An Electrochemical Evaluation on Corrosion Resistance of Anti-Corrosive Paints

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ABSTRACT

The relationship between the corrosion resistance and oxygen diffusion limiting current density of some types of anti-corrosive paints, including the acryl, fluorine and epoxy resin series, was investigated using electrochemical methods, such as the corrosion potential, anodic and cathodic polarization curves, AC impedance and cyclic voltammetry etc. The F101 anti-corrosive paint with the fluorine resin series at additives showed relatively good corrosion resistance compared to the other resin series, whereas the A100 of acryl resin series showed a higher corrosion current density than the other anti-corrosive paints. Furthermore, there were good relationships between the corrosion current density and oxygen diffusion limiting current density or its diffusion coefficient. For example, the corrosion current density decreased with decreasing oxygen diffusion limiting current density and diffusion coefficient. Consequently, it is believed that the corrosion resistance of anti-corrosive paint can be evaluated qualitatively by measuring the oxygen diffusion limiting current density or its diffusion coefficient.

KEY WORDS: Anti-corrosive paint; Corrosion resistance; Polarization curves; Electrochemical methods; Oxygen diffusion limiting current density; Oxygen diffusion coefficient

INTRODUCTION

Many steel structures used widely in continental and marine areas should have the optimum protection through coatings, electric protection or some other methods etc.. Most of these steel structures are protected mainly by a coating. However, some steel piles used under sea water are generally protected using electric protection methods, such as an impressed current or sacrificial anode (Cicognami, 1990; Compton, 1961; Garlind et al., 1984; Hiramatsi, et al., 1996; Jones and Nair, 1985; Newman, 1991; Steinsmo and Bardal, 1989; Steinsmo et al., 1989). One report from Japan showed that cost of coating protection comprises more than 63% of the total cost for various protection methods (Talati et al., 1984). Furthermore, an increase in environmental contamination might cause accelerated corrosion of steel structures. As a result, coated steel structures would deteriorate more rapidly than the designed life time due to acid rain caused by air pollution etc. Therefore, the corrosion resistance of anti-corrosive paint is believed to be very important in terms of safety and economics. In previous papers, anti-corrosive paints containing additives were examined by electrochemical methods (The Overseas Coastal Area Development Institute of Japan, 1998; Japan Society of Corrosion Control Technology, 1977).

The aim of this study was to determine what type of resin and additive affects the corrosion resistance and whether there are some relationships between the corrosion current density and oxygen diffusion limiting current density or its diffusion coefficient. It is believed that these results will provide data not only to improve anti-corrosive paints with long-term anti-corrosion properties but also allow a more efficient evaluation of the corrosion resistance using electrochemical methods.

EXPERIMENTAL

The test specimen used in this experiment was SS41 steel. The surface of the test specimen was polished with sand paper (from No.200 to No.1000 ), degreased with acetone and the rust removed using a blast cleaning method (Sa21/2) until a white color appeared on the surface. The average surface roughness (Ra) was 12.5–20μm. The coating was performed using an airless spray with an injection pressure of 125Kg/cm² at climatic conditions of 21°C and a relative humidity of 65–70%. The types of anti-corrosive paints used in the experimental coatings were the acryl resin series (A100, A101), fluorine resin series (F100, F101) and epoxy resin series (E100). The dry film thickness of the paints was 25μm.

Table 1. Chemical composition of the various anti-corrosive paints (wt%)

<table>
<thead>
<tr>
<th>Comp. kind</th>
<th>Acryl resin</th>
<th>Fluorine resin</th>
<th>Epoxy resin</th>
<th>Silica</th>
<th>Xylene</th>
<th>Tio₂</th>
<th>Petroleum hydrocarbons</th>
<th>Butyl acetate</th>
<th>Additive</th>
</tr>
</thead>
<tbody>
<tr>
<td>A100</td>
<td>25–30</td>
<td>20–30</td>
<td>15–252–6</td>
<td>5–10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A101</td>
<td>35–40</td>
<td>5–15</td>
<td>15–20</td>
<td>5–10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F100</td>
<td>30–40</td>
<td>5–10</td>
<td>15–20</td>
<td>5–10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F101</td>
<td>40–45</td>
<td>1–5</td>
<td>10–20</td>
<td>5–10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E100</td>
<td>55–65</td>
<td>25–30</td>
<td>5–10</td>
<td>5–10</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Table 1 shows the chemical composition of the anti-corrosion paints examined. After coating the test specimen, it was cut to dimensions of...