E.O. Paton Electric Welding Institute of the National Academy of Sciences of Ukraine

International Scientific-Technical and Production Journal

The Paton WELDING JOURNAL

December **2016**
No. 12

Published since 2000

English translation of the monthly «Avtomaticheskaya Svarka» (Automatic Welding) journal published in Russian since 1948

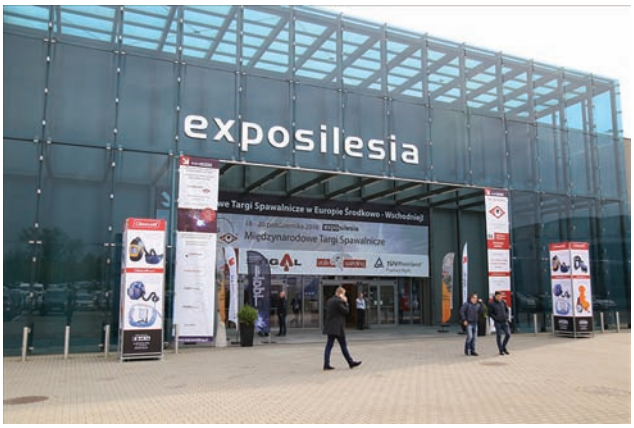
Address
E.O. Paton Electric Welding Institute,
International Association «Welding»
11 Kazimir Malevich Str. (former Bozhenko Str.),
03680, Kiev, Ukraine
Tel.: (38044) 200 60 16, 200 82 77
Fax: (38044) 200 82 77, 200 81 45
E-mail: journal@paton.kiev.ua
www.patonpublishinghouse.com

State Registration Certificate
KV 4790 of 09.01.2001
ISSN 0957-798X

Subscriptions
$348, 12 issues per year,
air postage and packaging included.
Back issues available.

CONTENTS

58th INTERNATIONAL WELDING CONFERENCE «TECHNOLOGIES OF THE XXI CENTURY» AND INTERNATIONAL WELDING FAIR EXPOWELDING-2016



The 58th International Welding Conference «Technologies of the XXI Century» was held on October 18–20, 2016 in Sosnowiec (Poland). The Conference was organized by Poland Institute of Welding and took place at ExpoSilesia Exhibition Center in scope of International Special Fair ExpoWELDING-2016.

ExpoWELDING-2016 Fair. Regular International Special Fair ExpoWELDING-2016 was held on October 18–20, 2016 in Sosnowiec. It is one of the biggest events of welding industry for Central and Eastern Europe. More than 174 companies from Poland, Czech Republic, Germany, Turkey, Netherlands, Slovakia, Ukraine, Canada, Finland, Taiwan and Sweden took part in the Fair work. The largest welding companies of the world were represented at the Fair. Around 5000 specialists of welding industry from Poland and other countries visited the Fair, 40 new products were exhibited. ExpoWELDING-2016 Fair particularly became also a fair of robotization and automation of welding processes applicable to different branches of industry. For the first time Ukraine was represented by a joint booth of five companies, namely E.O. Paton Electric Welding Institute, «TM. WELTEK» LLC (Kiev), «Vita Polis» LLC (Boyarka, Kiev region), «Sumy Electrode» LLC (Sumy) as well as plant of autogenous welding equipment «Donmet» (Kramatorsk).

All Ukrainian companies are already well known in Ukraine as well as out of its borders. Today «TM. WELTEK» LLC is the largest manufacturer of flux-cored wires for surfacing with wide range of materials; «Vita Polis» LLC is the young, but ambitious company specialized in production of wires for welding of carbon, stainless and heat-resistant steels and nickel-based alloys; «Sumy Electrode» LLC is the leading manufacturer of high-quality welding electrodes of special designation.

The joint booth was organized by International Association «Welding» upon an initiative of E.O. Paton Electric Welding Institute and was used for negotiations between Poland and Ukraine specialists. A technology of magnetically-impelled arc butt welding was presented on the booth. It raised interest of the representatives of Poland industry.

Regular XVIII meeting of the Board of International Association «Welding» with the participation of IAW founders, namely E.O. Paton Electric Welding Institute, Poland Institute of Welding, «KZU Group Engineering» (Bulgaria), Institute of Welding «JUG» (Macedonia), was held in course of Fair work. The Board stated the main directions of IAW long term activities and made a decision on having the next XIX meeting of IAW Board in Germany in September 2017.

The participants were awarded with the honorary diplomas of the Fair at awarding ceremony upon Fair work completing. The International Association «Welding» was awarded with a diploma for contribution in international cooperation.

Welding Conference «Technologies of the XXI Century». More than 350 researches and specialists from Poland, Germany, Netherlands, Slovakia, Ukraine and Finland participated in the Conference work. The Conference included a session on «Role of welding in the structures of nuclear power plants» in respect of Poland industry, where five reports were presented. To the beginning of the Conference the plenary papers were published in a special issue of «Biuletyn Instytutu Spawalnictwa» journal No. 5, 2016.

Below is a series of papers presented during the Conference.

Gary B. Marquis — «IIW: developing global best practices for the fatigue assessment of welded struc-

tures». The Intemational Institute of Welding (IIW) acts as the global network of knowledge exchange concerning the joining of materials. One of the working teams, i.e. Committee XIII, is dedicated to new research results and the implementation of innovative technologies in order to avoid fatigue failures in welded structures. Presently, the Committee is developing several new guidelines aimed to increase the fatigue service life of welded structures. One of the guidelines is concerned with the frequent use of mechanical treatment is a method of increasing the fatigue strength of welded structures. The article discusses aspects of the above-named guidelines and the uniqt1e international IIW collaboration enabling the development of these guidelines.

S. Keitel, U. Wolski, U. Mückenheim, Ch. Sondershausen, J. Müglitz — «MIG welding machines for large steel structures». The volume of welding fabrication, geometry and quality standards in the wind power sector require automation. The use of convertional industrial robots is often impossible due to safety, costs, workplace accessibility and programming time. On the other hand , typical processing rasks and post-processing activities such as cutting, arc welding and ultrasonic tests are excessively complex to be mechanised using simple tooling. Small and inexpensive modular devices on rails, known as crawlers, bridge the gap between simple mechanised equipment and industrial robots. Such devices combine easy handling and operational versatility, even in difficult site conditions, characteristic of mechanised equipment with programmability and sensor-controlled movements typical of industrial robots. This article discusses the possibilities and limitations of the above-presented concept in relation to a number of its practical applications.

M. Fiedler, A. Plozner, B. Rutzinger, W. Scherleitner — «Control of mechanical properties of high strength steels through optimized welding processes». The cooling time between 800 and 500 °C is a crucial factor significantly determining the properties of welded joints made of high strength steels. In field welding, the cooling time $t_{8/5}$ can be controlled by heat input even if different wall thicknesses of base materials are used. Modern arc processes with reduced hear input allow obtaining the same with comparable deposition rates and increase the stability of the strength level due to optimized equipment settings. This paper compares conventional GMAW processes, e.g. short arc, spray arc GMAW pulse with new processes such as PMC (pulse multi control) and otl1ers processes in relation to weld properties. Particu1ar emphasis is given to all weld metals and welds. The deliberations presented in the paper allow drawing practical conclusions and formulating recommendations aimed to optimize welding-related properties.

J. Górka, S. Stano — «Laser beam welding of 10 mm thick T-joints made of TMCP steel». The article presents research on the laser·beam welding of 10 mm thick T-joints made of thermomechanically worked high-strength steel S700MC without using a filler metal. The research-relared tests involved making single-sided and double-sided welded joints as well as performing non-destructive tests. The quality of joints satisfied the requirements of quality 1eve1 B according to the PN-EN ISO 13919-l standard. The single-sided welding performed using a beam power of 11 kW enabled the obtainment of 8 mm deep penetration without noticeable displacements in the web. The double-sided welded joints were characterized by correct geometry; the dimensions of pores present in the weld metal satisfied the maximum pore size c1iterion specified for quality 1evel B. The weld microstructure was bainitic-ferritic; the hardness of the weld was by about 60 *HV*1 higher than that of the base material (280 *HV*1). The HAZ revealed a small decrease in hardiness in comparison with that of the base material.

V. van der Mee — «Welding of (super) duplex stainless steels». The article presents and describes in detail duplex steels used in modern sectors of industry (duplex, super duplex, lean duplex and hyper duplex) with particu1ar attention paid to corrosion resistance and primary areas of application. The article also discusses welding-related issues including the preparation of the base material, welding techniques and procedures, requirements concerning heat input as well as pre-weld and post-weld heat treatment. The article emphasizes the growing use of duplex steels, among other things in welded structures, and forecasts their further development.

P. Bernasovský, A. Petráňová — «Failures of high alloy austenitic steel structures — case studies». The article presents failures of structures made of austenitic steels. The first part is concerned with accelerated (centrifugally) cast rubes (∅52.6×5.8 mm) made of steel 25–35 CrNi exposed to high temperature and severe reducing environment (a_c >> 1). The second part of the article presents test results related to a water meter element and a cooling water pipeline made of austenitic steel. In both cases, a relatively short period of service was accompanied by the appearance of

leaks. The tests revealed that the failures were triggered by microbiological corrosion caused by a sulphur reducing bacteria and not by the welding technology applied.

J. Adamiec — «Properties of laser welded tinned tubes made of nickel alloys». The article presents test results concerning properties of ribbed pipes made of the Inconel 625 nickel alloy in terms of their thermal efficiency, resistance to high — temperature corrosion and electrochemical corrosion resistance. It was ascertained that the use of 1ibs (fins) as the extension of heat exchanges surface increases the thermal efficiency of pipes almost by thrice without compromising high corrosion resistance in flue gas atmosphere and electrochemical corrosion.

Booth of Poland Institute of Welding

The improvement of the structure and mechanical properties of electron beam welded joints required the performance of post-weld heat treatment. The best mechanical characteristics of welded joints were obtained after a heat treatment performed in a furnace (annealing at T = 900 ºC for 1 hour and cooling along with the furnace) favouring the obtainment of an almost homogenous structure and the decomposition of metastable phases in the weld and HAZ.

A.A. Golyakevich, L.N. Orlov — «Surfacing performed using flux-cored wire in Ukrainian companies». The article describes experience of extending the service life of various machinery parts by surfacing them with flux-cored wires. High wear resistance during the rolling and straightening of steel is achieved by the formation of a martensitic matrix reinforced with dispersive carbides.

Booth of Fronius company

S.G. Grigorenko, S.W. Akhonin, W.Yu. Belous, R.V. Selin — «Heat treatment effect on the structure and properties of electron beam welded joints made of' high-alloy titanium». The article presents the specific formation of a joint made of high-strength high-alloy titanium alloy (α + β) subjected to electron beam welding in vacuum. Tests involved the use of Ti–Al–Mo–V–Nb–Cr–Fe–Zr specimens obtained through electron melting. The research involved tests focused on the effect of a welding thermal cycle and post-weld heat treatment on structural-phase transformations in the weld metal and HAZ of welded joints. It was revealed that the weld metal and HAZ were composed of a structure dominated by the metastable phase β, which led to the reduction of plasticity and toughness indexes.

Joint booth of Ukrainian companies

Participants of the Conference — «patonovtsy» (representatives of Paton Institute) of different years, *from left to right*: L.N. Orlov («TM.WELTEK» LLC, Kiev), M. Beloev (KZU Group Engineering, Sophia), S.G. Grigorenko (PWI, Kiev)

M. Beloev, N. Lolov — «Selected technological aspects concerning the making of ammonia storage tanks». The article discusses factor s connected with the stress corrosion cracking of ammonia storage tanks and presents the details of a welding technology ensuring the obtainment of the maximum service life of these tanks.

T. Piwowarczyk, M. Korzeniowski, A. Ambroziak, T. Kowal, R. Rutka, M. Karolewski — «Effect of pipe face preparation on the quality of magnetically impelled arc welded joints». The article presents magnetically impelled arc welding — a technology used when making butt joints mainly of elements having circular cross-sections. In addition, the articles indicates issues relate to the preparation of pipe faces and its effect on the quality of welds. The research-related experiment involved the use of selected power transmission elements. The research also included the performance of visual, geometry, metallographic, functional and technological tests of the joints as well as the determination of critical imperfections disqualifying the use of welded joints.

Z. Mikno — «High-frequency invertor welding machine — advantages of new technology». The article presents advantages of inverter welding machines having a high operating frequency of 10 kHz and compares conventional AC 50 Hz welding machines as well as inverter welding machines having operating frequency of 1 and l0 kHz. The article presents research results obtained within a currently implemented project of Programme of Applied Research (PBS3/B4/12/2015).

T. Hejwowski, K. Marczewska-Boczkowska, E. Zięba — «Microstructure, wear resistance and corrosion resistance of coatings surfaced with Ni–Co-base alloys». The article presents results of tests concerning coatings subjected to plasma surfacing involving the use of Co- and Ni-based powder mixtures. The research involved the performance of abrasive wear tests (with corundum abrasive) and adhesive wear tests in the roller-block system. Test concerning electrochemical corrosion were performed in a 3 % aqueous solution of NaCl. The article demonstrates the possibility of making wear resistant coatings of inrermediate chemical compositions.

Awarding ceremony, *from left to right*: A.T. Zelnichenko, Director of IAW; A. Pietras, Director of Poland Institute of Welding, Prof. J. Pilarchik

During IAW Meeting

J. Pikula, M. Lomozik, T. Pfeifer — «TIG method in the multiple repair welding of long-operated components in the power industry». The article presents the results concerning the repair welding of a long-op-

erated waterwall using the mechanized TIG method. The tests were focused on determining the effect of a repair performed in order to remove cracks in welded joints located along flat bars opening on the tube wall side on the structure and hardness of the heat affected zone (HAZ) of a repair welded joint in the waterwall. In addition, the tests investigated the influence of multiple repair welding on the formation of structural notches in the HAZ.

K. Luksa, M. Bednarek — «Weldability of toughened steels used in ballistic shields». The article characterises selected toughened steels used in the production ballistic shields, presents standard requirements in terms of the properties and chemical composition of these steels as well as enumerates and discusses guidance on the welding of such steels. The article also presents the results concerning the comparison of the carbon equivalents (C_e) of selected steels used for ballistic shields and preheating temperatures suggested by steel producers. The analysis of collected information revealed that the above named steels should be welded using low-hydrogen processes ensuring the obtainment of a diffusive hydrogen content below 5 cm^3 per 100 g of the weld deposit. It was also ascertained that sheets having thicknesses above 30 mm should be subjected to preheating and that interpass temperature should not exceed 200 °C. In addition, it was determined that welding should be performed using multiple runs and austenitic high-alloy filler metals, preferably G 18 8 Mn and that gas mixture-shielded welding processes should be performed using argon-based mixtures; preferably 82 % Ar + 18 % CO_2 or 92 % Ar + 8 % CO_2.

S. Stano, J. Adamiec, J. Dworak, M. Urbańczyk — «Laser welding of T-joints made of thin austenitic sheets». The article presents test results concerning the CO_2 and Yb:YAG laser welding of thin-walled T-joints made of steel X5CrNi18–10 (steel 304), X6CrNi18–10 (steel 304H) and XI5CrNiSi25–21 (steel 310) selected as stainless steels potentially useful in the production of ribbed pipes (finned tubes) intended for·operation in boilers of supercritical parameters. Welding tests were performed using two different laser sources, i.e. a CO_2 gas laser and a Yb:YAG solid state laser. The tests involved the determination of the appropriate angle of laser beam insertion into the interface of sheets, enabling the obtainment of properly shaped welds. Non-destructive tests classified the joints as representing quality level B in accordance with standard 13919-1. Selected joints were tested for the distribution of alloying constituents in the joint area. It was ascertained that laser welding made it possible to maintain the uniform distribution of alloying constituents without their significant depletion in the weld area. The tests were financed using the funds of project PBS1/A5/13/2012.

A. Świerczyńska, J. Łabanowski, D. Fydrych — «Effect of linear energy and microstructure on the content of retained hydrogen in welded joints made of superduplex steels». The article presents tests concerning the content of retained hydrogen present in FCAW and SAW welded joints made of superduplex steel. The use of various welding technologies resulted in the obtainment of welds having different microstructures and ferrite contents. Measurements of retained hydrogen present in joints (performed using the complete combustion method) revealed various contents of hydrogen in the base material and in the welds subjected to the tests. Ir was determined that the content of hydrogen in welds made of superduplex steels depends not on1y on the volumetric content of microstructures but also on their composition and welding linear energy.

Dr. A.T. Zelnichenko, IAW

PATON PUBLISHING HOUSE

www.patonpublishinghouse.com

SUBSCRIPTION

«The Paton Welding Journal» is Published Monthly Since 2000 in English, ISSN 0957-798X.

«Avtomaticheskaya Svarka» Journal (Automatic Welding) is Published Monthly Since 1948 in Russian, ISSN 005-111X.

«The Paton Welding Journal» is Cover-to-Cover Translation of Avtomaticheskaya Svarka» Journal into English.

If You are interested in making subscription directly via Editorial Board, fill, please, the coupon and send application by Fax or E-mail.

The cost of annual subscription via Editorial Board is $348 for «The Paton Welding Journal» and $180 for «Avtomaticheskaya Svarka» Journal.

«The Paton Welding Journal» can be also subscribed worldwide from catalogues subscription agency EBSO.

SUBSCRIPTION COUPON

Address for journal delivery _____

_____

Term of subscription since _____ **20** **till** **20** _____

Name, initials _____

Affiliation _____

Position _____

Tel., Fax, E-mail _____

We offer the subscription all issues of the Journal in pdf format, starting from 2009.

The archives for 2009–2014 are free of charge on *www.patonpublishinghouse.com* site.

ADVERTISEMENT

in «Avtomaticheskaya Svarka» and «The Paton Welding Journal»

External cover, fully-colored:
First page of cover (190×190 mm) — $700
Second page of cover (200×290 mm) — $550
Third page of cover (200×290 mm) — $500
Fourth page of cover (200×290 mm) — $600

Internal cover, fully-colored:
First/second/third/fourth page of cover (200×290 mm) — $400

Internal insert:
Fully-colored (200×290 mm) — $340
Fully-colored (double page A3) (400×290 mm) — $500

- Article in the form of advertising is 50 % of the cost of advertising area
- When the sum of advertising contracts exceeds $1001, a flexible system of discounts is envisaged

Size of journal after cutting is 200×290 mm

Editorial Board of Journal «Avtomaticheskaya Svarka» and «The Paton Welding Journal»
E.O. Paton Electric Welding Institute of the NAS of Ukraine
International Association «Welding»
11 Kazimir Malevich Str. (former Bozhenko Str.), 03680, Kiev, Ukraine
Tel.: (38044) 200 60 16, 200 82 77; Fax: (38044) 200 82 77, 200 81 45
E-mail: journal@paton.kiev.ua; www.patonpublishinghouse.com