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Comparison on Developed DSS and Developed Welded DSS by using Tensile Test

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Abstract

The purpose of this study is to subject the DSS with different intermediate thermal ageing temperatures such as 475°C and 375°C respectively and for the further study TIG welding is carried out in a view to understand how exactly the thermal ageing is influencing to the degree of brittleness in both developed and developed welded DSS. The tensile test carried out for both developed DSS and developed welded DSS investigation in turn helps to reduce the severity of brittleness and hence to avoid sudden failures during working on DSS. The microstructure test reveals that DSS (475°C) behaves much harder with a lack of ferrite due to carbide precipitation and irregular grain orientations.

Keywords *— Duplex Stainless Steel (DSS), thermal ageing, brittleness, microstructure, precipitation, grain orientations.*

1. Introduction

The duplex stainless steel (DSS) family was introduced commercially about 1920's mainly intended for the pulp and paper industry. However, the original duplex Alloys suffered from brittleness and low ductility. A second generation with improved Weld-ability, mainly due to higher additions of nitrogen, was developed in the early 80's. This was a breakthrough for the DSS. The use and fields of applications increased continuously. Traditional applications can be found in the chemical, oil and gas industries in applications such as pipelines and reaction vessels. DSS offers an alternative to the austenitic stainless steels especially at temperatures between -50°C to 300°C and is suitable for structural applications. The two-phase structure of ferrite and austenite Combines the beneficial effects of the phases and allows the steel to obtain high strength (Ferrite) and toughness (austenite) even at low temperatures. The high strength makes it possible to use thinner dimensions and accomplish weight savings. Furthermore, the material offers good resistance to localized corrosion, due to high Cr, Mo, and N additions, and stress corrosion cracking, due to the ferrite content. Other advantages of DSS are satisfactory fatigue properties, modest thermal expansion and modest cost due to low nickel content.

2. Methodology

The methodology involves the following to subject the developed and developed welded DSS into various mechanical tests to characterize its hardness, impact toughness and UTS results. Comparative study is also made between all those developed and developed welded grades to identify the grade, which exhibits better mechanical properties for applying at hulls of marines.

2.1. Development of DSS

Two categories of (Chromium-Nickel steels AISI 304) DSS blanks is manufactured by following heat treatment process for different thermal ageing temperatures such as 475°C and 375°C for first and second blanks respectively.

2.2. Welding of developed DSS

The welding parameters carried out for TIG welding process is carried out according to American Welding Society (AWS) such as plate thickness of 12mm, welding current of 55amp, electrode type as AWS E 316L.

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Fig. 1. Welded DSS (double V-groove TIG welded)

2.3. Evaluation of mechanical properties for DSS

The steps carried out for evaluation of mechanical properties for both developed DSS and developed welded DSS are same and are carried out by using tensile test. Tensile test is used to determine ultimate tensile strength and several other properties such as Young's Modulus, Yield Strength, and Proof Strength of material. This test in turn supports to study the fracture behavior of a material.

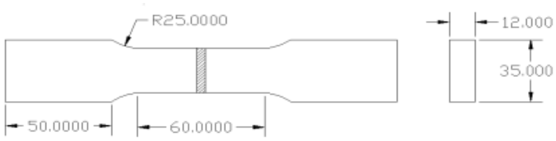

Fig. 2. Tensile Test Specimen specification

Fig. 3. Prepared Tensile Test Specimen specification

3. Results and Discussion

The results extracted from the tensile test on examining the influence of thermal ageing temperature on mechanical properties of both developed and developed welded DSS and serves as a basic for predicting the thermal ageing temperature at which their exhibits better mechanical properties. The results obtained from tensile tests have been shown below.

Table 1: Tensile Tests Results for TA475 and TA375

Sl. No	Material (Grade)	Trial. No	UTS (MPa)	Average (MPa)
1	TA475	1 2	703 711	707
2	TA375	1 2	676 668	671

Table 2: Tensile Tests Results for Welded TA475 and Welded TA375

Sl. No	Material (Grade)	Trial. No	UTS (MPa)	Average (MPa)
1	Welded TA475	1 2	604 596	600
2	Welded TA375	1 2	555 565	560

Table 3: Percentage of Elongation Results for TA475 and TA375

Sl. No	Material (Grade)	Trial. No	Initial Length (mm)	Final length (mm)	% of change in length	avg %
1	TA475	1 2	60 60	68.75 69.20	14.58 15.33	15
2	TA375	1 2	60 60	73.00 73.25	21.66 22.08	22

Table 4: Percentage of Elongation Results for welded TA475 and welded TA375

Sl. No	Material (Grade)	Trial. No	Initial Length (mm)	Final length (mm)	% of change in length	avg %
1	Welded TA475	1 2	60 60	67.95 67.5	13.25 12.50	13
2	Welded TA375	1 2	60 60	71.00 70.55	18.33 17.58	18

4. Conclusion

An attempt is made in this work to illustrate how exactly an intermediate Thermal Ageing (TA) temperature is affected to the embrittlement. After making the comparative study among the two of developed DSS grades of TA475 and TA375, again welding is carried out for the same grades of developed DSS of TA475 and TA375; it becomes possible to bring out the following conclusions.

On bases of tensile test and percentage of elongation results, TA375 and welded TA375 had lesser UTS and also show more percent of elongation among other grade. The higher percentage of elongation results in increased ductility (due to clean and high ferrite content) and hence it obviously loses its embrittlement. The lesser value of UTS for TA375 and welded TA375 proves the loss of embrittlement.

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