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ŁUKASIEWICZ – UPPER SILESIAN INSTITUTE OF TECHNOLOGY
CENTRE OF WELDING

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

Summaries of the articles

Anna Szewczyk, Klaudia Górska, Adrian Wolski, Dariusz Fydrych: **The Application of Cluster Analysis in the Assessment of the Weldability of Unalloyed Steels**

DOI: *10.17729/ebis.2023.3/1*

Non-alloy steels constitute a large group of steels characterised by diversified chemical composition, structural morphology and a wide range of mechanical properties (determining weldability). The paper presents results of multidimensional analyses (based on cluster analysis) of 110 selected unalloyed steel grades. Properties adopted as diagnostic features included the chemical composition, mechanical properties (yield point) and values of selected indicators concerning susceptibility to technological crack formation. The analyses (performed using Ward's and k-means methods) resulted in a division of the 110 steels into five steel groups (clusters). The comparison of results obtained using two clustering methods and involving various classification criteria revealed that multidimensional analyses constituted a prospective method making it possible to assess the weldability of steels. However, results of such multidimensional analyses should be subjected to thorough and substantive analyses.

Piotr Śliwiński, Marek St. Węglowski, Krzysztof Kwieciński: **Electron Beam Welding – Dissimilar Joints of Steels and Nickel Alloys**

DOI: *10.17729/ebis.2023.3/2*

Because of differences in physical and chemical properties of materials being joined as well as due to phenomena such as the formation of intermetallic phases, the making of dissimilar joints poses significant problems for the welding industry. Owing to its high power density, achievable high welding rates and the possibility of obtaining high metallurgical purity, electron beam welding is one of the most suitable methods enabling the reduction of adverse phenomena taking place during the welding of dissimilar joints. The research work discussed in the paper involved the making of joints using steel grades 25HM and 304 with nickel alloy (Inconel 600) and the performance of metallographic tests, tensile tests, bend test and hardness measurements. The electron beam welding method used to the make welded joints discussed in the paper meets the criteria specified in the PN-EN ISO 15614-11 standard.

Joanna Wyciślik-Sośnierz, Jolanta Matusiak, Janusz Adamiec: **The Assessment of the Effect of Technological Conditions of the Laser and Hybrid Welding of Corrosion-Resistant Steels on Welding Fume Emission**

DOI: *10.17729/ebis.2023.3/3*

Corrosion-resistant steels are used in many industrial sectors, including the food, chemical, petrochemical, power engineering and the building engineering industry. Welding processes constitute the main method enabling the joining of corrosion-resistant steels. Typically, corrosion-resistant steels are joined using manual metal arc welding, gas-shielded metal arc welding (MIG/MAG), flux-cored arc welding, TIG welding and submerged arc welding processes. In turn, advanced welding processes include laser beam, hybrid (laser + arc), plasma arc and electron beam welding methods. The growing popularity of laser methods in enterprises has necessitated the determination of the effect of technological conditions on the emission of welding fume, i.e. the dominant risk factor when welding corrosion-resistant steels. In 2017, welding fume (formed through the condensation and oxidation of metal vapours) was rated among factors of proven carcinogenic effect (in accordance with the requirements of the International Agency for Research on Cancer (IARC).

Mateusz Sowa: **The Development of a Technology for the Welding of Dissimilar Joints of Copper and Austenitic Steel**

DOI: *10.17729/ebis.2023.3/4*

Welded joints made of copper alloys and austenitic steels are commonly used in heat exchangers, pipelines and other equipment typical of the power industry. The above-named materials are difficult to weld because of their varying thermal properties. The obtainment of proper welded joints necessitates the performance of tests aimed to develop a technology enabling the welding of copper and austenitic steels. This article provides insight into research dedicated to the development of a TIG welding-based technology enabling the joining of copper and austenitic steel.

Katarzyna Hyc-Dadak, Jacek Pawlicki: **The Use of a Rotary Impact Testing Machine in Tests of Materials under Dynamic Strain Conditions**

DOI: *10.17729/ebis.2023.3/5*

The article presents characteristics of an upgraded rotary impact testing machine featuring a new measurement system based on strain gauges and enabling the recording of short signals. A dedicated test rig enabled the performance of dynamic tensile and bend tests within a linear velocity of a forcing element (striker/claw) restricted within the range of 5 m/s to 40 m/s. Tests involved TRIP and DP steels as well as alloys of non-ferrous metals PA4 and AZ31. Dynamic tensile tests were performed in relation to a striker linear velocity of 5 m/s, 15 m/s and 30 m/s. The results obtained in the above-named tests were compared with those obtained in static tensile tests. The dynamic tensile tests and structural examinations made it possible to identify correlations between strain rates, mechanical properties of the materials and the morphology of fractures. The testing methodology discussed in the article could constitute an effective tool enabling the assessment of properties of structural materials under dynamic strain conditions. The research-related test results could be used when designing the structure of energy-consuming elements of vehicles and load-bearing elements of aircraft exposed to dynamic loads.

Radosław Ciokan, Michał Urbańczyk, Santina Topolska: **The Development of a Technology for the Conventional Welding of Butt Joints (of Membrane Walls) of Composite Tubes**

DOI: *10.17729/ebis.2023.3/6*

The article presents results of tests leading to the development of a technology enabling the welding and conventional cladding (methods 141/111) of butt joints of composite tubes made of Sanicro 38/4L7 (nickel alloy/carbon steel) and 3R12/4L7 (stainless steel/carbon steel). In addition, the article discusses process parameters used in the welding of the inner layer and in the cladding of the outer layer of the tube made of Sanicro 38 and 3R12. The article also presents results of macro and microscopic metallographic tests of the joints.

Antoni Sawicki: **The Modelling of Electric Arc with Stochastic Disturbances Part. 2. Simulating the Impact of Randomly Disturbed Models of Electric Arc on the Welding System and Power Supply Network**

DOI: *10.17729/ebis.2023.3/7*

The article contains the justification for undertaking a study concerning the impact of random disturbances of AC arc on power supply systems of welding machines. In addition, the paper describes principles governing the development of arc macromodels using controlled voltage and current sources. Particular attention is paid to the magnitude of harmonic distortions of the THD+N signal (helpful in the quantitative assessment of the impact of randomly disturbed non-linear devices on supply networks). The article also presents macromodels of arcs corresponding to selected mathematical models, results of the simulated operation of these macromodels in the form of dynamic current-voltage characteristics and corresponding sets of measurement values of harmonic distortions of voltage. The study discussed in the article involved the investigation of processes occurring in the power supply system of the welding transformer loaded with randomly disturbed electric arc (found to be effective in the filtering of higher harmonics).