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Optimizing TIG Welding Parameters for AZ31B Magnesium Alloys: A Review

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Abstract:
The effect of tungsten inert gas welding in AZ31B magnesium alloy was carried on by varying some parameters to obtain maximum hardness in the weld. Thus, for finalizing the parameters to be used in the manual tungsten inert gas welding, some literatures studies are carried on. TIG welding process provides very high quality of weld when compared among other welding process. In this literature survey, the impact of ultrasonic assisted laser welding, alternating current, peak current, base current, pulse frequency, pulse on time, activated flux TIG, pulse frequency TIG and heat input on AZ31B magnesium alloy are studied to determine porosity, grain size in the HAZ (heat affected zone) depth of penetration, tensile strength of the weld area and hardness of the welded area. The literature survey tends to identify the optimum parameters for the gas flow rate and current supplied for manual tungsten inert gas welding.

Keywords: TIG Weld, AZ31b Mg alloy, HAZ, porosity.

I. INTRODUCTION

Welding is one of the permanent joining processes where similar and dissimilar metals can be welded. The welding take place by melting the contacting surfaces with the help of heat or pressure. This tends to form a permanent joint between the materials. In welding, some of the processes requires filler rod to make a bond between the materials and some processes are performed without the help of the filler rods.

DCSP (Direct Current Straight Polarity): The tungsten (electrode) which is attached to negative (-) terminal and work piece is attached to positive (+) terminal of power supply. This help to produce deep penetration as 2/3 total heat is at the work piece and 1/3 total heat is at the tungsten electrode. This leads to good penetration and narrow profile in the weld area.

DCRP (Direct Current Reverse Polarity): The tungsten (electrode)which is connected to positive(+) terminal and the work piece is connected to negative (-) terminal of the power supply. It produces a total heat 2/3 on tungsten electrode and produce 1/3 total heat to the work piece. These are mainly used in thin sheets and has higher deposition rate. Magnesium alloy has an impressive characteristic such as high specific strength, low density, good damping capacity, weldability and machinability. Thus, magnesium alloy plays a vital role in engineering fields in twenty-first century. In various composition of magnesium alloy, the Al-Zn ternary bond has been used in large number of applications in industries. These are mainly used in aerospace industries and automotive sectors. The tungsten inert gas weld plays a vital role when comes to joining process of non-ferrous materials such as magnesium, aluminum and titanium etc. Thus, when compared with other welding, the GTAW provides high quality of weld than any other arc-welding process. This is due to reliability, strength of weld and the clearance. In tig welding, to prevent oxidation formation in welding area, an argon gas flow rate is used to prevent oxidation. Thus, argon act has shielding gas in TIG welding.

A. *LITERATURE SURVEY*

I) Zheng long lei,[32] et al has done a research on ultrasonic assisted laser welding of AZ31B Mg alloy. In this they have referred some literatures which helped them to determine the type of welding. Luo et al, has done a experiment by joining the AZ91D and ZG61 by using friction stir welding and determined that fine grain strengthening and texture strengthening are the factor which help to increase the strengthening of the weld.

From these literatures they have concluded that when two material are welded there are some pores found in the weld mount. Thus, to avoid the pores found in the weld mount they used ultrasonic vibration to eliminate the pores during the welding. Thus, these will help to increase the strength of the welding during the tensile test.

When to metal are joined by laser welding there are two possibilities to form porosity in the weld. The first one is, the vapour pressure found in the welding of AZ31B alloy. Which will form keyholes which becomes unstable when it reaches certain limit. Thus, they will finally collapse and form porosity in the weld.

On the other hand, when the welding process is completed and left for cooling process, it causes some non-equilibrium cooling rate. Thus, when metal changes from liquid phase to solid phase, there are some pores of hydrogen found in the welding. This will gradually form hydrogen bubbles and reduces the tensile strength of the weld.

These two kinds of pores where easily found in the welding and are evenly distributed. Then these work pieces are subjected to ultrasonic vibrations and the results are calculated using Image-pro plus software. These results showed that, the porosity found in the welding areas are much less and porosity is reduced by 0.9%.

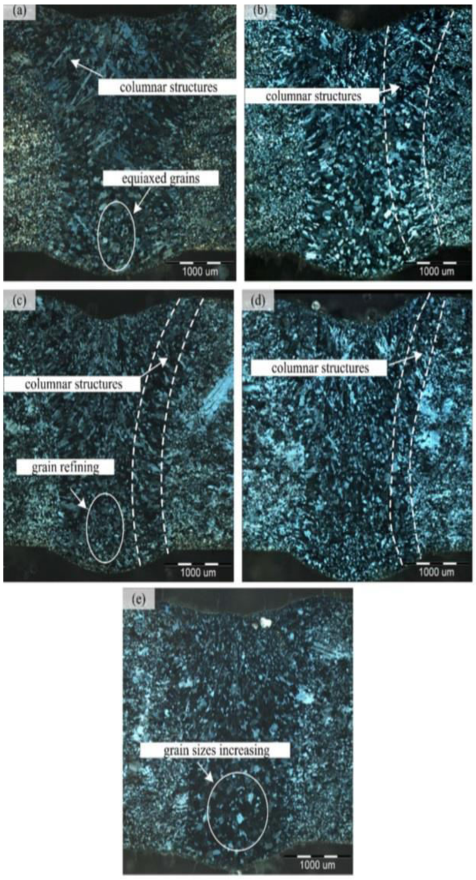

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Figure.1. Grain size

II) Padmanaban et al,[27] conducted the experiment to optimize pulsed current of gas tungsten arc welding process to maximum tensile strength in AZ31B magnesium alloy. These experiments were done by varying four parameters such as peak current, base current, pulse frequency and pulse on time. This concluded that, if peak current was less than 190A, there were incomplete penetration and If peak current was greater than 230A, some undercuts and spatters are observed. Thus, they conducted the experiments between 190A and 230A. In this response surface methodology is used to formulate the empirical relationship for tensile strength of the pulsed current gas tungsten arc welding. It is observed that when 2Hz pulse frequency is supplied, then the tensile strength of the joint is much lower but when the pulse frequency is increased to 6Hz, the tensile strength of weld joint is increased and found to be maximum. The pulse on time place a important role since, when the pulse on time increased it directly decreases tensile strength of weld. This is due to when the pulse on time is increased, the heat produced in the weld area has much more time to form fusion zone. Thus, these fusion zones consist of coarse particles which decreases the tensile strength of the material. For the pulse on time 50%, the maximum tensile strength was obtained. III) Dong Hong gang et al,[29] has investigated on AZ31B Mg alloy for the porosity present in the heat effected zone(HAZ).The main cause for failure of the material in tensile test is due to increase in porosity present in the HAZ.In this it is observed that maximum tensile strength of the material is 282MPa at the travel speed of 6.7mm/s but at these condition the porosity found in the weld area were maximum when compared with other parameters. Thus, by considering the porosity, at 120mm/s of welding speed the porosity in the weld area were found to be minimum when compared with other parameters. Thus, concluded that by increasing the welding speed, the porosity of the material is reduced and strength of the material is increased.

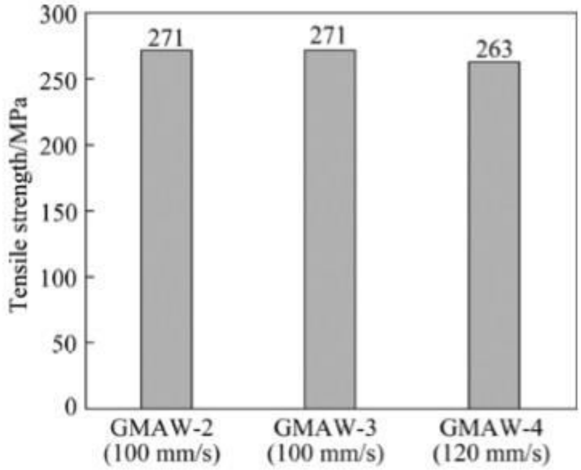

Figure.2. Minimum porosity

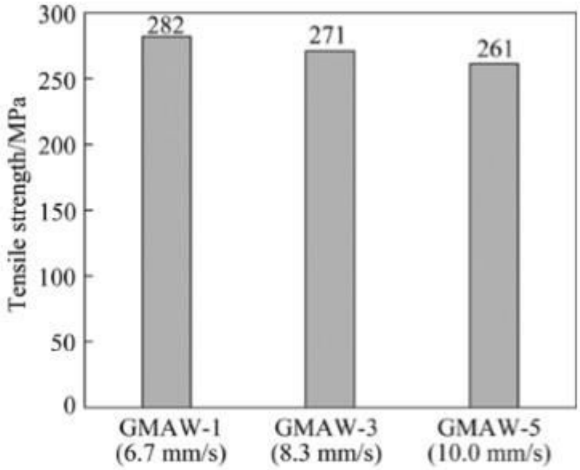

Figure.3. maximum porosity

IV) Optimum rolling speed and relevant temperature and reduction of interfacial friction behaviour during the breakdown rolling of AZ31B alloy. Weitao jia et al [28], have studied the tensile properties of best observation as the speed of 50.0± 0.8 m/min.Hence forth the hardness value at the crack region shows significant variation from others values of speed. As the uniformity in microstructure observed at 18.0±0.8 m/min is gradually varying with increase in speed up to 50.0±0.8 m/min. The twinning properties of microstructures again changes in inter-trans crystalline boundaries, when increasing the rolling speed till 720±0.8 m/min.This is due to the uneven deformation of the material. V) Bilge Denrir et al, has studied the butt welding of AZ31 magnesium alloy sheet of 3mm thick using tungsten inert gas welding. In this they examined AZ31 Mg sheet by varying the parameters such as alternating current and pulsed current. Then they concluded that grain size present in weld metal, HAZ and base metal. By the experiment they concluded that the grain size with eqi-axial grain size were more dominant in weld metal structure when compared with the HAZ.

Thus the microhardness relationship between the BM, HAZ and Weld metal of welded joints are, the weld metal is greater than the base metal and base metal is greater than the Heat affected zone (HAZ). They carried a test regarding the tensile strength of the material by varying the heat input. When heat input was 8.5 kj/mm, the tensile strength of the welded part is 205 MPa.Which is 85% of Base metal (pulsed current) Then by increasing the heat input to 9.8 kj/mm the tensile strength of the weld joint was found to be 84% of the base metal (alternating current). thus, welding joint showed lesser strength than base metal but, the pulsed current has higher strength when compared with alternating current. VI) Akhilesh Kumar singh et al,[1] has performed some experiment in different methods, which increase the weld penetration in tungsten inert gas welding. For this some experiments were conducted such as (i)Activated flux TIG(AFTIG), (ii)Flux bounded TIG(FBTIG) and (iii)Pulsed current TIG(PCTIG). In activated Flux TIG, the flux is the composition of binder (sodium silicate) and the solvent (acetone). These are coated as a layer on the top of the surface. These fluxes will help to form narrow arc, which increase the depth of the penetration. The Flux bounded TIG, gave significant change from normal tungsten arc welding. In FBTIG, the flux is coated on the top of the surface but away from the centre of the weld joint. These help to increase a narrow arc. The disadvantage in this process is that, the weld penetration will decrease when the flux coating gap is increased. In pulsed current TIG, they concluded that if peak current is set at high, it tends to increase the ripple of the weld, but when pulsed current is high, it tends to form uniform heat distribution in the workpiece. This helps to reduce the height of ripples. Thus, pulsed current tungsten inert gas welding (PCTIG) has better results when compared with normal tungsten gas welding.

II. CONCLUSION

- The ultrasonic vibration assisted laser welding has significantly increases the properties of AZ31BMg alloy welding. The laser welding without the equipment's of ultrasonic vibration has more porosity (4.3%).Then after the weld area subjected to ultrasonic vibration the porosity can be inhibited effectively. The porosity was found to be only 0.9%.
- The pores in the weld area was mostly found on top or bottom of the weld. This leads to generation of crack in the weld area. The travelling speed and feeding speed helps to control the porosity present in the weld. Fracture mainly occurs in heat affected zone.
- The pulsed current gas tungsten arc welding was performed on AZ31B Mg alloy, then an empirical relation has been formed using response surface methodology. The maximum tensile strength of 188MPa were obtained when peak current of 210A, base current of 80A, pulse frequency of 6Hz and pulse on time of 50%.
- The microstructure and recrystallisation will increase gradually as the rolling speed increases from 18.0±0.8 to 50.0±0.8 m/min. At 50.0±0.8 m/min crack was found to be less and has better tensile properties. The experimental condition says that external friction effects the co-efficient from 1.25 to 2.35.
- AFTIG (Activated Flux TIG) has shown an improvement in depth of penetration when compared with normal TIG welding. The activated flux helps to narrow the arc thus increasing the depth of penetration.
- FBTIG (Flux bounded TIG), welding penetration as depth as AFTIG, but the drawback of this welding is that the distance between the flux and weld plates has to be maintained properly to obtain better penetration.
- Pulsed current TIG weld shows that if peak current is high, then it forms deeper penetration along with higher ripples. But when pulsed current is high, the heat is distributed uniformly this leads to deeper weld with less ripple's height.

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