Optimizing Parameters for Hotformed Tailored-Blank Applications

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TWB & WISCO’s Tailor Welded Blank Group

**China**
- TB Chongqing
- TB+SSC Wuhan

**Europe**
- Olofström (SE)
- Gelsenkirchen (DE)
- Duisburg (DE)
- San Gillio (IT)
- Tito Scalo (IT)
- Bursa (TR)

**NAFTA**
- Monroe (MI) US
- Glasgow (KY) US
- Smyrna (TN) US
- Nashville (TN) US
- Prattville (AL) US
- Hermosillo (MX)
- Saltillo (MX)
- Silao (MX)
- Puebla (MX)

2 plants / 5 lines
6 plants / 17 lines
10 plants / 25 lines

TWB & WISCO Tailored Blank Groups support the global automotive market
Tailored Products – 50 Products Applied

- Tailor Welded Blanks
- Hotformed Blanks - HFTB
- Tailor Welded Coils
- Tailored Aluminum Blanks
First to Market in 2007, Millions of Parts Supplied

B-Pillar
> 4.5 Mil. pcs
MBW1500
MBW500

Tunnel Reinf.
> 4 Mil. pcs
MBW1500
MBW1500

Source: AUDI AG

Rear Long. Rail
> 2.4 Mil. pcs
MBW1500
MBW500

Source: AUDI AG
HFTB – Global Market Share

Total volume in 2015: 5.6 Million blanks

Hotformed blanks supplied since 2007: >15 Million blanks
HFTB Overview

Uncoated or Zn Coated
- All Material Combinations
  - Conventional LASER Welding

AlSi Coated
- MBW1500-MBW1500
  - Ablation + Conventional LASER Welding
  - Ablation + Hotwire Welding
    (t>2mm or Δt>0.5mm)
- MBW1500-MBW500
  - Hotwire Welding
Conventional HFTB MBW1500/1500 with Ablation

Thickmess < 2mm
Thickmess step < 0.5mm
**HFTB Overview**

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    - Ablation + Conventional LASER Welding
  - MBW1500-MBW500
    - Hotwire Welding
  - Ablation + Hotwire Welding
    - (t>2mm or Δt>0.5mm)
Hardness Drop Phenomenon

Phenomenon occurs due to:
- Hotstamping process variation
- Thick material (>2mm)
- Large thickness step (Δt>0.5mm)

~20% martensite in weld seam
Reasons for Hardness Drop

Welding process:
- Grain size of weld seam – very small grain size due to laser welding

Hot stamping process:
- Alignment of thickness step in forming die
- Cooling condition around weld seam
- Blank temperature entering die
LASER welding process produces much finer grain size in weld zone than in base material.

Smaller grain size lowers the martensite start temperature and shifts the Ferrite, Pearlite and Bainite “nose” to the left. Thus, less than critical cooling rates lead to ferritic or bainitic transformation.

The weld zone is still hardenable. Cooling in oil always leads to a martensitic structure of the weld zone.
Alignment of Thickness Step

Cooling rate depends on form lock in hot stamping tool.

Misalignment $\Delta$ of thickness step leads to lower cooling rates in area of weld seam due to air insulation. A hardness drop can occur with a 4 mm misalignment. Misalignment greater than 4 mm can influence hardness of the base material.

Compared to other solutions: TBs better positioned due to high geometry tolerances and abrupt thickness step.

Vickers Hardness

- Gap 2mm
- Gap 4mm
- Gap 6mm
- Gap 8mm
- Gap 10mm

Compared to other solutions: TBs better positioned due to high geometry tolerances and abrupt thickness step.
Low blank temperature and long transfer time can lead to ferritic transformation before stamping. Especially for thin sheets, the blank temperature after transfer into the die can be below 700°C depending on oven temperature and transfer time. Quenching parameters should be designed for the thinnest sheet.
Cooling Condition Near Weld Seam

Hot spots can arise at segmented partitions of the die.

Weld seams should not be placed at possible hot spots, such as those that originate from segmental partition or lifter positioning.
Test Setup and Matrix

- **Thickness combinations**
  - 1.47 – 1.33 mm
  - 1.75 – 1.36 mm
  - 1.36 – 0.97 mm

- **Oven temperatures:**
  - 940 °C
  - 870 °C

- **Transfer times:**
  - 9 s
  - 13 s

- **Misalignment:**
  - 2 mm
  - 6 mm
Low oven temperature and/or long transfer times can result in low blank temperature upon entering the die and lead to ferritic or bainitic transformation.

- **870°C – 13s**
- **870°C – 9s**
- **940°C – 13s**
Hotforming Process Parameter – Oven Temperature

Low oven temperature results in predominant failure of weld seam in tensile test. Regular oven temperature results in predominant failure of thin parent material.

920°C

870°C

1.47 – 1.33 mm
1.75 – 1.36 mm
1.36 – 0.97 mm
Critical cooling rate

Temperature

- Uniform hardening of laser weld seam and base material can be challenging for the hot stamper.
- To widen the window of hot stamping process, TWB / WISCO Tailored Blanks developed Hotwire welding.
- The Hotwire process uses the principle of weld seam alloying.

Thickness > 2mm
Thickness step > 0.5mm
Alloying of the weld seam opens process window for thick Hotformed tailored blanks.

870°C – 13s (Conventional)  

870°C – 13s (Alloying)  

Improved hardness even with poor hot stamping conditions.
Hotwire welding can eliminate the ablation process for MBW1500-MBW500 combinations.
HFTB MBW1500/500 with Hotwire

No hardness drop!
Hardness of weld always above hardness of micro-alloyed steel.
Fracture in tensile test always in micro-alloyed steel.

Tensile test at high strain rates ("Crash")
according to DIN EN ISO 26203-2
- 2.3 m/s ⇔ 40 s⁻¹
- 13.0 m/s ⇔ 200 s⁻¹
Samples from Hotwire process show better fatigue strength when compared to ablation process.

Test of cyclic load capacity
- Load ratio $R = 0.1$
- Frequency 90 Hz
- Limiting number of load cycles $2 \times 10^6$
- Start at $\sigma_{\text{max}} = 200$ MPa; increase of +20 MPa for not failed specimen
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TWB / WISCO Tailored Blanks have the solutions for all your hotformed product requirements.
Future Trends

• Growing use of MBW1500-MBW500 tailored blanks for precise energy management

• Hot forming with mixed materials is a significant contribution to light weighting

• Hot wire process development underway for MBW1500-MBW1500
Questions?

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