MAIN TOPICS, ABSTRACTS & KEY WORDS

The Double Zero Soft Switching Arc Welding Power Source

CHEN Shu—jun(Beijing Polytechnic University, Material Science and Engineering School, Beijing 100022, China), LU Zhen—yang, HUANG Pengfei, YIN Shu—yan, PU Chun—hua. p1~5

Abstract: The FB—ZVZCS—PWM converter subjoined a block capacitor into the FB—ZVS—PWM converter. At the freewheeling interval, the primary current is attenuated fast to zero and maintained. And then, power devices of the static leg become a Zero—Current—Switch (ZCS), power devices of the shifted leg become a Zero—Voltage—Switch(ZVS). In this way, on the one hand the IGBT with tail current can be easily used for fullbridge soft—switching converter, on the other hand additional circuiting energy is greatly reduced. At the same time, small duty cycle loss, lower secondary parasitic ringing and wide soft—switching load range are achieved. Finally, based on above achievement, a 10 kW class arc welding power source prototype with FB—ZVZCS—PWM converter has been developed. Due to the considerable decrease of switching losses, the temperature—rising of this soft—switching arc welding power source is vety low. The temperature measurement shows that it is almost 20 ℃ lower than that of a hard—switching arc welding power source with the same output power. At the same time, the power devices of the arc welding power source operate under the zero—switching situation, which reduces the current and voltage stress. Therefor the reliability of the arc welding power source is improved greatly.

Key words: arc welding inverter power source; soft switching; zerovoltage—switching (ZVS); zero—current—switching(ZCS)

Welding of High Manganese Steel to High Carbon Steel(Paper I)

GUO Mian—huan(National Key Laborary of Advanced Welding Production Technology, Harbin Institute of Technology, Harbin 150001, China), ZHAO Min—hai, DONG Wei—guo. p6~10

Abstract: Welding of high manganese steel to high carbon steel is difficulty because there are so many difference between these steels such as chemical, physical and mechanical properties respectively. Each weldability of high manganese steel and high carbon steel was examined through the study in paper I and paper II. By the microstructure analysis, SEM analysis and energy depressive analysis of welded joint, the welding method of high manganese steel to high carbon steel was determined. The method supplies particular welding technology. It is studied in the paper II to weld directly or with an intermediate layer between two kinds of steel. Then the best welding technology was worked out.

Key words: high manganese steel; high carbon steel; welding technology

The Computer Simulation of Concentration Field for Be/HR—1 Stainless Steel on HIP

KONG Ji—lan (College of Materials Science and Engineering, Chongqing University, Chongqing 400044, China), ZHANG Peng—cheng, ZHOU Shang—qi, ZOU Jue—sheng. p11~14

Abstract: In order to provide the best technic parameter for the HIP process, the diffuse—bonding concentration field of Be/stainless Steel under a certain condition was simulated by the finite element method. More study had been done on the relationship between the diffuse distance and the diffuse time. The results show that the simulative consistency curves fit with the experience ones well and there is a parabola relationship between the diffuse distance and the diffuse time.

Key words: concentration field; computer simulation; HIP; Be/stainless steel

Effect of Transformation Temperature on Improving the Fatigue Strength of Welded Joints

WANG Wen—xian (Welding Division, College of Material Science and Engineering, Tianjin University, Tianjin 300072, China), HUO Li—xing, ZHANG Yu—feng, WANG Dong—po. p15~18

Abstract: The phase stresses produced by transformation expansion strain at different transformation temperature can affect the kinds and values of the residual stresses of welded joints. The effect of transformation temperature of weld metal on the residual stresses and the fatigue strength of welded joints is analyzed based on their test. The fatigue specimens of welded joints with longitudinal stiffeners welded by five welding electrodes whose transformation temperatures of deposited metal are different, are selected to conduct fatigue test, which have high restraint intensity and stress concentration. It is shown that the fatigue strength of welded joint is the highest in all welded joints at around 191 ℃ of transformation temperature. It is also shown that the welding electrodes with low transformation temperature can improve the fatigue strength of welded joints.

Key words: transformation temperature; fatigue strength; welded joints; compressive residual stress

The Model of Spatter Prediction in CO_2 Arc Welding Based on the Character of Sound Signal MA Yue-zhou (Colo. of Materials Engineering, Gansu Univ. of Tech., Lsnzhou 730050, China), MA Chun-wei, ZHANG Peng-xian, CHEN Jian-hong. p19~22

Abstract: In this paper, the correlativity is analyzed among characters of time domain and frequency domain of arc sound signal, process of transfer and spatter in CO_2 short circuiting welding. In different frequency bend, wavelet packet is applied to sound signal analysis to get the energy character that can be regarded as the characteristic vector to denote the spatter. The model which can denote the spatter using character vector is proposed using the neural network to predict the spatter in CO_2 short-circuiting arc welding. The simulation shows that welding spatter can be satisfactorily predicted through the characteristic vector of sound vector and that it is a new way on-line quality control.

Key words: welding arc acoustics; wavelet analysis; neural network; CO_2 arc welding; spatter prediction; quality control

Hydrogen-Induced Cracking Feature of steel 20MnNiMo **ZHANG Xian-hui (Harbin Research Institute of Welding, Harbin 150080, China), JIAO wei, TAN Chang-ying.** **p23~25**

Abstract: In this paper the effects of diffusible hydrogen content and cooling rate ($t_{8/3}$) on hydrogen-induced cracking (HIC) of steel 20MnNiMo have been investigated by implant teat, and the fractography of implant is observed by scanning electron microscope (SEM). The experimental results show that HIC of steel 20MnNiMo is relative with diffusible hydrogen content strongly. At low hydrogen level, high restrain stress is needed to nucleate HIC; but at high hydrogen level, only small restrain stress can cause HIC occurrence. At the same hydrogen content level, the better the HAZ toughness, the higher resistance to HIC.

Key words: 20MnNiMo; hydrogen-induced cracking; fractography; toughness

Real-time Control System of Torch-height Based on Through-the-Wfre Sensor ZHU Zhi-ming (Tsinghua university, Beijing, China), BAO Yun-jie, YU Song-tao. p26~28, 48

Abstract: Considering the characteristics of through-the-wire sensor, a real-time tracing and control system of torch height for waveform-controlled short-circuit CO_2 welding is established based on the MCU (Motorola MC6SHC11A1) in this paper. After real-time measuring and processing the wire extension signal during the period of short-circuit, the real-time and precision control of torch-height for short-circuit CO_2 welding is realized by using this system designed with reasonable framework. The experimental results show that the system has excellent stability and dynamic response under different conditions, such as different slope angles, wire feeding rates and welding speeds. This realization makes the welding process more stable and the welding quality improved.

Key words: short-circuit CO_2 welding; through-the-wire sensor; torch-height; real-time control

The HAZ Grain Growth Diagram of the New Generation Steel with Yield Strength 400 MPa QU Zhao-xia (Technology Center, Baoshan Iron&steelco. Ltd, Shanghai 201900, China), TIAN Zhi-ling, DU Ze-yu. p29~31

Abstract: The new generation steel will be the main structural material in 21st century. The MAC pulsed welding, one of the conventional fusion welding, can suit to the new generation steel. In order to promote the research on its weldability and engineering application, the weld thennal cycle equation is described correctly according to the measured MAC pulsed weld thermal curves. And then the HAZ austenite grain growth equation and diagram of the new generation steel with yield strength 400 MPa are established. The grain growth in all parts of HAZ can be predicted through the diagram, which reflects its heat sensitivity, being one kind of its weldability. The conclusion of investigation is that the prediction data of the grain growth diagram mate well with the experimental data.

Key words: new generation steel with yield strength 400 MPa; heat affect zone; grain growth diagram

Operation Object Calibration Algorithm Used for Robotic Off-line Programming SONG Yue-e (National Laboratory of Advanced Welding Production Technology, Harbin Institute of technology, Harbin 150001, China), WU Lin, TIAN Jing-song, DAI Ming. p32~36

Abstract: With the application and development of the off-line programming system (OLPS), as one of the key techniques for the applying of OLP technology, robot calibration technique is being paid more and more attentions. Aiming at the problem of OLPS application, this paper makes a further discussion on adjusting and matching operation object in off-line planning. According to the operation object modeling feature, the part calibration and path calibration algorithms are presented and analyzed in this paper. There are three part calibration methodologies and one path calibration methodology presented: the calibration of the orthogonal plane part, the four points calibration of the circular reference part, the three points calibration of the auxiliary feature points, and least square fitting path calibration. By combinating the part calibration with path calibration, the problem of adjusting and matching operation object can be solved completely in the application of robotic off-line programming.

Key words: robot; part calibration; path calibration; off-line programming

Effect of Second Phase Particle on Microstructure and Toughness of CGHAZ in HSLA CHEN Mao-ai (MOE Key Lab of Liquid Structure and Heredity of Material, Shandong University, Jinan

250061, China), WU Chuan—song, WANG Jian. guo, TANG Yi—min, LOU Song—nian. p37~40

Abstract: Carbon extraction replica analysis was employed to measure the quantities and size distributions of particles in Ti microalloyed steel and its simulated CGHAZ to reveal the response behavior of second phase particle to the welding thermal cycle. And the microstmcture and impact toughness of CGHAZs in Ti microalloyed steel and a kind of HSLA steel with similar chemical content and manufacture process were investigated with OM, TEM and series charpy impact test. The results show that a large amount of small—size TiN particles exist in the Ti microalboyed steel. During the weld thermal cycling, TiN particles prohibit the original austenite grain from coarsening, prevent the formation of coarse upper bainite, accelerate the formation of acicular ferrite, and promote the decomposition of M—A constituent into ferrite and cementite, thus improve the toughness of CGHAZ in HSI. A steel remarkably. With the $t_{8/5}$ increasing from 16s to 120 s, the toughness of CGHAZ in Ti microalloyed steel increased because the secondary microstructure of CGHAZ changes from upper bainite to acicular ferrite and the austenite grain size coarsening is not serious.

Key words: microalboyed steel; second phase particle; austenite grain size; toughness

Control System of Automatic Butt Fusion Welding Machine for Pressurized Plastic Pipe YANG Dai—jun (College of Material Science and Engineering, Tianjin University, Tianjin 300072, China), HUO Li—xing, ZHANG Yu—feng, Qi Fang—juan. p41~44

Abstract: Parameters of butt fusion welding of plastic pressure—pipe are different for varying pipe diameters and ambient conditions, and it is also affected by personal factor. Therefore, in this paper, four stages of the welding process were driven and the welding compression force was supplied by hydraulic system. In order to remove human element to improve the welding quality, the welding temperature, time and operation of hydraulic cylinder were controlled by 89C196 microprocessor, and welding parameters were selected and adjusted automatically according to pipe parameters and ambient conditions.

Key words: pressurized plastic pipe; butt fusion welding machine; control system

Study on the Morphology and Action of the Interface Between Ni Base Self—Fluxing Alloy Coating and Steel Substrate XIANG Xing—hua (School of Mechanical Engineering, South China University of Technology, Guangzhou 510640, China), MU Xiaodong, LIU Zheng—yi, LI Shang—zhou. p45~48

Abstract: The interface morphology between WC enhanced Ni base self—fluxing alloy coating and 3SCrMoAI steel substrate, which were fabricated respectively by oxyacetylene flame spraywelding, plasma spraying + oxyacetylene flame re—melting, plasma spraying + re—melting in electric furnace, was investigated. The results show that the composition diffusion between the coatings and substrate occurs during the coatings — melting process, which mainly is Fe element in substrate diffusing into the melted coating. The composition diffusion has definitive influence on the interface morphology. When the temperature of substrate surface is high enough, there will be amount of Fe element diffusing into the coating, and a thin and dense layer of Fe—Ni solution phase forms at the interface between the coating and substrate. So the adherent strength will be improved remarkably and the coating will have excellent anti—spell property.

Key words: Ni—base self—fluxing alloy coating; interface diffusion; adherent strength

Study on Hardness and Redhardness of Surfacing Metal of Metal Powder—Cored Wire of Age Hardening Tool Alloy for TIG Surfacing

WEI Qi (Beijing Polytechnic University, Beijing 100022, China), LI Wen—jing, ZHU Xue—jun, HU Qiang. **p49~52**

Abstract: By changing the content of cobalt and the technology of postheat treatment the following subjects are studied: the hardness and redhaitlness, the age hardening mechanism of the surfacing metal of metal powder—cored wire which is a type of age hardening tool alloy for TIC surfacing. The results of the study show that the effects of cobalt content and postheat treatment on hardness and redhaxdness are notable. With the increasing of cobalt content in deposited metal the hardness and redhardness of surfacing metal rise apparently. The hardness of surfacing metal can go up to HRC 69.4 and remain above HRC 60 after heated at 650℃ for 6 hours. The optimum age technology is 560℃ x 2.5 h.

Key words: age hardening tool alloy; metal powder—cored wire; hardness and redhardneas

Research on the Image Processing of Multi—pass Seam Based on Line Structure Light SUN Li—xin (Hebei University of Technology, Tianjin 300130, China), DAI Shi—jie, LI Kai, HAN Wei, CAI He—gao. p53~55, 70

Abstract: Arc light and splash, which have great influence on images, become key problems in image processing. According to the high speed of splash, effective methods, which reduce the disturbance of arc light through multi—images processing with AND operation and combining filter glasses, are represented in this paper. Moreover, because the width of laser strip is constant, and the laser strip is continuous, LOG filter and image segment filter are proved to be very effective. Scam tracking experiments show that all methods described above work very well.

Key words: Image process; Multi—pass welding; Structure light; Filter

Obtaining Composite Deposits Consisting of Fe—base Alloy + WC Cemented Carbide Particles Under PTA ZHAO Kun (

Harbin Research Institute of Welding, Harbin 150080, China), WANG Hong-ying, CHENC Zhi-guo, Dong Zu-jue, WANG Chun-yi. p56~58

Abstract: Composite deposits consisting of Fe-base alloy F321 powder and WC-Co cemented carbide particles are obtained with a new developed PTA torch that transports WC alloy particles outside the arc transportation. In deposits, WC alloy particles are kept equispaced. These deposits have low defect rates and good external appearance. WC alloy particles' content is limited to 40~42% wt in the deposit, and these particles exhibit high hardness as that before surfacing. Surface of WC alloy particles exhibit few refusoion and embrittlement-free of deposited layer with few alloys disivity, deposit matrixes have a microstructure of martensite + retained austenite + eutectic. Average rate of the deposit defect examined is below 1.5%. The causation and situation of microcracks and voids are analysed in the test.

Key words: plasma arc; surfacing; Fe-base alloy; tungsten carbides

Selection of Action Function When Establishing the Neural Network Monitoring Model on Quality of Spot Welding ZHANG Zhong-dian (National Key Laboratory of Advanced Welding Production Technology, Harbin Institute of Technology, Harbin 150001, China), LI Dong-qing, ZHAO Hong-yun, FAN Wei-guang. p59~62

Abstract: Multilayer feedforward neural network is the most popular network model, and the approach ability and training algorithm are the key of its application. The Back-propagation algorithm is the first choice algo rithm to multilayer feedforward neural network because of its many merits, but its convergence rate is slow, which is its shortcoming. This article found that "false saturation" is one of the main reasons which causes BP algorith's convergence slow and is also the main obstruction to decrease the error of quality monitoring model for spot welding. In order to reduce the appearance possibility of "false saturation" in the learning process of BP algorithm and accelerate learning rate, this article puts forward the principle about selecting the type of neural action function.

Key words: quality of spot welding; monitoring model; neural network; HP algorithm; action function

A New Surfacing Power-Carbon Electrode Arc Constrained by Argon ZHOU Yu-sheng (Automobile Engineering Academy of Harbin Institute of Technology, Shandong Weihai 264209, China), YU Feng-fu, HE Wen-xiong, LI Jun-yue. p63~66

Abstract: In order to decrease dilution ratio and burning ratio of hard metal alloys and increase deposition rate in surfacing, the physical characters of carbon electrode arc constrained by argon have been investigated by using a diagnosis device of multi-line spectrum of plasma arc in this paper. The spectrum signal measured was transformed into electric signal and was magnified, and then it was feed into a A/D device. After it was transformed into digital signal, it was feed into a computer to be proceased. Therefore, the temperature, composition, pressure and their distribution were gained. The results show that the temperature of carbon electrode arc constrained by argon is higher than that of free carbon electrode arc, the arc gas is of deoxygenization, and the distribution of temperature and pressure of the arc is hom, ogeneous. These characters are benefit for the quality of bead welding.

Key words: surfacing quality; physical characters of arc; constrained arc

Depositing Regularity of Solid Particles During the Gas and Slag Reaction for CaO-CaF_2 Slag System Electrode LI Xiao-gang (Material science and Engineering Department, Dalian Railway Institute, Liaoning Dalian 116028, China), YU Qi-zhan, XUE Ji-ren. p67~70

Abstract: The relationship between the amount of the solid particles in arc atmosphere and the coat composite was analyzed by using welding fume drawing method. The results show that both the vaporized amount of NaF in gas phase, the product of metallurgical reaction in molten slag, and that of SiO_2 MnO in coat joining less metallurgical reaction are closely related to the coat composite content. Meanwhile a numerical model was built through non-linear and linear regression. The amount of NaF is proportional to the n power of fluorite content, and the constant coefficient is proportionally decreased with increase of the marble content, and that of SiO_2 MnO is proportionally increased with increase of the marble content.

Key words: gas and slag reaction; CaO-CaF2 slag system

A Research on Automatic Ultrasonic Inspection System for Weld Flaw UU Zhi-yuan, (Department of Control Science and Engineering Harbin Institute of Technology, Harbin 150001, China), PEI Run, WANG Ling, LIU Zhi-lin. p71~74

Abstract: In this paper, we presented a method of design and implement of an automatic ultrasonic inspection system HAUT-1 for with flaw with four channels. The configuration of HAUT-1 includes magnetic wheel, ultrasonic scanner, water couplant pump, motor controller, ultrasonic transmitter and receiver, high-speed data collection circuition welding tracing device and portable industrial computer. HAUT-1 can be applied to inspect the flaws of 10~100 mm-depth armor plate, huge sphere tank and conduit pipe. Moreover, the performance of HAUT-1, the method of automatic inspection and the algorithm of tracking weld were analysed and discussed further. And experimentation on welding φ1 600-specimen and φ1 800-boiler drum showed that HAUT-1 has eximious performance in the precision of inspection, the reproducibility and the image manipulation of the flaw.

Key words: weld; flaw; ultrasonic inspection

Some Discussions on Principle of Causing and Relieving Welding Residual Stress **WANG Jian-hua (Shanghai Jiaotong University, Shanghai 200030, China), LU Hao.** **p75~79**

Abslract: In order to explain some different views about princi-

ple of causing and relieving welding residual stress, a steel bar with two constrained ends and a long welded plate are analyzed as one-dimensional models. Two thennal cycles are used. One includes heating and cooling stages and the other includes only cooling stage directly from high temperature to room temperature. The results show that in the — welds the residual compressive plastic strains are caused in the former case and the residual contractive thermal strains are caused in the second case. Their actions are equivalent for causing the welding residual stress. However it is the best way to introduce the concept of inherent strain which includes the thermal strain, plastic strain and phase transformation strain caused in welding cycle and can be considered as a source of welding stress. Some relative problems are dbcussed in this paper.

Key words: welding; residual stress; plastic strain; thermal strain; inherent strain

Numeric Analysis for Density Distribution of Element at the Interface in Diffusion Bonding HE Peng(National Key Laboratory of Advanced Welding Production Technology, Harbin Institute of Technology, Harhin 150001, China), FENG Ji-cai, QIAN Yi-yu, HAN Jie-chai, MAI Han-hui, JIA jin-guo. p80 ~ 82

Abstract: Distribution of element at the interface in diffusion bonding is a cross behavior related to diffusion, phase transformation, and interfacial reaction, which affects bond performance. Therefore computing technology and numeric simulation were used in order to control diffusion bonding processes and forecast bond quality. In this paper, aiming to make diffusion bonding of dissimilar materials, on the basis of thermodynamic law, the density distribution of element at the interface of the joint was numerically analyzed, and a model of interface reaction for establishing a solid solution interface layer was suggested, so that the effect of diffusion bonding parameters on bond performance can been analyzed qualitatively and semi-quantitatively. Diffusion bonding of heat resistant alloy K5 to heat resistant steel 2Cr12NiMoV validated correctness of this model, and which gave reference to establishing diffusion bonding parameters.

Key words: diffusion bonding; numeric analysis; dissimilar materials; density of element

Feedback Control for Welding Current in Present Output Pulse for Inverter TIAN Song-ya (Hehai University, Jiangsu Changzhou 213022, China), CHEN Li-hua. p83 ~ 84, 96

Abstract: Compared with other power switcher, IGBT(insulated gate bipolar transistor) has rapider switch speed and collector current is more, collector to emitter saturation voltage is less so it is widely used in inverter welding machine. To improve welding machine reliability, present pulse control circuit for inverter is designed, which is based on the treatment for instantaneous signal of welding current. Rapid regulation without overshoot of welding current can be realized in the whole range of arc load. It can meet the requirement of varied welding process and ensure the performance reliability of inverter. The circuit also may be used in half-bridge, full bridge and single ended forward inverter.

Key words: IGBT; inverter power source; feedback

Research on Defect Detection and Evaluation in WeldS with X-Rays ZHOU Zheng-gan(School of Mechanical Engineering & Automation, Beijing University of Aeronautics &Astronautics, Beijing 100083, China), TENG Sheng-hua, JIANG Wei, LI He-ping. p85 ~ 88

Abstract: The current technical level of inspection of welds with Xrays is analyzed and with which some drawbacks are pointed out. Approaches based on human inspector or computer to detect and evaluate radiographic films and digital radiographic images of welds are introduced respectively. The state-of-the-art of automated evaluation of digitized radiographs and digital radiographic images of welds is described in detail. It is concluded that the digital radioscopy is the tendency of defect detection in welds and the technology about automatic identification and evaluation of X-rays digital image are the foundation of making digital radioscopy a success.

Key words: nondestructive testing; image processing; pattern recognition; welding

State-of-the-art of Numerical Simulation In Welding WU Yan-gao (Institute of material and science engineering, Tianjin University, Tianjin 300072, China), LI Wu-shen, ZOU Hong-jun, FENG Ling-zhi. p89 ~ 92

Abstract: Welding is a sophisticated metallurgical process, numencal simulation of the welding phenomenon with the help of the computer has got more and more wide application. In this article, the concept and analytical methods of numerical simulation and primary coverage and meaning of numerical simulation in welding are introduced; the present state and perspectives of welding numerical simulation at home and abroad in the analysis of thermal process, metallurgical, stress and strain, service performance of component, hydrogen diffusion, special welding process are reviewed. Suggestions for the development of the numerical simulation in welding in china are put forward.

Key words: welding; numerical simulation; research states

Existing Condition of the Technology About US Automatic Inspecing Welded Construction ZHOU Xu-nan (Shenzhen Boiler&Pressure Vessel Inspection Institute, Shenzhen 518029, China), ZOU Jing. p93 ~ 96

Abstract: US automatic inspecting welded consturction is a synthetical technology syncretizing several methods including unhurt detection, mechanical automatic control, computer software and harware application. It not only has some virtues such as high repetition rate and rapid detection, but can be applied under bad conditions instead of manual work. With the improvement of cost, US automatic inspecting welded consturction will be more and more important and broad in many fields.

Key words: ultrasonic; automatic detecting; weld