Effect of Mechanical Treatment on Intergranular Corrosion of 6064 Alloy Bars

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Experiment

The chemical composition of the EN AW-6064A bars is shown in Table (in wt.%).

<table>
<thead>
<tr>
<th>Element</th>
<th>Si</th>
<th>Fe</th>
<th>Cu</th>
<th>Mn</th>
<th>Mg</th>
<th>Cr</th>
<th>Pb</th>
<th>Bi</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.60</td>
<td>0.23</td>
<td>0.27</td>
<td>0.04</td>
<td>1.03</td>
<td>0.05</td>
<td>0.28</td>
<td>0.49</td>
</tr>
</tbody>
</table>

The bars were made by an industrial hot extrusion process and right after extrusion the bars were water water-cooled (temper T1). The quenched bars were then drawn to the final diameter of 15 mm (temper T2) and straightened (temper T2S). The final operation is artificial ageing (temper T8). The effects of artificial ageing (underaging, peak-aging, overaging) on the intergranular corrosion was investigated on the bars in the T1 and T2 temper.

The resistance to intergranular corrosion was mapped using corrosion tests according to EN ISO 11846, method B.

Microstructure and corrosion

Corrosion attack of surface and cross-sections of bars after straightening

Surface – temper T2
Surface – temper T8
Cross-section – temper T8

Corrosion tests after experimental heat treatment (artificial ageing)

Surface – three types of corrosion

IGC = underaged condition from T1 and T2 temper
Pitting corrosion = peak aged and overaged condition from T1 and T2 temper
Transgranular corrosion = peak aged and overaged condition from T2S temper (after straightening)

Cross-section – the typical depth of corrosion in aged condition

Temper T1 extruded + ageing 180°C/4h+220°C/4h
Temper T2 drawn + ageing 180°C/4h+255°C/4h
Temper T2S straightened + ageing 180°C/4h+220°C/4h

CONCLUSION

The bar surface exhibited three types of corrosion:
• IGC in underaged specimens: typically extensive corrosion with a depth of more than 300 µm.
• Pitting corrosion in more aged and overaged extruded/drawn bars, where the corrosion depth was approximately 100 µm.
• Transgranular pitting corrosion in more aged and overaged bars which had undergone final straightening. Here, the corrosion depth was larger and exceeded 300 µm.

With more intensive ageing and overaging (temperature, time), IGC changed into pitting corrosion in extruded/drawn bars. There was an adverse impact of the post-drawing straightening operation on the resistance to surface corrosion in the bars, evidenced by deep transgranular pitting corrosion.

In most cases, the transverse cross-sections exhibited very deep pitting corrosion with depths up to 800 µm which followed the bands of coarse cathodic phases. Exceptions were found in severely overaged bars (extruded or extruded and straightened) which showed sporadic pitting corrosion with depths of approximately 100 µm.

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