INFLUENCE OF RESIDUAL STRESS LEVELS IN CORROSION RESISTANCE OF COATINGS APPLIED BY WELDING

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ABSTRACT

Metallic welding coating of corrosion-resistant steel and special alloys is a reasonable economic alternative compared to solid components manufacture from these alloys. The objective of this work was to evaluate surface residual stress in stainless steel AWS308-L T-1 coatings applied by Flux-Cored Arc Welding and Submerged Arc Welding on ASTM A36 steel plates. Residual stress measurements were performed by a portable X - ray diffractometer on coating surfaces. The main results showed that residual stress on coating surface presented compressive nature, also residual stress magnitude versus welding energy was not a linear function, and thus it is noticeable potential level influence on corrosion resistance of coatings.

Keywords: Welding, stainless steel, residual stress, x-ray diffraction, corrosion.

INTRODUCTION

Global economic demands and national oil basins characteristics have been promoted the use of acid on heavy oil by oil refineries processes. This requires excellent corrosion resistance and hot mechanical properties by materials used in the exploration and oil processing plants. Among metallic materials for this application it can be highlighted stainless steels and nickel super alloys. Nonetheless, the manufacture of solid components from theses alloys results in uneconomical equipment. Therefore, a viable alternative to this problem is the metallic coatings by welding process from these alloys on steel pipes and structures.

In this context, this study aimed to evaluate the level of surface residual stress in E308-L T-1 stainless steel coatings applied by Flux-Cored Arc Welding (FCAW) and Submerged Arc Welding (SAW) in ASTM A36 steel plates, as well as its influence on the coating corrosion resistance.

RESULTS AND CONCLUSIONS

Table 1 presents dilutions results, chromium and nickel equivalents, magnitude of residual stress and corrosion rate per year. It was expected that the coatings applied by the FCAW process had a higher corrosion resistance due less dilution values. However, this was not observed. This behavior is attributed to the higher magnitude of the compressive residual stresses in the coatings applied by the SAW process, so the more intense compressive residual stresses, the greater the corrosion resistance of the coatings was.
Table 1 - Coating properties

<table>
<thead>
<tr>
<th>Coating</th>
<th>Dilution (%)</th>
<th>Cr eq</th>
<th>Ni eq</th>
<th>TRL (Mpa)</th>
<th>TRT (Mpa)</th>
<th>Corrosion Rate (mm/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAW (7)</td>
<td>15.65</td>
<td>18.56</td>
<td>9.38</td>
<td>-619</td>
<td>-347</td>
<td>0.21</td>
</tr>
<tr>
<td>FCAW (4)</td>
<td>14.28</td>
<td>19.3</td>
<td>9.57</td>
<td>-591</td>
<td>-278</td>
<td>0.42</td>
</tr>
</tbody>
</table>

Figure 1 shows the linear potentiodynamic polarization curve of welded joints.

The chemical composition expressed here as chromium and nickel equivalent, favors the formation of passivation film on coatings applied by the FCAW process. This behavior was not observed in coatings applied by the SAW process. However, although the absence of passivation film coatings applied by the SAW process, it was observed that these coatings showed more corrosion resistance, since the current at which occurs the corrosion process was inferior to that observed in the coating applied by FCAW process. One can raise the following hypotheses concerning this behavior:

- The chemical composition is highly relevant regarding the formation of passivation film; however, the speed at which the process occurs greatly depends on the level of residual stresses caused by welding process.
- The levels of residual stresses promote significant influence on the current levels at which the corrosion process occurs. It can be noticed that the SAW 7 coat, although it does not form the passivation film has a lower corrosion rate, because the current in which corrosion process occurs is inferior to the current that stabilization of the coating passivation film FCAW 4 takes place.

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REFERENCES