Current information from the Welding and Joining Institute of the RWTH Aachen University

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Single-sided resistance spot welding as a welding alternative for light steel structures in vehicles

Gregor Gintrowski

Single-sided resistance spot welding without back weld pass is a process variation that allows for the welding of parts with only one-sided accessibility and is thus an alternative to laser beam welding or mechanical joining methods. Within the framework of publicly sponsored research projects, typical process characteristics were identified. It was, moreover, determined that for selected sheet joints strength values were obtained which are comparable to conventional spot welding.

Light steel structures: Despite the increasing application of aluminium and fibre composite materials in automotive engineering, steel will for the time being remain one of the preferred materials. This is due to economic and also technical aspects. Steel is less expensive, it has higher strength and it is easier to process than other materials. However, also vehicles made of steel must nowadays follow the idea of lightweight design concepts. The current method of using steel for lightweight design is structural lightweight engineering. Here, the mechanical-technological advantages, especially the increase of stiffness of closed profiles are used for the reduction of wall thickness and thus of mass. During the conversion of the vehicle structure from shell construction to tubular design, new demands on the joining methods are arising. Just a few joining methods which operate single-sided, e.g. laser beam welding, MIG brazing or some mechanical processes are applicable. It is appropriate to investigate also the most important welding method in car body construction, the resistance spot welding (RSW) for its potential with regard to an altered single-sided application, Figure 1.

Fig. 1: Single-sided resistance spot welding on steel hollow sections

Single-sided resistance spot welding (SSSW): Within the last few years, the ISF has carried out comprehensive tests about single-sided resistance spot welding. In doing so, it was established that this process variation has a high potential for specific applications. Although the method has limits with regards to plate thickness combination, process design or mechanical strength, still a weld quality which can be compared to conventional spot welding can be produced. At that, the user must consider characteristic features, such as shunt behaviour, reduced electrode force and changed nugget geometry. With the aid of a robot-controlled push-welder it was established that soft cover plates (e.g. DC04, 0.7 mm) can be welded robustly onto stiff profiles (e.g. 22MnB5+AS, 1.5 mm), this, however, employing mechanical-technological properties which are partially identical with RSW. Despite the differences in the nugget shape, the curve of the cross-tension force shows comparable behaviour, Fig. 2.

Fig. 2: Macro-sections and cross-tension force for RSW and SSW of DC04/22MnB5 joints

While, during the last couple of yours, research was limited rather to the fundamental characteristics of the welding process, among other things statements about the influence of plate gaps, electrode inclination or a consideration of the fatigue behaviour of the single-sided produced welding nugget have still not been established. At the beginning of 2017, the ISF has started work on another publicly sponsored research project which deals with the investigation of exactly those characteristics. This work will bring about even more complete conclusions about the potential of one-sided spot welding without back weld pass.

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Approaches towards emission minimisation in pulsed arc welding

Martin Christ

The aim of this research project is to develop a concept which allows for the reduction of welding fumes in pulsed arc welding which are harmful to health and environment. To this end, the functional relevant connections between process parameters, weld quality and the specific emission rates are prepared. A correlation of the empirically determined data with a mathematical description shall allow for the derivation of concrete set-up recommendations for the user.

Pulsed arc welding is, like all other gas metal arc welding processes, inevitably connected with the development of welding fumes although the extent of the emission development shows clear differences with regard to the applied method. For the project strategy, the fact that the emission degree of a welding process can be additionally influenced by the parametrical configuration is taken advantage of.

In order to work a larger range of possible welding tasks, a spectrum of deposition efficiencies has, via the determination of different wire feed speeds been set up within which defined parameter variations can be carried out. The weld tests are carried out in a so-called fume box in which all developing welding fumes are collected and recorded, Figure 1.

![Fig. 1: Exterior view of the fumebox with viewing window (left) and interior view with stationary mounted GMA welding torch (right).](image)

Next to the extraction, i.e. in the upper region of the fumebox, a filter insert system is positioned. As a consequence of the extraction air flow, the welding fume particles are depositing on a filter and are, immediately after welding has stopped subjected to gravimetical analysis. This way, a process-specific emission rate as comparison criterion is determined which indicates the mass of welding fume per welding time in the unit [mg/s]. For a description and evaluation of the welding processes, transient current and voltage measurements are recorded and completed by synchronised high-speed recordings in order to record phenomenological characteristics in the process zone. For example, a classification of the material transfer, the determination of the droplet and arc geometry or the detection of possible spatter may be pointed out, Figure 2.

![Fig. 2: Figures, by way of example, of high-speed recordings for the classification of the metal transfer: Projectile transfer (left), spatter (centre), backstroke transfer (right).](image)

The extended optical process analysis allows for the physical classification and specification of the effects in the transient electric measurement data.

The current investigations show that accumulated parameters can be determined which show clear dependencies with regard to the development of emission. A mathematical description of the connections under consideration of the influence of the individual pulse parameters shall finally serve the user to approach the empirically elaborated target values which allow to expect a minimised emission load by means of parameter corrections.

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Staff

In December 2016, Mrs. Julia Schoft started her work as scientific assistant in the team „Adhesive bonding“. As guest scientist, Erik Olivares enriches the team of our arc welding department. Also in December of last year, Mrs. Christine Danhausen returned to the team of our administration after her paternity leave. Mrs. Stefanie Bier, research assistant in the team “Adhesive bonding“ has, after the birth of her daughter and a break of several months, also returned to the ISF. We congratulate Alexandros and Sofia Pipinikas and also Aleksej and Miriam Senger on their wedding. Mr. Stephan Klein has left the electron beam department at the turn of the year and has taken over a new assignment at the FH Aachen (University of Applied Sciences). In January, Patrick Thieme finished his training for industrial mechanic successfully and has left the ISF.

Promotion

Our cordial congratulations go to Mrs. Dr.-Ing. Marion Purrio who has successfully concluded her doctorate about the topic “New application fields of optical in-situ sensor systems for process analysis and monitoring in gas metal arc welding“ on December 20, 2016 with the oral examination.

Promotion Jubilees

The ISF congratulates the “golden“ promotion jubilarians who concluded their promotions in the ISF in the year 1967: Mr. Dr.-Ing. Uwe Klimant, Mr. Dr.-Ing. Ernst-O. Dessel, Mr. Dr.-Ing. Friedhelm-H. Walter and Mr. Dr.-Ing. Alfred Meyer.

We also congratulate the “silver“ promotion jubilarians who concluded their promotions in the year 1992: Mr. Dr.-Ing. Heinrich Wietrzniok and Mr. Dr.-Ing. Moh.-Ali Ahmadian Baghbadorani.

Concluded research projects

Steigerung der Produktivität bei der Verarbeitung von dickwandigen Bau- sowie Duplexstäben durch die Anwendung des Laserstrahl-schweißen unter Grobvakuum (AIF 17.780 N) (Increase of the productivity in processing of thick-walled structural steels and duplex steels by the application of laser beam welding in coarse vacuum)

Konzeption und Erprobung eines mobilen Vakuumsystems zur Optimierung der Wirtschaftlichkeit des Laserstrahl- und des Elektronenstrahlschweißen (AIF 17.968 N) (Conception and testing of a mobile vacuum system for the optimisation of the economic efficiency of laser beam and electron beam welding)

Steuerung der Aufmischung beim Auftragschweißen mit hoher Abschmelzleistung durch modifizierte Zweiadrahprozesse (AIF 17.885 N) (Control of the dilution in surfacing with high deposition efficiency by modified two wire processes)

Emissionsminimierung für industriell relevante Metallschutzgas-Schweißprozesse unter Einhaltung einer geforderten Nahtqualität (AIF 18.333 N) (Emission minimisation for industrially relevant gas metal arc welding processes with adherence to the required weld seam quality)

New research projects

Methoden zur Auslegung und Simulation von Metall-Glas-Klebungen im Bauwesen (AIF 19.158 N/219.158 N2) (Methods for the design and simulation of metal-glass bonds in civil engineering)

eRP-ProBe – Einfluss von Produktionsbedingungen auf das einseitige Widerstandspunktschweißen ohne Gegenlage (AIF 18.769 N1) (Influence of production conditions on single-sided resistance spot welding without back pass weld)

Einsatz optischer Sensorik für die Charakterisierung von Emissionen und Prozessstabilität beim MSG-Schweißen (AIF 19.037 BG/2) (Application of optical sensor systems for the characterisation of emissions and process stability in GMA welding)

Methode zur Umsetzung von Rührreibschweißen auf konventionellen Fräsmaschinen mittels eines empirischen Ansatzes (AIF 191 EN/1) (Method for the conversion of friction stir welding processes to conventional milling machines via empirical approach)


Miscellaneous

The ISF has successfully participated in the fair JEC 2017 which took place in Paris from March 14 to March 16. The displayed welding exhibits and research results were appreciated with highly positive resonance by the visitors. The ISF exhibition took place on the joint stand of the Aachener Zentrums für integrativen Leichtbau (AZL) (The Aachen Center for Integrative Lightweight Production) of RWTH Aachen University which had a dimension of approximately 300 m² ...

Fig. 2: ISF staff at the AZL joint stand

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