last some weeks.

_Figure 1. Fish scale_
4. CONCLUSION

The paper presented the vitreous enamel as coatings, which can be used in the environment low and high temperature corrosion, organic acids and their salts, hot water, steam, hot gases, aggressive atmosphere. The enamels are hygienic harmless. Porcelain enamels are resistant to abrasion, low temperature (to -50° C), high temperature (to 500° C).

References