BIULETYN INSTYTUTU SPAWALNICTWA

BULLETIN

OF THE INSTITUTE OF WELDING

ISSN 2300-1674

63. INTERNATIONAL WELDING CONFERENCE

Łukasiewicz
Instytut
Spawalnictwa

No. 4/2022

BIULETYN INSTYTUTU SPAWALNICTWA

BULLETIN

OF THE INSTITUTE OF WELDING

No. 4/2022 BIMONTHLY

CONTENTS

ŁUKASIEWICZ – INSTITUTE OF WELDING

The International Institute of Welding and The European Federation for Welding, Joining and Cutting member

Zbigniew Mirski, Jarosław Pabian – Adjustment of Process Parameters in the Brazing of Aluminium Heat Exchangers

DOI: 10.17729/ebis.2022.4/1

Brazing in tunnel continuous furnaces constitutes the primary technology used when brazing heat exchangers made of the 3XXX series of aluminium alloys. The pure nitrogen-shielded brazing process is performed using non-corrosive flux Nocolok. The primary parameters applied during the brazing of aluminium heat exchangers include brazing temperature and time as well as the type and the amount of filler metals. One of the most commonly used brazing metals (having the form of coatings deposited on elements subjected to brazing) is silumin AlSi7.5. All parameters, significantly affecting the quality of the brazing process, enable the prevention of unfavourable physicochemical phenomena such as the dissolution and the erosion of brazed joints. The article presents results of brazing tests performed using normal, hot and very hot temperature profiles. A wedge test discussed in the article (performed using the normal brazing profile and involving metallographic examination) enabled the determination of the capillarity and wettability of the filler metal. The test also revealed the slight dissolution of materials subjected to brazing, yet within acceptable limit values.

Tomasz Węgrzyn, Bożena Szczucka-Lasota – Welding of Thin-Walled Mobile Platform Structures Made of Steel Docol 1400M

DOI: 10.17729/ebis.2022.4/2

Because of their high immediate tensile strength and significant fatigue strength, Docol steels (belonging to advanced high-strength steels (AHSS)) are increasingly commonly used in the fabrication of mobile platforms. The welding of the above-named steels is difficult due to the fact that the dominant structure is martensitic. As a result, the welding of such steels requires both experience and high qualifications. The tests discussed in the article aimed to identify appropriate welding parameters as well as to determine the effect of such process parameters as welding rate, the method of bevelling and the application of preheating on the quality of the joints obtained in the process.

Mariusz Janusz-Bielecki – Requirements of Pressure Equipment Safety Regulation (PER 1105, UK) for Joining Personnel and Procedures

DOI: 10.17729/ebis.2022.4/3

The launch of goods and services in markets of many countries requires the satisfaction of safety-related factors. This applies in particular to the safety of products used for various purposes. Individual countries develop requirements which must be met by the manufacturer or the service supplier, importer or the distributor. Some international organisations, such as the European Union, are developing a common legal framework for the safety of users as well as the free movement of people, goods and services. The aforesaid framework includes, among others, a set of essential safety requirements that must be satisfied by the manufacturer before launching products in the market. Having met the aforesaid conditions, the manufacturer can mark the product with the CE mark and issue a related declaration of conformity. After the UK left the European Union, the UK government has implemented measures aimed to support companies marketing their goods. This system requires conformity assessment based on British regulations and, inter alia, apply the UKCA (United Kingdom Conformity Assessed) marking on products launched on the market. For safety-related reasons, the personnel

and the procedures concerning the making of permanent joints in pressure equipment to be used in the British market must be qualified by a British approved body.

Jacek Górka, Tomasz Kik, Marek Chruściel, Wojciech Jamrozik, Marta Kiel-Jamrozik – The Analysis of the Structure and the Hardness of TIG-welded Joints Made of Nickel Superalloy Inconel 600

DOI: *10.17729/ebis.2022.4/4*

The tests discussed in the article aimed to analyse the structure and hardness of the heat affected zone and that of the weld in thin butt joints (1.0 mm) made of nickel superalloy Inconel 600 using the TIG method and variable welding linear energy restricted within the range of 45 J/mm to 80 J/mm. The test joints were subjected to visual tests, macro and microscopic metallographic tests, scanning electron microscopy-based structural observations and hardness measurements. The tests concerned with the effect of parameters applied during the TIG welding of butt joints made of 1.0 mm thick sheets (Inconel 600) in laboratory conditions revealed that the most favourable quality of the sheets was obtained when welding arc linear energy was restricted within the range of approximately 45 J/mm to 80 J/mm. An increase in linear energy within the above-presented range led to an increase in the width of the weld and that of the HAZ (observed in the joints subjected to macroscopic metallographic tests). In addition, an increase in linear energy restricted within the aforesaid range increased the grain size in matrix γ (in the HAZ) from approximately 120 μm to approximately 200 μm. The structure of the weld contained the zone of columnar grains oriented towards the fusion line as well as large groups of primary grains having the dendritic structure with clearly visible axes of primary dendrites of varied orientation. In addition, the weld structure also contained precipitates in the form of low-melting eutectics located in interdendritic spaces. The X-ray microanalysis concerning fragments having an area of 0.045mm^2, examined in the individual zones of the welded joints made of Inconel 600, revealed only slight differences in terms of mass and atomic concentrations of the primary chemical elements of the superalloy matrix such as nickel, chromium and iron or larger differences as regards carbide-forming elements such as niobium and titanium and the concentration of carbon itself.

Maciej Jurkowski, Leszek Łatka – The Effect of Cooling Time $t_{8/5}$ on Properties of MAG-Welded Joints Made of High-Strength Steels Using Robotic Methods

DOI: *10.17729/ebis.2022.4/5*

The paper presents results of tests concerning butt welded joints made of structural high-strength steel S1100QL using a robotic welding station. The subject of the tests was to determine the effect of cooling time $t_{8/5}$ on primary mechanical properties of joints. Time $t_{8/5}$ was controlled by changing preheating temperature in relation to constant linear energy (SE specimens) and changing linear energy in relation to constant preheating temperature (ST specimens). Both of the above-named cases involved the preparation of three test plates in relation to three times, i.e. 5 seconds, 7.5 seconds and 10 seconds. The test welded joints subjected to non-destructive and destructive tests represented quality level B (in accordance with PN-EN ISO 5817). No effect of time $t_{8/5}$ on mechanical properties was noticed in terms of the ST series specimens. The tensile strength identified in the tests amounted to 1020 MPa. The specimen ruptured in the weld. However, the effect of the tensile strength on hardness was noticeable, particularly in the HAZ (even above 450 HV1). The reverse tendency could be observed in relation to the SE series specimens. The value of time $t_{8/5}$ was important in terms of joint strength, amounting to more than 1100 MPa in

relation to the shortest time, where the specimen ruptured in the HAZ. In turn, the effect of time $t_{8/5}$ was negligible as regards hardness.

Krzysztof Pańcikiewicz – The Chemical Composition of the Weld Deposit in Metallic Products Made Using Wire Arc Additive Manufacturing Methods

DOI: *10.17729/ebis.2022.4/6*

The article presents an analysis concerning the obtainment of weld deposit properties (declared by the manufacturer of the filler metal) in the finished products made using additive manufacturing processes involving the application of arc welding methods. The use of an incompatible base material during the initial stage of the additive manufacturing process led to significant changes in the chemical composition of the obtained layer (when compared with the chemical composition of the weld deposit declared by the producer of the filler metal). The dilution of the partly melted incompatible base material with the weld deposit resulted in the obtainment of a layer characterised by different properties (i.e. microstructure, hardness, corrosion resistance) than those declared by the manufacturer of the filler metal. The results obtained in the tests described in the article were compared with the requirements related to the making of the weld deposit subsequently subjected to the analysis of chemical composition (in accordance with the PN-EN ISO 6847 standard). The requirements specified in the aforesaid standard are used during tests related to, among other things, the conformity assessment procedure applied when qualifying filler metals.

Joanna Wyciślik-Sośnierz, Jolanta Matusiak – Environmental Assessment of the Arc and the Laser Welding of Austenitic Steels

DOI: *10.17729/ebis.2022.4/7*

The article presents results of research work enabling the environmental assessment of the arc and the laser welding of corrosion resistant austenitic steel X5CrNi18-10 (1.4301). The steel, characterised by high corrosion resistance, favourable mechanical properties and good weldability enjoys growing popularity in many industrial sectors. The application of welding technologies in industry necessitates the performance of tests aimed to identify conditions guaranteeing safe work and protecting workers' health. Welding and allied technologies belong to the group of processes adversely affecting a work environment. Various welding processes trigger the emission of welding fumes and other pollutants containing numerous substances posing health hazards. The performance of environmental assessment makes it possible to identify and analyse how a given product or a technological process affect the environment. The assessment also enables the comparison of manufacturing processes and technologies in order to indicate those characterised by the lowest environmental impact. The primary ingredients of corrosion resistant steels are chromium and/or nickel. The compounds of the aforesaid chemical elements, present in welding fumes, are rated among substances having a potential or proven carcinogenic effect.

Dariusz Golański, Paweł Cegielski, Paweł Kołodziejczak, Andrzej Kolasa, Tadeusz Sarnowski – Verification of Selected Performance Parameters of Manipulators - External Robot Axes and the L-type Positioner

DOI: *10.17729/ebis.2022.4/8*

The creative process ranging from the development of the concept of a complex industrial manipulator through design works, simulation and calculation to the implementation of a finished product is a "mammoth" task. Designers' intentions and users' expectations are confronted with material and equipment-related limitations. Because of the usually special and unique nature of such machines, tests relating to them are not the subject of complex

standards and detailed description available in various reference publications but are primarily based on manufacturers' own procedures. The article discusses the verification of a newly developed manipulator design (L-type positioner), the prototype of which was subjected to extensive movement-related and technological tests. The study was developed within a research work concerning new types of machines developed at PPU "ZAP Robotyka" in Ostrów Wielkopolski in collaboration with the Department of Welding Engineering of the Warsaw University of Technology.

Mariusz Welcel – Verification of Equipment for Measurements of Resistance Welding Parameters - Standard Requirements and Testing Equipment

DOI: *10.17729/ebis.2022.4/9*

The article discusses parameters affecting the resistance welding process as well as methods and equipment used to measure such parameters. The verification of actual welding parameters involves the use of portable meters, measurement systems or monitoring systems, which, in accordance with related standards, should be periodically verified for the accuracy of indications. The accuracy of indications can be verified using a dedicated testing station, developed and constructed at the Łukasiewicz Research Network – Institute of Welding. The above-named station enables the performance of the simultaneous verification of root-mean-square welding current, current flow time and electrode force. The article also describes the general design of the testing station, its crucial elements as well as software applied during the verification of related equipment. In addition, the article presents testing station accuracy in relation to measurements concerning both welding current and electrode force.

Bulletin of the Institute of Welding / Biuletyn Instytutu Spawalnictwa

ISSN 2300-1674

Publisher:

Łukasiewicz - Instytut Spawalnictwa

Łukasiewicz
Instytut
Spawalnictwa