A Study of Mechanical Behaviour on Similar and Dissimilar Metals of Inconel 617and SS-316 using ATIG Welding Process

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Abstract: *Now, several metal gaskets have been developed as structural materials for various industrial applications, providing a good combination of mechanical properties such as strength and corrosion resistance at a lower price. The process of combining extracts for such materials is difficult due to their physical and chemical properties. Stainless steel gaskets and smooth steel structures are densely populated applications. Connecting stainless steel and Inconel heavy sheet metal in one welding step is a cumbersome task for many manufacturers. Similarly, the selection of welding technique, fillet, wire and welding conditions of similar and different weld metals is increased. Based on an extensive literature review, a selection of base metals was developed for their applications. Inconel 617, a nickel-based superalloy, is widely used in chemical, aerospace, nuclear and power plant applications. Also, SS 316 is used for low carbon austenic stainless steel in the above mentioned applications. Both metals have higher corrosion resistance and mechanical properties at elevated temperatures.*

The present investigation is on the Inconel 617 and SS 316 mines, relating to similar and different agreements. Selection of the suitable activation flux for the welding candidate metals was made in one step. Joints similar and different from the metals mentioned above were fabricated by the Activated TIG Glue (ATIG) process using a flux composite of 50% SiO_2 + 50% TiO_2. Mechanical properties such as hardness, tensile strength and bending properties of similar and different metal elements will be studied in this process using ATIG welding.

KEYWORDS: ATIG, Mechanical Properties, Similar, Dissimilar metal welding, stainless steel, INCONEL.

1. INTRODUCTION

Stainless steel is one of the most popular materials for structural applications, because of its outstanding physical properties, but also that it increases the price of its structure. The supplementary code's advantages and guidelines have contributed to its use in stainless steel industrial applications of conventional engines such as civil constructions, nuclear reactors, thermal power plants, tanks, and heat exchangers for various industrial applications [1-5]. Higher efficiency, simple process, low cost fabrication, solid durability, and efficient metal linking processes are essential for the production of multiple structural and mechanical parts [6]. Metallurgical changes such as microsegregation, second phase precipitation, the presence of porosity, solidification cracking, grain growth in the affected zone, and loss of materials caused by evaporation are the main problems that have poor mechanical properties in stainless steel welding [7-8]. Therefore, for structural applications, stainless steel can be used efficiently for different types of steel including stainless steel and carbon steel, with an effective and economical application of the unique features of each steel dependent on the same structure.

Inconel 600 series is a large nickel-chromium-iron alloy widely used in the chemical, aeronautical and nuclear industries [9-12]. Evaporation tubes, wrap-around trays and heaters in the chemical industry are made from Inconel 600 due to its high strength, high strength, and high corrosion resistance operability. The high nickel content alloy provides excellent resistance to corrosion and the presence of high chromium content provides resistance to oxidation at hot temperatures [13].

Present day, many joint structures have been constructed using cemented constructions. Recently, sticky inert gas reduced processing (ATIG) has been attracted by craftsmen and craftsmen due to their high production capacity and the ability to resolve thicker sections with less-affected zone bathrooms. In recent decades, the U.S. Navy has successfully completed the ATIG welding process for its ships and aircraft construction[14]. In the ATIG welding process, before the welding, oxide particles are applied in a fine flow form to the base metal (BM), which contracts the weld arc toward the center of the weld and transforms the weld patterns. alters the walking surface tension to create deeper penetration with reduced zones and altered areas [15-17]. Kuang-Hung Tseng et al., [18] used five different types of oxide tubes as MnO_2, TiO_2, MoO_3, SiO_2, and Al_2O_3 in the ATIG welding process and studied their effect on the morphology and distortion of pasted AISI 316L stainless steel steel. The authors reported that the fluxes of SiO_2 and MoO_3 showed better results in the bond penetration and depth ratio.

2. EXPERIMENTAL DETAILS

In this present study, an Inconel 617 and SS 316 plate of 5 mm thickness was used as a BM. To reveal the chemical composition of a BM, the Atomic Emission Spectroscopic (AES) test was conducted on the sample taken from the as-received plate and the results are shown in Table.1.The three different fluxes namely SiO_2, TiO_2 single component fluxes and the compound flux of 50% SiO_2 + 50% TiO_2 were used in this investigation.

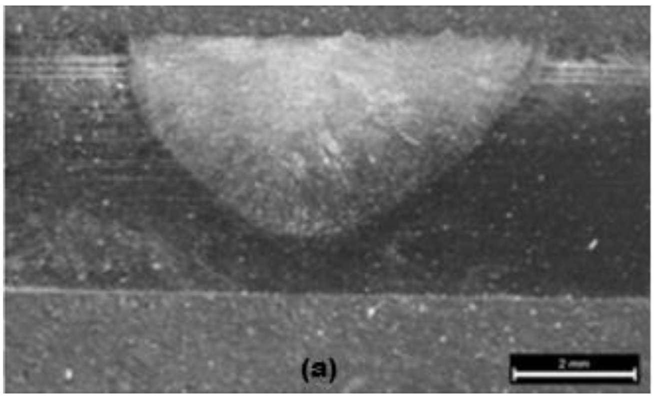
To study the effect of activating fluxes such as SiO_2, TiO_2 and compound flux of 50% SiO_2+50% TiO_2, a bead on plate trails were carried out on Inconel 617 and SS-316 with similar

Table-1. Chemical composition of the base metal

Elements	C	Mn	P	S	Si	Cr	Ni	Mo	N	Co	Fe
Inconel 617	0.15	1.0			1.0	20-24	49-62	8-10		10-15	Bal
SS-316	0.08	2.00	0.04	0.03	0.75	16-18	10-14	2-3	0.10		Bal
SS-316L	0.03	2.00	0.045	0.015	1.00	16-18	10-13	2.0-2.5	0.10		Bal

and dissimilar plate of 200 mm long x 60 mm wide x 5 mm thickness by employing the optimal welding condition which is obtained from the Taguchi method. Before ATIG welding as shown in below Fig: 1, the plate was buffed and cleaned with acetone, and theactivating fluxes were prepared by mixing them with acetone to get a paste like consistency. Just before welding, a layer of flux was applied on the surface of the plate with the aid of brush. After welding, samples were prepared by using EDM and then macroscopic examination was carried out. The experimental results of the ATIG bead on plate weld are shown in Fig: 2.

Fig-1: TIG MLS 4000 welding machine with automatic torch travel setup



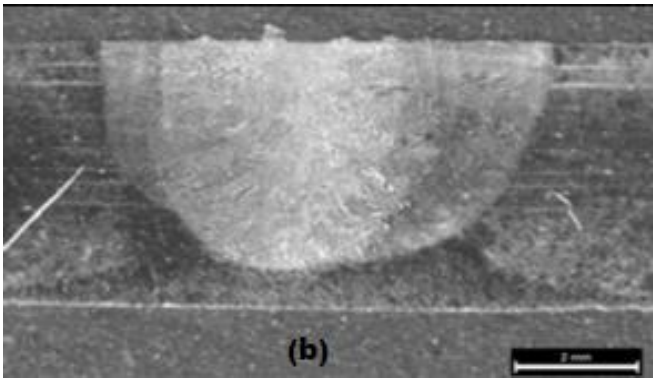
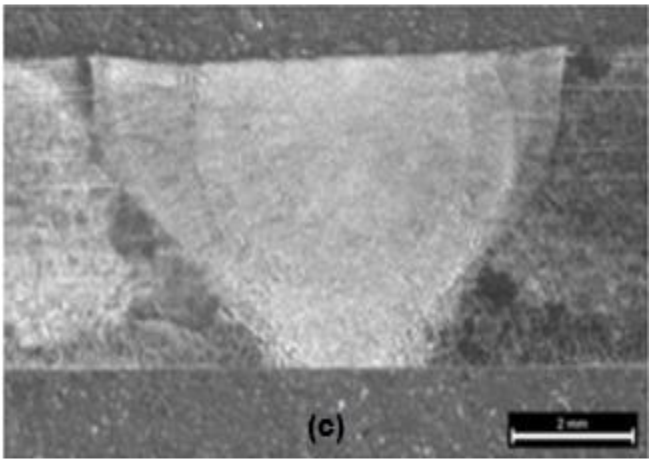


Fig-2: Microsructure study of ATIG bead on plate welding of Inc-617 and SS316 at a)50%SiO_2 b)50%TiO_2 c)50%SiO_2+50%Tio_2



3. TESTING AND RESULTS

3.1 Hardness study:

Vicker"s micro hardness test was carried out at the composite area of ATIG weldment of Inconel-617 and SS316 similar and dissimilar joints. The hardness profile of weldment and the average hardness was found ATIG is to be 263.75 HV & 280.17 HV which is slightly greater than the similar metal hardness due to the grain coarsening effect. The obtained hardness results are in well agreement with the tensile and toughness results. Further, it is identified from the EDAX results that the intermetallic phases and oxides, which could affect the hardness, are not present in the weld zone.vicker hardness Images dor similar and dissimilar are shown in Fig: 3.

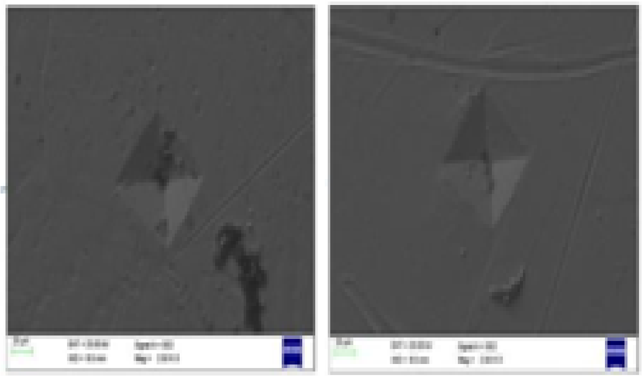


Fig-3: Vickers Hardness Microstructure of Similar and Dissmilar joints

Table-2: Vicker Hardness Testing values for ATIG

S.No	Metal	Specimen	Vicker Hardness(HV) ATIG
1	Similar	Inconel-617	269.55
2	Similar	SS316	241.53
3	Dissimilar	Inconel-617-SS316	280.17

3.2 Tensile Test:

In this experiment, the tensile test has been done for ATIG welded of Inconel-617 and SS316 Plates of similar and dissimilar joints. The experimental values of ATIG are as follows. Due to activated flux present in TIG welding the values of tensile strength is more when compared with TIG and similar metal joint and the tested specimen is shown in below Fig 4.

Table-3: Tensile Strength Testing values for ATIG

S.No	Metal	Specimen	Tensile Strength(MPa) ATIG
1	Similar	Inconel-617	511
2	Similar	SS316	576
3	Dissimilar	Inconel-617-SS316	617

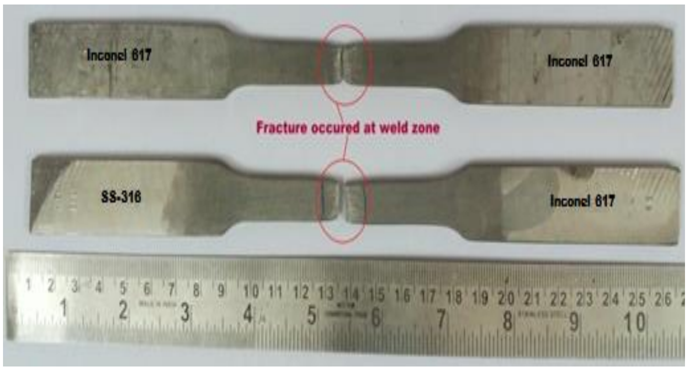


Fig- 4: Tensile test specimen after Testing

3.3 Bend test:

Bending strength of the material can be determined by using 3 point bend test has been done for ATIG welded of Inconel-617 and SS316 Plates of similar and dissimilar joints. The specimens are made into U shape by the bend test as shown in Fig.5. The results were analyzed and tabulated in the Table 4. Specimen welded with 316L to dissimilar joint is existing more bending strength then similar joints of SS310 and SS316.

Table-4: Bending Strength Testing values for ATIG

S.No	Metal	Specimen	Bending Strength(MPa) ATIG
1	Similar	Inconel-617	553.26
2	Similar	SS316	616.07
3	Dissimilar	Inconel-617-SS316	629.30

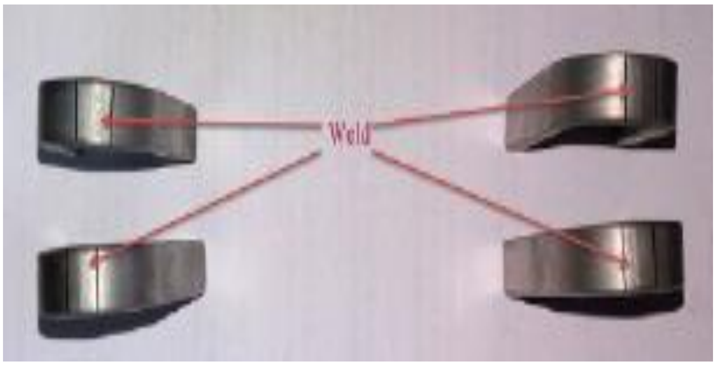


Fig-5: Specimen under bending test

3.4 Microscopic Study:

After the welding operations were carried out on the sample, a SEM analysis was conducted to study the effect of welding temperature on the sample. The device is using for microstructure at 20μm magnification. The three main microstructure zones like dimples, ductile tears and macro,micro voidsas shown in Fig: 6(a) and (b) for Similat and Dissimilar fracture joints.

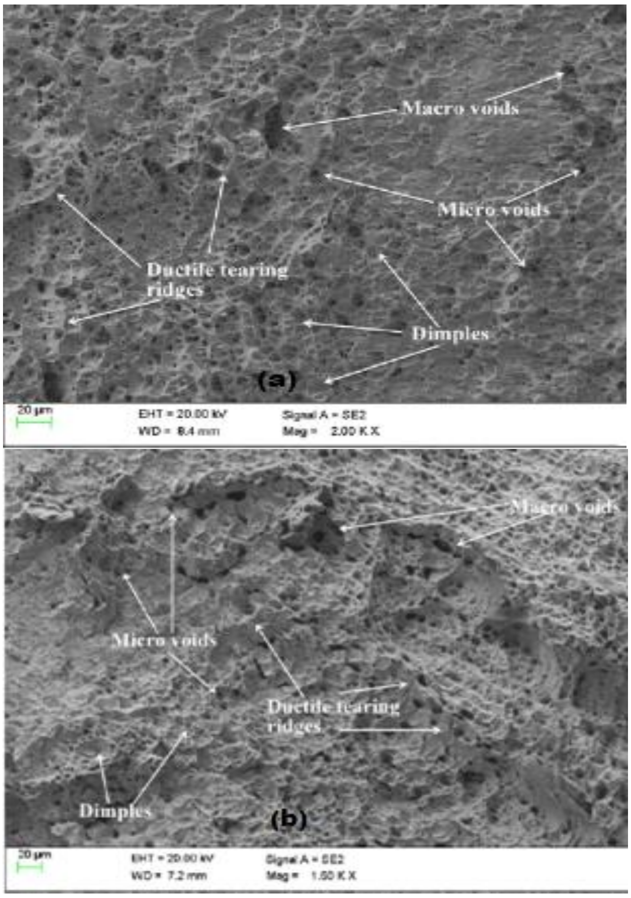


Fig-6: (a) Microstructure of fracture SS316 (b) Microstructure of fracture Dissimilar Joints

4. CONCLUSION:

The experimental work is related to the optimal ATIG welding parameters and the influence of the active flux penetration on the Inconel 617 and SS 316 base metals, and therefore similar and dissimilar joints of metal candidates using the chosen safety conditions has been reported. All weldments were made of mechanical and metallic properties, the results reported that the tensile failures occurred at the weld zone for all the investigated weldments.

i. The ATIG beads used in the welding method produce composites of 50 SiO_2 + 50% TiO_2 used for full compact penetration to produce a complete compact morphology of the chosen metals.

ii. Groups of similar and dissimilar solid metals, such as Inconel 617 and 316 SS 316, were developed using the ATIG welding process under stable glue conditions.

iii. Metallurgical studies of Inconel 617 and SS-316 contain similar liquid metal zones with columnar dendrites and short dendrites equivalent to MGB. EDAX analysis confirms the absence of multiple growth points and no change in chemical composition.

iv. The results of similar studies on similar and different marriages were examined. Unlike in harder joints at the same time.

v. The results of the variance test confirm a good operable composition of similar and different composites that have been built using different conditions for welding stability.

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