STUDY OF THIN COATING FOR ANTI-CORROSIVE PROTECTION OF STEEL SUBSTRATE

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Abstract

Contribution discourse about development and studies thin organic coating and their possibilities using for short-term anticorrosive protection of material metallurgical performance.

Aim is study and application of thin coating with zinc-phosphate nano and micro particles. Zinc-phosphate is using in paint systems for increasing corrosion resistance. Thin coating is applicated on shot blasting steel substrate. Experiments are intent on classification anticorrosive protection of thin coating. The using of particles nanosizes has influence on properties of protective coatings.

Results shows that small amount of nanoparticles increasing corrosion resistance already but important is influence a thickness of thin coating. Use of thin coating is presuming in anti-corrosive protection of surface steel substrate of mechanical parts. Thin anticorrosive coating has good adhesion to steel substrate. Corrosion test is according by standard to ČSN EN ISO 9227. From the experimental test of anticorrosive protection was found, that the both coatings resist 24 hours with damage of cut. That is 4 months short-time anticorrosive protection in real environment C5. Anticorrosive coating with nanoparticles without damage resist 120 hours. That is 20 months anticorrosive protection in real environment C5. Anticorrosive coating with microparticles without damage resist 240 hours. That is 40 months anticorrosive protection in real environment C5.

Development of organic coating respects decreases VOC matters with using water like solvent components.

Keywords: thin coating, nanoparticles, microparticles, anticorrosive resistance, steel substrate, properties

1. INTRODUCTION

Nanotechnology is burgeoning science at the present time. The field of science and research where is using nanotechnology and nanoparticles is very extensive. In present time on world market are paint systems on nanoparticles base. Predominantly are this paint systems on TiO and ZnO base. The using of particles nanosizes has influence on properties of protective coatings.

Experimental works are aim at study and application of thin coating with zinc-phosphate particles. Zinc-phosphate is using in paint systems for increasing corrosion resistance. Thin coating is applicated on shot
blasting steel substrate. Experiments are intent on classification anti-corrosive protection of thin coating. Results shows that small amount of nanoparticles increasing corrosion resistance already but important is influence a thickness of thin coating.

Use of thin coating is presuming in anti-corrosive protection of surface steel substrate of mechanical part.

2. EXPERIMENTAL MATERIAL

KOSMALT E300T sheet-steel was used as background material for experimental water-borne transparent anticorrosive coating on base of alkyd resin. The samples were shot-blasted to a surface cleanliness of Sa 2.5 according ISO 8501-1 using cut steel wire. The steel sheet was degreased by immersion in a 1:4 solution of the Simple Green preparation and water with a temperature of 23.2 °C and a pH of 8.32 for 6 minutes. Then it was rinsed by immersion in water with a temperature of 21.5 °C and a pH of 8 for approximately 2 minutes.

Experimental water-borne transparent anticorrosive coating was tempered with a white anticorrosive pigment of a zinc orthophosphate hydrate with content 4–6 percent by weight. For use were prepared two variants of experimental anticorrosive coating. First with medial size of pigment particle 2 – 3.5 µm and second in particle size fraction of pigment 4 - 200 nm. The nanoparticles was prepared of WATER JET MILL on Institute of Physics, VŠB-TU Ostrava. Application of layer by painting (100 µm of wet thickness); air-drying of samples by 2 hours and after drying at a temperature of 80°C for 6 hours and air-cooling.

Fig. 1. Zinc orthophosphate – ordinary size (2500x and 6500x magnification, SEM - Scanning Electron Microscope, Nanotechnology Centre VŠB-TU Ostrava)

Fig. 2. Zinc orthophosphate – grinded to nanosize (2500x and 6500x magnification, SEM - Scanning Electron Microscope, Nanotechnology Centre VŠB-TU Ostrava)
Before the application of the anticorrosive paint systems on the surface, we measured the surface roughness of background material with Mitutoyo Surftest – 301, according to ČSN EN ISO 4287.

The adhesion of anticorrosive paint systems was solved to cross cut adhesion test according to ČSN EN ISO 16276-2.

![Cross cut test comparison](image)

**Graph.1.** Comparison of the cross cut adhesion

3. **EXPERIMENTAL RESULTS**

The anticorrosive protection was solved to corrosion tests in artificial atmospheres, salt spray tests according to ČSN ISO 9227.

Type of samples:
- A – water-borne transparent anticorrosive coating with a nanoparticles of white anticorrosive pigment of a zinc orthophosphate hydrate, thickness of dry layer is 49 µm
- B – water-borne transparent anticorrosive coating with a microparticles of white anticorrosive pigment of a zinc orthophosphate hydrate thickness of dry layer is 55 µm

1 – damage by cut, 2 – without damage

![Fig. 3. Corrosion tests according to ČSN ISO 9227 after 72 hours](image)
Fig. 4. Corrosion tests according to ČSN ISO 9227 after 120 hours

Fig. 5. Corrosion tests according to ČSN ISO 9227 after 240 hours

Graph. 2. Comparison of the anticorrosive protection

Proposal of the Calculation time corrosive resistance in environment with degree of corrosive aggressiveness C5

In proposal of calculation is presumption for organic coating corrosive resistance most 10 years in environment with degree of corrosive aggressiveness C5, where this time matches 720 o’clock of the exposition coating in corrosive chamber with salt fog.
Table 1. Corrosive resistance in corrosive chamber

<table>
<thead>
<tr>
<th>Simulated time in corrosive chamber</th>
<th>Reality- approximately</th>
</tr>
</thead>
<tbody>
<tr>
<td>720 hours</td>
<td>10 years</td>
</tr>
<tr>
<td>72 hours</td>
<td>1 year</td>
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<tr>
<td>6 hours</td>
<td>1 month</td>
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4. CONCLUSION

The aim of these experiments was to determine anticorrosive protection of steel substrate with using of thin coating.

The adhesion of water-borne transparent anticorrosive coating with a nanoparticles or microparticles of white anticorrosive pigment of a zinc orthophosphate hydrate was classified like rate number 2. That is good adhesion of anticorrosive coatings to steel substrate. From the experimental test of anticorrosive protection was found, that the both coatings resist 72 hours with damage of cut. That is 12 months anticorrosive protection in real environment C5. Anticorrosive coating with nanoparticles without damage resist 120 hours. That is 20 months anticorrosive protection in real environment C5. Anticorrosive coating with microparticles without damage resist 240 hours. That is 40 months anticorrosive protection in real environment C5.

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LITERATURE
