MAIN TOPICS, ABSTRACTS & KEY WORDS

Study on macro deformation of TA2/Q235B composite plate by double vertical explosive welding

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Abstract The macroscopic deformation of double vertical explosive welded composite plate increased the manufacturing cost and even caused the product to be scrapped. In this paper, the one-dimensional dispersion of detonation products was analyzed by using the characteristic line method, and the distribution curves of explosive impulse in X and Y directions of the plate were obtained. In order to explore the influencing factors of macroscopic deformation of TA2/Q235B composite plate, four groups of double vertical explosive welding comparison tests were conducted. Under the condition that the mass ratio was 1∶0.36∶3.19, the deformation law of flexible sand and soil protection followed the impulse distribution curve, and the existence of concave and convex pits was observed in the composite board when rigid stone wall protection was adopted; under the condition that the charge mass ratio was 1∶0.4∶7, the composite plate mainly presented internal bending deformation due to its high strength, and the macro deformation of large area composite plate was reduced by adopting rigid + flexible comprehensive protection device. The macroscopic deformation of the plate was influenced by the charge mass ratio, the characteristics of the protective device and the action impulse of the explosive, and the influencing factors of these three factors decreased in turn. The macroscopic deformation caused by double vertical explosive welding can be further solved by appropriately reducing charge mass ratio, optimizing protection device and popularizing double vertical explosive welding + rolling technology.

Key words: **double vertical explosive welding**, **macro deformation**, **explosion mechanics**, **characteristic lines**

Numerical simulation of multi-pass and multi-layer welding residual stress of X70 steel thick plate

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Abstract The filling process of weld metal in multi-pass and multi-layer welding was simulated by being activated layer-by-layer, and the finite element model of multi-pass and multi-layer welding for thick X70 steel plates with different thickness by using semiellipsoid heat source model and uniform cylinder heat source model to describe the arc and metal droplet heat sources, respectively. The evolutions of welding temperature field and stress field and the state of welding residual stress were simulated and analyzed. The results indicate that, the residual stress in weld after multi welding heat cycles has the similar state with that in HAZ. The residual stress at the weld root is higher than that at the weld toe of cosmetic bead. The difference of thickness between thick plates has few influences on the residual stress at the weld root of root welding, which reaches up to 468 MPa, and the residual stresses at weld root and weld toe are lower that the yield strength of the base metals. The simulated results is in good agreement with the experimental results, which indicates that the founded model has high reliability and accuracy.

Key words: **multi-pass and multi-layer welding**, **welding of thick plate**, **numerical simulation**, **welding residual stress**

Influence of Ti, B on microstructure and transformation of weld metal processed by high-heat input welding process though in-situ observation

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Abstract Transformation process associated to Si-Mn, Ti, Ti-B weld metals processed by high-heat input welding process were systematically investigated by in-situ high temperature laser confocal microscope, and influences of Ti and B on transformation process in the weld metal were analyzed and discussed. Results indicate that the transformation can be completely finished in the high temperature region with respect to Si-Mn weld metal, and large amount of equi-axed ferrites are initiated. When Ti is added into weld metal, the transformation temperature region of weld metal is slightly decreased. GBF is firstly initiated at austenite boundary, and the inclusions composed of Ti begin to induce AF nucleation and growth in austenite subsequently. When B is further added into weld metal, the GBF transformation can be effectively prohibited in the austenite, which directly promotes the AF transformation in austenite.

Key words: **in-situ observation**, **weld metal**, **acicular ferrite**

Effect of component and content of oxide based on surface tension on welding spatter

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Abstract Based on changing surface tension according to different chemical bond energy of oxides in flux-core, the effect of composition and content of flux oxides in self-shielded flux cored wire on welding spatter was investigated, meanwhile droplet transfer and spatter of wire by high-speed camera. The results indicated that the surface tension depended on the oxides composition and content in flux and had an important influence on droplet transfer characteristic, then effected welding spatter. Spatter by repelled transfer with small drop occurred when the surface tension was small, explosive splash by short circuiting transfer occurred when the surface tension was big. Under this experimental condition, the surface tension can reach the best value by adjusting the content of rutile, zicon sand and magnesium aluminum powder in flux-cored when the spatter loss coefficient reached minimum and blasting spatter of transition liquid bridge with arc bridge occurred.

Key words: **self-shielded flux-cored wire**, **welding spatter**, **surface tension**, **dropiet transfer**

Adaptive multi-layer multi-pass welding based on laser sensors

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Abstract Aiming at the positioning deviation, processing deviation and laser sensor installation deviation in the process of automated welding, this paper proposes a Multi-layer and multi-pass path planning method with laser vision sensor to obtain the shape and position information of the weld seam, which make the robot adjust the position automatically and control attitude of the welding gun to correct the deviation for welds. First, perform hand-eye calibration to convert the bead space point information from the visual coordinate system to the robot base coordinate system. Then scan the workpiece, preprocess and calculate the actual coordinate point information, and adaptively adjust the posture of the tool

coordinate system to compensate for the deviation. Finally, according to the characteristic parameters of the weld groove and the welding process requirements, the path of multi-layer multi-pass welding is planned to complete the welding. This paper tests the groove of carbon steel single V medium and heavy plate, and the results show that this method has good practicability.

Key words: laser sensor, coordinate conversion, adaptive, multi-layer multi-channel

Effect of parameters on microstructure and mechanical properties of friction stir spot welded joint

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Abstract Refill friction stir spot welding joint of a 1.0 mm thickness 6016-T4 aluminum alloy was prepared by different parameters. The comprehensive properties of 6016-T4 aluminum alloy joint by different parameters was studied through the analysis of its surface formation, shear tensile, crossing tensile and micro-hardness by using orthogonal test. The results show that the optimum parameters are with the welding time of 4.5 s, the rotation speed of 1 600 rpm and the depth of 1.4 mm. The shear tensile force and cross tensile strength of the joint are respectively 4.02 kN and 1.32 kN. The micro-hardness of the action area of the pin is more uniform, and the micro-hardness value is higher than that of the base metal area. The joints do not show any looseness during the peeling tensile test, indicating that the joints are firm and qualified.

Key words: 6016-T4 aluminum alloy, refill friction stir spot welding, orthogonal test, mechanical propertie

Double-sided double-arc MIG welding process of titanium alloy T-joint

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Abstract Double-sided double-arc MIG welding was applied to weld T-joint of titanium alloy with large thickness for the first time, and the influence of welding parameters on formation and defect forming of T-joint of titanium alloy was systematically studied. The result showed that too large or too small distance between welding gun and workpiece would lead to the increase of weld porosities, which were mainly process porosities. The welding gun angle α_1 should be reduced as far as possible during backing welding, while the welding gun angle α_1 should increase appropriately during filling and cosmetic welding. The incidence of porosity was lowest when the welding gun angle α_2 was about 60°. The larger the heat input of single-arc TIG was, the longer the high-temperature residence time of the molten pool was and the smaller the quantity of porosity was. The ratio of welding current I to welding speed v had an important influence on formation of T-joint. The matching of I and v was improved with the increase of v. Compared with ordinary single-arc TIG, the impact energy A_{KV} of the cruciform joint prepared by double-sided double-arc MIG welding was significantly improved, and the joint had better plasticity, toughness, and comprehensive performance.

Key Words: double-sided double-arc, titanium alloy, T-joint, welding parameters, formation, defect

Research progress on welding technology of Fe-Mn-Al-C low density and high strength automobile steel

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Abstract With the rapid development of automobile industry and the increasingly stringent requirements of "energy saving and emission re-

duction", automobile lightweight has become an inevitable choice for the development of automobile industry. Fe-Mn-Al-C low density high strength steel is one of the potential materials for automobile manufacturing. It is very important to master its welding method and improve its welding performance. Based on the microstructure and properties, welding difficulties and main welding methods of Fe-Mn-Al-C low-density high-strength steel, the welding difficulties caused by precipitation of second phase, volatilization and segregation of alloy elements, grain growth and softening in heat affected zone, current mainstream welding technology and its application in Fe-Mn-Al-C low-density high-strength steel are reviewed. According to the characteristics of typical welding process, combined with the problems of precipitation of second phase, welding crack and composition segregation in the welding process of Fe-Mn-Al-C high strength steel, it is pointed out that laser arc hybrid welding, laser brazing, friction stir welding and other new welding technologies will have better advantages in solving the welding problems of this kind of steel, which are worthy of close attention in the future.

Key words: Fe-Mn-Al-C high-strength steel, microstructure and performance characteristics, welding difficulties, welding methods

Effect of rolling treatment on wear resistance of reactor coolant pump sleeve

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Abstract In order to improve the surface wear resistance of Reactor Coolant Pump sleeve, the rolling machining was conducted on the surface of stainless steel, its wear resistance was studied. The grain size in the hardened layer were characterized with the EBSD system. Surface roughness, microhardness as well as the friction and wear properties of stainless steel were tested with white-light interferometer, microhardness tester and friction and wear tester. The results showed that Arithmetic mean of contour(Ra) of rolling layer is 63.7 nm, which is about 1/4 to 1/5 as that of substrate; The grain size of rolling layer is refined and the proportion of small grain size is increased; The surface microhardness of rolling layer is 550 HV, which is 2.2 times higher than that of substrate; The friction coefficient of rolled layer decreased. The changes of the above parameters improve the wear resistance of the shaft sleeve surface.

Key words: rolling, wear resistance, reactor coolant pump, sleeve

Assembling, welding and brazing procedure summary for neutral bus device of nuclear power half speed turbogenerator

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Abstract In order to realize the manufacture for neutral bus device of nuclear power half speed turbogenerator, investigation of assembling, welding and brazing technics for neutral bus device was carried out. By utilizing technical means such as using ϕ1.6 mm ERCu (AWS A5.7) welding wire, CJ301 welding flux and 40% Ar + 60% He protecting gas, setting the preheating temperature no lower than 600 ℃, and laying graphite backing on the back side of weld seams, completed the gas metal arc welding of the neutral bus device cover which is made of copper successfully, realized one-side welding with back formation. By using different filler metals and different brazing flux, designing reasonable assistant tools, using flame brazing technology, obtained reliable brazing joints for copper tube and stainless steel tube, copper tube and ueutral bus device cover. The quality of manufactured neutral bus device is up to the design requirement.

Key words: nuclear power half speed turbogenerator, neutral bus device, gas metal arc welding, brazing