Repair welding

of

HOKOTOL

- The high-strength alloy: HOKOTOL
- Filler alloys
- Preparation for welding
- Welding
- Welding parameter
The high-strength alloy HOKOTOL

This high-strength alloy which was developed for the aeroplane industry, was still further optimised for the tooling industry. The result is an alloy for tooling plates, called HOKOTOL, with highest strength and wear-resistance as well as high regularity of strength. Adapted to the EN-Standards for HOKOTOL the name is AlZnMgCu2,0. These characteristics produce excellent machinability, also at large plate thickness, and remains constant throughout the entire plate thickness. A remarkable feature of HOKOTOL is a high form stability during machining. Due to the very high strength of HOKOTOL the advantages could also be used for other application ranges which normally used medium- or high-strength steels. High-strength aluminium alloys of type AlZnMgCu are in principle difficult to weld without any cracks. Repair welding with suitable welding processes, like TIG and MIG, are possible for conditions which are listed in the following.

Hardness profile of a 300 mm (11.8 inch) thick plate
Typical values of Yield strength

**Welding Conditions**

**General**

- In comparison to steel the welding temperature is not visible since aluminium melts do not turn the color to red.
- High energy (heat input) should be quickly applied.
- Oxide film (melting temp.: 2020 °C) on the material surface is harmful to welding. It should be removed before welding.

**Welding method**

- MIG and TIG are generally used. For thick plates, MIG is the better method to apply.
Filler alloys

• Filler material (rod and wire)
  The order is the recommendable ranking for usage.
  • 1) AA 2319 (AlCu6Mn(A))
  • 2) AA 5183 (AlMg4,5Mn0,7)
  • 3) AA 5556 (AlMg5Mn0,7)
  • 4) AA 4043(A) (AlSi5)

<table>
<thead>
<tr>
<th>Chemical composition of filler (weight %)</th>
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<tbody>
<tr>
<td><strong>Alloy</strong></td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>AA 2319</td>
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<tr>
<td>AA 4043A</td>
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<td>AlSi5</td>
</tr>
</tbody>
</table>

• Filler must be put in an appropriate container and kept dry.
• Bare hands or contaminated gloves should not be used when handling a filler wire.

Preparation for welding
• Oil contamination and oxide film must be removed before welding.
• Mechanical method: - Wire - brushing. Brush of stainless steel wire should be used.
  - Filing
  - Machining etc.
• Chemical method: - Using organic solvent (Aceton)
• Weld preparation: Examples of weld preparation are given in the following tables.
Weld preparation

• Preparing and welding of edges

Bad

Good

\[ 45^\circ \]

\[ R > 10 \]

Welding direction

First pass

Second pass

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Hardness profile of welded HOKOTOL

- Welding process: TIG
- Filler alloy: AA 5556
Hardeness profile of welded HOKOTOL

- Welding process: TIG
- Filler alloy: AA 2319

![Graph showing hardeness profile of welded HOKOTOL with Weld seam and Heat-affected zone marked.]
• Preparing and welding of areas.

Bad

Good

Crack
• **Welding sequence for welded areas.**

![Welding sequence diagram]

Bad

![Bad welding sequence diagram]

Good

![Good welding sequence diagram]
Hardness profile of welded HOKOTOL

- Welding process: TIG
- Filler alloy: AA 2319

![Heat-affected zone](Image)

![Hardness profile graph](Image)

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Hardness profile of welded HOKOTOL

- Welding process: TIG
- Filler alloy: AA 5556
Bad

Good

\[ R > 6 \]

Welding direction

Crack

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• **Influence of filler alloy**

<table>
<thead>
<tr>
<th>Filler alloy: AA 2319</th>
<th>Filler alloy: AA 4043A</th>
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</thead>
<tbody>
<tr>
<td>first pass</td>
<td>first pass</td>
</tr>
<tr>
<td>Crack</td>
<td>no crack</td>
</tr>
</tbody>
</table>

**Weld preparing**

R > 6

**Welding**

- Filler alloy AA 2319
- Filler alloy AA 4043A

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Hardness profile of welded HOKOTOL

- Welding process: TIG
  - Filler alloy: AA 2319
  - and: AA 4043A
Weld parameter

- Welding conditions are determined on size, thickness and welding position of material to be welded.
- Starting and ending points should be carefully observed in order to avoid welding defects and incomplete fusion which could often occur. Return welding is recommended.
- The ending point is prone to crack, end crater control is definitely recommended. Return welding is also recommended.
- Pre-heating and temperature between passes should not be more than 175 °C.
- Welding parameters for TIG - welding are shown in the next pictures.
Welding should be done in a downward direction
The best possible welding conditions would be:

**Torch assembly**

![](image)

**Influence of Shielding gas**

- **Argon**
  The arc with argon is more stable than the arc with helium.

- **Helium**
  The helium shielded arc has a higher voltage than the argon arc and therefore the welding speed for the helium shild arc is higher.

- **Argon - helium - mixtures**
  With increasing helium (up to 75 %), arc voltage would increase the penetration. Cross-sections of weld beads made with Argon and a mixture of 50 % argon + 50 % helium are illustrated in the following picture.

<table>
<thead>
<tr>
<th>ARGON (100 %)</th>
<th>Mixture: ARGON + HELIUM</th>
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<tbody>
<tr>
<td></td>
<td>50 % + 50 %</td>
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