

HIGH TEMPERATURE OXIDATION AND CORROSION STUDIES ON DISSIMILAR WELDMENTS IN AGGRESSIVE SOLUTION OF A $\text{Na}_2\text{SO}_4 + \text{V}_2\text{O}_5$ ENVIRONMENT

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Abstract: Oxidation and hot corrosion are serious problems in marine industries, Air craft industries and land base gas turbines. It is because of the usage of wide range of fusel couples with increasing operating temperatures, which leads to the degradation of turbines. To avoid these problems, superalloys, viz. Inconel 718, ASS 316 superalloy (Medium grade) are the important materials for the high temperature applications. The objective of the current work is oxidation and hot corrosion behavior of Inconel 718 and Austenitic Stainless Steel (ASS) 316 sheet metal performance in the salt environment. The metals welded with Gas Tungsten Arc welding with pulsed current and examine the metallurgical and mechanical properties of dissimilar metals. The hot corrosion of Inconel 718 and ASS 316, which is $\text{Na}_2\text{SO}_4 - 50\% \text{V}_2\text{O}_5$ in salt environments at 950°C in cyclic conditions. Weight changes made during experiments are used to detect oxygen standards such as Neo, Cr_2O_3 , and NiCr_2O_4 , which provide resistance to heat corrosion. Surface melt patterns variants are carried out by SEM / EDS and XRD analysis.

Keywords: oxidation, corrosion, Na_2SO_4 , V_2O_5 , NiCr_2O_4 , NiO, Cr_2O_3 , SEM / EDS and XRD analysis

1. INTRODUCTION:

There is an attempt to obtain different welding of Inconel 718 and ASS316 stainless steel through the pulsed current gas tungsten arc welding process. The mechanical and metallic properties of the dissimilar weld metals were studied. A more descriptive analysis is in molten salt to estimate the behavior of hot corrosion by exposing coupons. Inconel 718 and ASS 316 were combinations can be used in high temperature and corrosive environments in chemical industries and oil gasification plants etc. Additionally, the combination of modern oxidative resistance and creep strength has expanded their application to steam generator tubes and other parts to work at temperatures up to 550°C in conventional fossil fuel power plants. Hot corrosion is the main problem in the present days. This problem comes in gas turbines and Incineration of industrial waste. Many people are researching many angles to prevent this. The most important of which is research on the existence of more problems in the salt environment.

As differences in the metals of physical, mechanical, and parent metals are involved, asymmetric metal welding is generally more challenging than these metals. Due to chemical composition differentiation and thermal expansion coefficients, the combination of the similar and dissimilar challenging metals, the major problems likely occur during welding is Weld's illegal mergers. The substances used as coatings for the high-temperature surface are consistent, Slow-growing surface oxide, to produce smart surface behaviors [1]. Superior 800H has been developed for high-temperature contests, surfer gas at turbine industries at better than 50% temperature of gas turbine weight. [2]. These compounds slowly begin to deposit on turbine blades, as the phenomenon of rapid transport in the liquid phase increases due to the phenomenon of cat-stroke corrosion [3]. But the thickness of after the spread of the corrosion is low 50 wheels are not more than $50\mu\text{m}$ in severe weather ($\text{Na}_2\text{SO}_4 + 50\% \text{V}_2\text{O}_5$)[4]. Corrosion is limited to the outer surface of the coating and forms a thick size of oxidants of Cr, Ni, and their spinel oxides, which serve as an extension of the transport of coating rings [6]. The surface coating method is more important to address this challenge in the area of Technology; where the materials operate in corrosive surroundings, stress, and tough conditions Temperature etc [7 Fossil fuels and low-level fuel oils were used in power genetic systems and dissolved n sodium sulfate (Na_2SO_4) and vanadium pentoxide (V_2O_5). Vanadium is in vanadium fuel in the form of pentoxide, which varies over time into combustion into V_2O_5 . V_2O_5 and Na_2SO_4 forms are low melting mixtures, which are less than 600°C than catalytic action. Marine weather reduces the fuel melting point to 620°C with NaCl and Na_2SO_4 . When a former dead melting point of deposit temperature [8]. The performance of the GTA weldments of the Monel 400 and AISI 304 using the E309L and ERNiCu-7 filler wires will be analyzed and analyzed heat cycle behavior in the cyclic dissolved salt environment and gas oxidation environments at 600°C . The welding zone reduces carbon distorted smooth zone forming [9]. The base metal is corroded with an intense peeling and spreading. But on the other hand, the WC-17Co coating performed well then the uncoated steel surface [10]. The current study, CM747LC is known to cause hot corrosion than IN738LC due to total chromium and tungsten, which is

described by the degradation mechanism. Quoted IN738LC has a longer lifespan other models [11]. W₂C Presence Tungsten Aluminum Carbide alongside HVOF Spraying of Carbides during Spraying Plates [12].

2. EXPERIMENTAL PROCEDURE:

The base metals used in the study 30x25x3 mm thickness of Inconel 718 plate and 30x25x3mm thickness of ASS 316. The nominal chemical composition of base metals and filler metal are in Table 1.

Table.1. Nominal Chemical composition of INCONEL 718 and ASS 316

Element	Base metals	Ni	Cr	Fe	Mo	Ti	Al	C	Si	S
Wt.%	Inconel 718	53	17.5	Bal	3.13	0.97	0.51	0.03	0.1	0.002
Element	Base metals	Ni	Cr	Fe	Mn	Ti	P	C	Si	S
Wt.%	ASS 316	10	18	Bal	2.0	0.80	0.04	0.08	1.0	0.03

Table 2 Conditions of Galvanized Tungsten Arc Welding

Welding Parameters	Peak Current (I)	Back ground Current (I)	Speed	Vol-tage	Flow Rate	Polarity	Pulse Frequency	Heat Input
Selection	75 A	37 A	149 mm/min	12 V	40 Min/lit	DCEN	6 Hz	271 J/min

After cleaning the two metals, then welded with GTA welding method and then cut into three pieces with a diamond cutter. The pieces are cut into the base metals separately and Heat Affected Zone (HAZ) part separately shown in Fig 1. Heat Affected zone piece is called Weldment.



Fig 1 Base metals and weldment after completion of polishing.

These models are polished with grit size 220, 320 and A46 and to clean 1/0, 2/0, 3/0 and 4-grade papers. Finally, the metals are cloth polishing carried out with 1µm alumina in dry suspension. Apply the salt past (Na₂SO₄ + 50% V₂O₅) for a weldment and base metals with the brush and these metals are one hour heating at 1050°C in a furnace followed by twenty minutes cooling at room temperature. And remove the metals from the furnace, measure the weight by using a weighing machine with a sensitivity of 1mg for each cycle. The maximum level was added during the measurement of weight change to determine the total deterioration. The kinetics of hot corrosion analyzing from the weight loss or weight gain measures and the specimens are analyzing for phase identification and XRD surface morphology and composition analysis for Scanning Electron Microscopy/EDAX.

3. RESULTS AND DISCUSSIONS:

3.1 Micro hardness evaluation of weldment:

The hardness data on the Welds in the central area for similar and unequal combinations has been representing in fig.2. The Micro Hardness of Weldment is measured using a ZWICK 3212 hardness test. A load of 1000 gms (1kg) was applied duration of 15 seconds. The hardness measured 1mm along the 1mm distance and base metal across the internal. From a hardness profile, the Inconel 718 has a maximum hardness [265 HV], similar to other zones of welding. The average hardness of weldment is [255.5 HV] and the average hardness of weld zone is [235.5 HV].

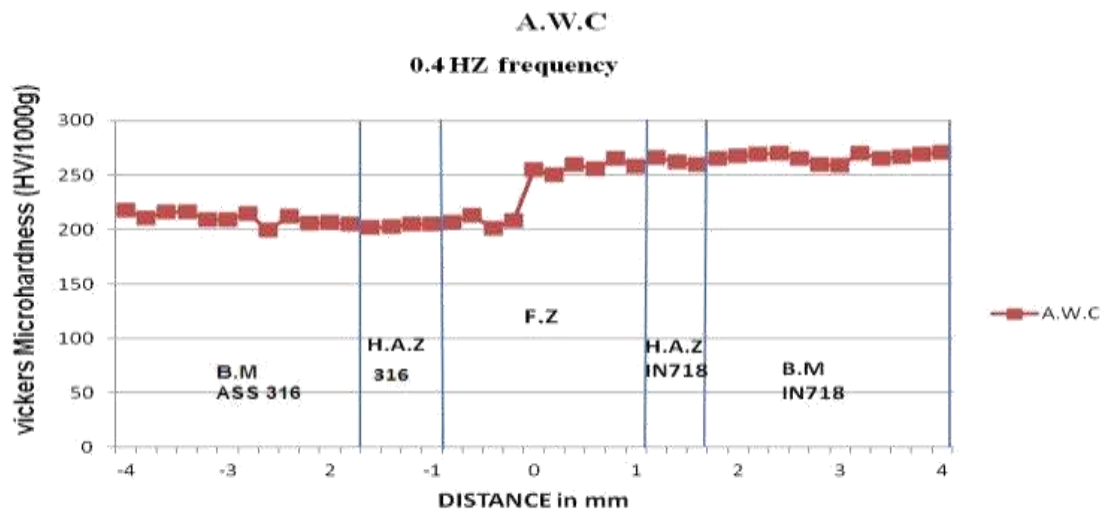


Fig 2. Micro hardness of weldment

3.2 Visual Examination:

Macro morphology of the oxide scale for different regions of GTAW dissimilar weldment in $\text{Na}_2\text{SO}_4\text{-50\% V}_2\text{O}_5$ at 1050°C for 75 cycles shown in fig.3. Inconel 718 behavior in the skeleton has been formed due to weight increases from the first to the 28th cycle due to high oxidation. After the 28th cycle to 34th cycle, the oxidation rate is small changes due to the low oxidation of material shown in Fig 2. ASS 316 material behavior represents shown in fig, up to 12th cycle is constant and the 12th to 19th cycle, the weight is fixed due to the lowest oxidation of the material and 19th to 54th cycle is weight is small increases due to oxidation.

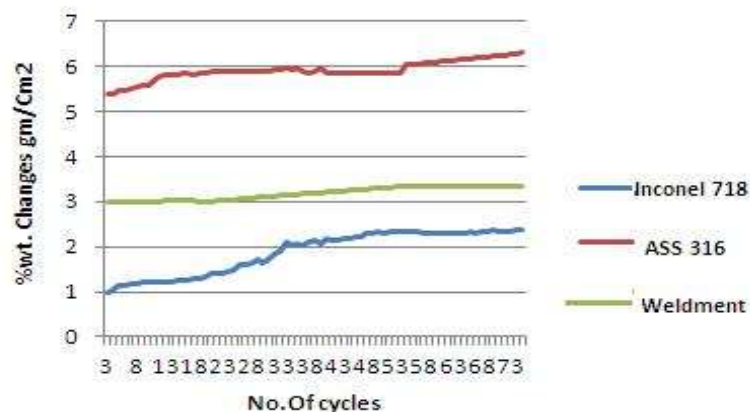
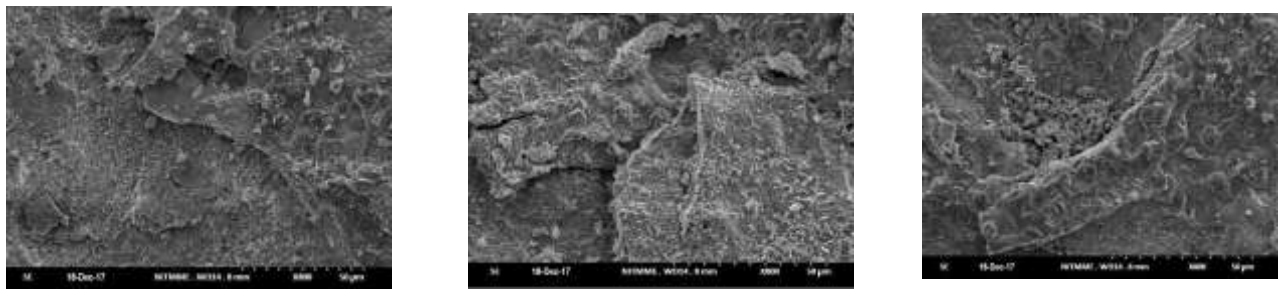


Fig. 3.The Change in the Mass Time (Oxidation Kinetic) Curves of Stainless Steel ASS316 and Inconel 718, and Weldment Coated with $\text{Na}_2\text{SO}_4\text{-50\%V}_2\text{O}_5$) at 950°C for 75 Cycles.

Weldment is maintained the standard oxidation up to 23rd cycle, and further cycles the weight increases due to the oxidation of the material. Finally, the weldment portion is strongest part compare to base metals.

3.3 Micro Structure Evaluation:

The simplification of asymmetrical weldment has been shown clearly The welding zone dendritic growth has been observed. SEM / EDAX analysis in the combined area of GTA Welding shown in Fig.4. It is clear the analysis of the ASS 316 as Fe has the wealthiest amounts of Ni and Cr and contains the small number of items such as Mn, Nb, and Si. However, the HAZs of Weld Zone and the Inconel 718 have Ni, Cr, Mo, and Nb. The existence of objects such as Fe, Al and Ti are also recognized. The weldment piece is good communicative metal compare to base metals.



(a) Inconel 718

(b) ASS 316

(c) Weldment

Fig 4. Microstructures of the base materials (a) Inconel 718, (b)ASS 316 and (c)Weldment

The XRD graphs for the air oxidation are shown in Fig. 5. The phases identified in case of air oxidation are Cr₂O₃, NiO, NiCr₂O₄, Al₂Fe₂O₆ and some amount of Fe₂O₃. Same results have been also reported in literature [13]. The strong peaks corresponding to matrix are showing that the scale is very thin or a little oxidation has occurred even after 50 cycles of oxidation. This result is in accordance with the very small value of parabolic rate constant for air oxidation. The protection against corrosion and oxidation is hence provided by the Cr₂O₃ layer. However in case of hot corrosion, the intensity of peaks corresponding to matrix became very less in weldment. The major phases identified are: Cr₂O₃, and NiCr₂O₄. Finally weldment is good corrosive resistance metal compare to base metal.

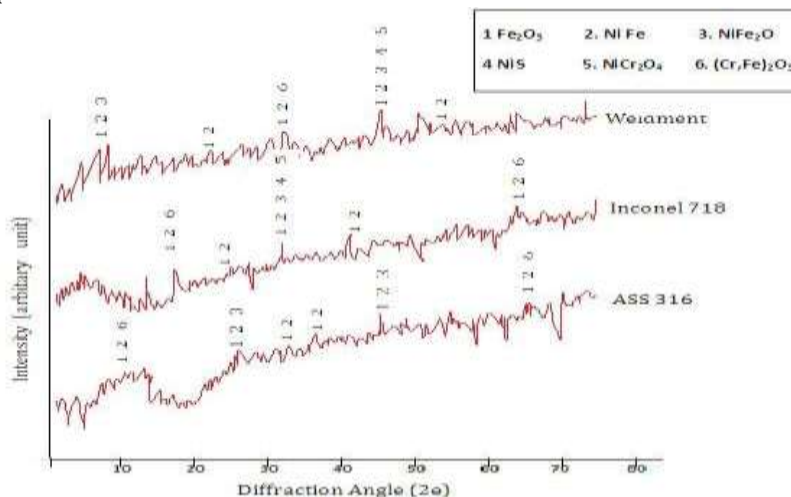


Fig. 5. XRD Pattern for hot corrosion at 950°C with salt environment of Na₂SO₄ +50% V₂O₅

4. CONCLUSIONS:

Conclusions from the current investigation that includes Inconel 718 and ASS316 dissimilar weldments obtained by gas tungsten arc welding.

- Oxidation and hot corrosion experiment conducted on superalloys Inconel 718 and ASS 316 with a welded suitable electrode.

- XRD analysis has indicated the presence of Fe_2O_3 as a predominant phase in the hot corrosion environment.
- The high temperature has enhanced weight gain due to coats of metal oxides as well as the formation of fluxing outcomes. The synthesis of oxide layer scale on the surface of alloys at 950°C and presenting the form of Cr_2O_3 , NiO and SiO_2 .
- Weight gain in the weldment is 3.9%, weight gain in base metal is 6.8%, and therefore the rate of decline is much higher due to more oxidation of Cr in base the metals compared to weldment because the weldment contains less quantity of Cr.

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