INFLUENCE OF CLAY SMALL SIZE ON MECHANICAL PROPERTIES OF VITREOUS ENAMEL COATINGS

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Abstract

Vitreous enamel coats are glassy inorganic coatings, which ensure perfect protection of metal materials against corrosion, thereby modify properties of surface background material. We can use this coating in energy-, ecological-, agricultural- engineering, further in architecture industries and on consumer goods. Contribution studies effect size of clay component like input raw material on mechanical properties of vitreous enamel coatings. Used clays are sizes 400nm in 1D size. Experimental results shows, that clay components have different influence on mechanical properties of vitreous enamel coatings. Microhardness and fracture toughness at the first.

Key words: enamel coating, finely ground clay, aging clay, mechanical properties, nanosize

1. INTRODUCTION

Vitreous enamel coating is one way of surface protection, which ensures good resistance to highly aggressive environments and corrosion. Enamels seems very reasonable, even though their use is limited by high labor input of production, intensity of compliance with the prescribed technologies and energy costs. Enamels have many excellent properties such as chemical resistance to acids, wholesomeness or abrasion resistance. On the other side, however, also disadvantages. The low value of fracture toughness caused by low resistance to cracking and cracking enamel coating.

2. EXPERIMENTAL MATERIAL

For the experimental tests was used background material with commercial name KOSMALT E300T. The samples were shot-blasted to a surface cleanness of Sa 2.5 using cut steel wire according to ISO 8501-1. The steel material was degreased by immersion in a 1:10 solution of the Simple Green preparation and water. Samples No. 1 was degreased by immersion with a temperature of 23.2 °C and a pH of 9.32 for 5 minutes. Then it was rinsed by immersion in water with a temperature of 23.2 °C and a pH of 8 for approximately 1 min. Samples No. 2 was degreased by immersion with a temperature of 24.2 °C and a pH of 9.16 for 5 minutes. Then it was rinsed by immersion in water with a temperature of 24.4 °C and a pH of 8.28 for approximately 1 min. Samples No. 3 was degreased by immersion with a temperature of 25.0 °C and a pH of 9.44 for 5 minutes. Then it was rinsed by immersion in water with a temperature of 21.7 °C and a pH of 8.92 for approximately 1 min.

Vitreous enamel slurry was applied to degreased experimental material by hand spraying using a pressure spray gun. Drying of samples was at a temperature 100°C for 5 minutes. Burning enamel coating was carried out at a temperature of 820 - 840°C for 8 minutes and after air-cooling of enamel coating. On
samples No. 1 were used two types of vitreous enamel slurry with clay component size smaller than 5 µm with 1D size of 400 nm (basic and cover). On samples no. 2 were used two types vitreous enamel slurry with clay component size smaller than 5 µm with 1D size of 400 nm (basic and cover), where the clay component was used after two years since grinding. Specimen no. 3 were used two types vitreous enamel slurry with clay component size smaller than 5 µm with 1D size of 400 nm (basic and cover), where the clay component was used after three years since grinding. Grinding of clay was carried out on a Jet vertical Mill Sturtevant.

The tests were carry out on experimental samples with vitreous enamel coating, which was contained by clays one, two and three years old.

<table>
<thead>
<tr>
<th>Sample no.</th>
<th>Sign</th>
<th>Basic enamel</th>
<th>Sign</th>
<th>Basic + cover enamel</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A.</td>
<td>Finely ground clay - used after one years</td>
<td>B.</td>
<td>Finely ground clay - used after one years</td>
</tr>
<tr>
<td>2</td>
<td>C.</td>
<td>Finely ground clay - used after two years</td>
<td>D.</td>
<td>Finely ground clay - used after two years</td>
</tr>
<tr>
<td>3</td>
<td>E.</td>
<td>Finely ground clay - used after three years</td>
<td>F.</td>
<td>Finely ground clay - used after three years</td>
</tr>
</tbody>
</table>

**Vickers microhardness test by ČSN EN ISO 4516**

For measuring microscope was used to NEOPHOT with Hanemman microhardness tester. Indentor loading force was 1 N for 10 s.

![Microhardness of basic enamel coating](image1)

![Microhardness of cover enamel coating](image2)

**Fig. 1. Microhardness of basic and cover enamel coating**

**Calculation of Fracture Toughness**

Measurements microhardness coating and calculation by equation [1] was determined fracture toughness of enamel coatings.
Fracture toughness of basic enamel coating

Fracture toughness of cover enamel coating

3. CONCLUSION

Experimental tests showed that the clay component of ground two and three years old, and after this time applied to the enamel coating, significantly exert influence up the fracture toughness of both basic and cover enamel.

Results of microhardness measurements on the basic and cover vitreous coating in Fig. no 1. showed on value rise in dependence on time out of clay ageing. This rising of microhardness is evident in both vitreous enamel coatings with clay component used in enamel slurry after a time out of two and three years. The growth of values was recorded for measurement of fracture toughness of experimental samples. Only the basic vitreous enamel coating was recorded appearance of Palmqvist cracks also after three years. By the cover enamel coating, when clay was aged for three years from grinding the cracks wasn’t found. This experimental results are very important for using enamel coating in practice, especially for wheel the enamel construction.

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Literature