Schweißen am laufenden Band
Welding on the Current Metal Strip

Bolzenschweißen in Blechumformwerkzeugen
Arc Stud Welding with Tip Ignition in Sheet Metal Working Tools

13. Werkstoff-Forum
Hannover Messe 11.04.2013
Dr.-Ing. Dominic Gruß, Phoenix Feinbau GmbH & Co. KG
Agenda

- Phoenix Contact
- Tool integration of joining processes
- Arc stud welding with tip ignition
- Tool integrated arc stud welding
- Summary
PHOENIX CONTACT Group

Hall 9, Stand F40 (Main stand)
PHOENIX CONTACT
Markets

Energy supply  Chemical industry  Automobile  Wind power  Telecommunication

Railway technology  Water supply  Machine building  Industry electronic  Building technology
PHOENIX CONTACT
Products of PHOENIX FEINBAU

- 3000 stamping part products
- Complex forming operation
- Tool-integrated processes
  - Assembling
  - Thread moulding and cutting
  - Welding (Resistance, Laser etc.)
  - ...

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Tool integration of joining processes
Process chain

**Conventional Process Chain**
- Metal strip
- Progressive die
- CD Arc stud welding (manual/automatic)
- Further processing

**Integrated Process Chain**
- Metal strip
- Progressive die with integrated welding stage
- Further processing

Primary **aim of process integration** is the single-stage fabrication
- → Increase in **productivity** and value added in stamping processes
- → Improvement of **quality** of processes and products

Prozess chains by comparison
Tool integration of joining processes

Results

- Influence on productivity
  - Loss of logistic of semi-finished products
  - Shortening of through-put time
  - **But:** Modification of operational availability of production-line

- Influence on quality
  - Increase of precision of positioning of joining parts in tool
  - High mechanical stiffness and strong clamping of sheet metal part
  - Good repeatability of process because of stable boundary conditions

**Press-in and welding elements**

**Benefit of welding processes**

- Safety metallic continuity
- Applicable on thin metal sheet
- High leak-tightness
Arc stud welding with tip ignition

Process

I. Positioning of the stud and pressing on
II. Vapourising of tip and arc ignition
III. Dipping of the stud in melting bath
IV. Welded stud on work-piece

Process characteristic
- Energy of capacitor discharge
- Total process time < 5 ms
- Arc time < 3 ms

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Arc stud welding with tip ignition
Process control and parameters

Essential variable
- Current circuit: ohmic resistance, inductivity
- Mechanic: accelerated mass, friction, stiffness
- Joining components: joining area, surface, material

Setting parameter
- Capacity of capacitor
- Charging voltage
- Elastic force

Representative measured curves of process control
Arc stud welding with tip ignition
Joining elements

- Types of joining element
  - Threaded studs
  - Bolts and nails
  - Contact plugs

- Dimensions
  - Joining diameter from 1 to 12 mm
  - Thickness of metal sheet up from 0.5 mm
  - Cylindrical or related stud geometries

- Materials
  - Ferritic and austenitic steel
  - Aluminium alloys
  - Copper alloys

Short welding time and flat melting bath allow weldings with
- restricted miscibility and
- intermetallic compounds
Arc stud welding with tip ignition

Technical capabilities

- Stable and light welded sheet metal constructions → due to **full-faced connection** without further overlap
- Unaffected back-sided sheet metal surface (>1 mm) → due to **low energy input** and flat melting zone
- Welding on thin-walled hollow structures → due to **only one-sided access necessary**, low joining force
- High resistance to corrosion of welding area → due to **gapless welding**
- Possibility of welding coated sheet metal → due to **cleaning effect** of arc

Key benefits of arc stud welding with tip ignition for integration in tools

- Short process time
- Low energy and heat input
- Simple kinematics (process with contact)
Tool integrated arc stud welding
Experimental tool

- Main system
- Welding stage
- Press controlling
- Stud feeding
- Part separation
- Quality controlling
- Wastage discharge
- Welding controlling
- Source of welding current
- Emission absorption
- Testing system

Welding head
Tool integrated arc stud welding
Sample part

- Progressive die with 3 operation steps
  1. Pearcing for positioning and referencing
  2. Welding of the stud
  3. Cutting-off the demonstration parts (60 mm x 50 mm)

- Experimental material
  - Threaded stud S235 M5x16-4.8 DIN EN ISO 13918 (Pad footing-Ø 6.5 mm)
  - Steel sheet DC 04; 1 mm (as delivered, with thin oil film of 5 g/m²)
Tool integrated arc stud welding
Process video
Tool integrated arc stud welding

- Process stability
- Electrical parameter welding current and voltage show
  - Repeatable ignition and process behaviour
  - High process stability
  - Short welding time of 2 ms

Accessible positioning accuracy: +/- 0.02 mm

Sheet: 1 mm, DC04
Stud: M5 x 16 – 4.8

Measured data of 20 following weldings

Reference adjustment
- Capacity: $C = 66 \text{ mF}$
- Charging voltage: $U_L = 130 \text{ V}$
- Welding force: $F_{auf} = 72 \text{ N}$
- Charging energy: $W_L = 558 \text{ Ws}$

Welding area

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Tool integrated arc stud welding
Process robustness

- Test series of more than 3,500 welding in automated operating mode up to 30 per minute
- Unbuttoned diameter shows high carrying capacity
- Process shows high stability and robustness

Trend of unbutton-diameter in automated production
Test of load-carrying capacity and analysis of micrographes
Summary

- Integration of joining processes in sheet metal working tools raise profitableness and process quality.

- Arc stud welding with tip ignition is appropriate for integration in tools.

- Solutions for integration of stud welding are available.

- Tests with the integrated arc stud welding process show good welding results with high process stability and robustness.
Thank you very much for your attention!

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