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Comparison of Mechanical Properties on 15CDV6 Steel Plates by TIG- Welding with and without copper coated filler wires

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Abstract: **Now day's wide variety of metals are used in industries and other areas due to their excellent mechanical and thermal properties such as strength, hardness, toughness. The metals are joined by suitable welding procedure with suitable filler wire to form a product must possess very good properties such as strength, hardness. Comparison of Mechanical Properties on HSLA Steels (15CDV6 plates) by TIG welding with and without Copper Coated Filler Wire (8CD12) is carried out to compare the properties mainly near the weldment between two plates. The plates are prepared with weld angle (30^0) and a route gap of 1mm thick is maintained at the bottom. During keeping the plates together, the plates will form an angle of 60^0("V" groove). TIG welding is performed on joining two plates with copper coated filler wire and other two plates without copper coated filler wire thus the behavior and strength of both with and without copper coated filler wires are studied. Post weld tests such as Die Penetration Test and Radiographic test are carried out near the weldment to find the internal and external weld defects. Tensile tests were carried out on samples cut from welded plates and Mechanical properties of copper coated and non-copper coated welded samples are compared. Copper coated weldment specimen yields less strength compared to non-copper coated weldment.**

Key words: **Weldment, TIG Welding, Filler wires, HSLA Steels**

I. INTRODUCTION

Steels containing other metals such as iron, chromium, nickel, manganese, tungsten, or vanadium are called alloy steels. This steel finds application in jet engines, nuclear reactors, electric motors and transformers. The 15CDV6 alloy steel is a low carbon steel with excellent yield strength, very good toughness and weld ability.

The major applications of 15CDV6 alloy steel are roll cages, pressure vessels, rocket motor casings, sub frames, track and push rods, wishbones, uprights, suspension components and motorsport applications. The chemical composition of 15CDV6 alloy steel is given table No1.1

TABLE 1 Chemical Compositions of 15CDV6 alloy steel

Element	Min (%)	Max (%)
C	0.12	0.18
Si	-	0.20
Mn	0.80	1.10
S	-	0.015
P	-	0.020
Cr	1.25	1.50
Mo	0.80	1.00
V	0.20	0.30

According to ASTM standards to weld 15CDV6 plates using TIG-welding by 8CD12 filler wire recommended because of its exceptional cleanness elements of the composition which ensure a bead without defects or micro porosity. The fig no 1.1 shows 8CD12 filler rods with coated and without coated cupper material.

Fig. 1. 8CD12 filler rods with coated and without coated cupper material.

K. Praveen & R. Ramesh [1] studied in their technical paper the manufacturing method of pressure vessel to find out the effect of welding, the type of testing and method of analysis adopted on Non-Destructive in nature and can be carried out in an effective manner. 15CDV6 is a major structural material

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and is used in variety of structural application including construction of boilers, Solid Rocket Booster (SRB), Solid Rocket Booster involves that provide most of the main force or thrust needed to lift the space shuttle off the launch pad. Chandrasekhar N et al [2] studied in their technical paper the commonly used welding process for fabricating this steel are electron-beam welding, and tungsten inert gas (TIG) welding. Therefore, Activated-flux tungsten inert gas (A-TIG) welding, a variant of TIG welding has been developed in-house to increase the depth of penetration in single pass welding. In structural materials produced by A-TIG welding process, weld bead width, depth of penetration and heat affected zone (HAZ) width play an important role in determining in mechanical properties and also the performance of the weld joints during service. To obtain the desired weld bead geometry, HAZ width and make a good weld joint, it becomes important to set up the welding process parameters. The current work attempts to develop independent models correlating the welding process parameters like current, voltage and torch speed with weld bead shape will bead shape parameters like depth of penetration, bead width, HAZ width using ANFIS. These models will be used to evaluate the objective function in the genetic algorithm. Then genetic algorithm is employed to determine the optimum A-TIG welding process parameters to obtain the desired weld bead shape parameters and HAZ width. In this technical paper useful technical information has gathered from [3, 4, 5, 6, 7].

II. MATERIALS AND METHODS

A. Experimental details

Single V-notch Edge preparation carried out on 15CDV6 steel plates by milling machine and machining parameters adopted during machining are listed in Table No II. The "V" groove of an angle 60^o with 1mm thickness at the bottom for forming a route gap to deposit the filler material during the welding process. The fig. 2 shows the actual dimensions of the specimen.

TABLE.II. Milling Machining Parameters

Machining Parameters	Values
Spindle speed	224 rpm
Feed	45-50 mm/min
Cutting Angle	30^o
Cutting Tool Material	Carbide Tool
Tool Diameter	24mm

Fig. 2. Single V-notch Edge preparation carried out on 15CDV6 steel plates

The Tungsten Inert Gas welding produces coalescence of metals by heating them with an arc between a tungsten electrode and the work-piece. Weld pool is protected from atmosphere by argon inert gas. The fig. 3 shows TIG welding process set-up and its welding process with and without copper coated filler wires, parameters are listed below.

Root gap : 2.5 mm
Shielding gas : 15 lit/min
Purging gas : 15 lit/min
Type of gas : Argon Inert Gas
Filler wire used : 8CD12
Dia. of filler rod : 1.6mm

Fig. 3. TIG-Welding Set-up

TABLE.III. Welding with copper coated filler

Pass	Current(A)	Time (Sec)	Voltage (V)
1st	195	3′56″	9
2nd	210	6′	10
3rd	220	7 ′2″	12
4th	220	9′	12
5th	220	9′ 18″	10.9
6th	220	6′ 57″	12.9
7th	200	6′54″	13

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TABLE.IV. Welding without copper coated filler

Pass	Current (A)	Time (Sec)	Voltage (V)
1st	195	4′ 15″	9.3
2nd	210	4′11″	10.3
3rd	220	5′24″	12.9
4th	220	7′39″	11.1
5th	220	7′53″	13.5
6th	220	7′58″	10.9
7th	200	8′27″	9.8

FIG.4. Welded 15CDV6 steel Plate

Die Penetration test is carried out after the welding, in order to find weld defects. In this test penetratent is applied on the welded area for10mins and after the penetratent is cleaned with NDT cleaner, then NDT developer is sprayed on the welded area. The fig. 4 and fig..5 shows results of Die penetration test and No defects were found on the weldment for both with and without copper coated welded specimens.

Fig.5. Die penetrant on without Copper Coated welded specimens

Fig.6. Die penetrant on with Copper Coated welded specimens

Also radiography test is carried out to find out the internal defects near the weldment. In this test the X-Rays are passed towards the weldment, if any defects are present, they can be seen on X-Ray Film. The fig. No 2.6 shows set-up of radiographic test. No defects were found on the weldment for both with and without copper coated welded plates.

Fig. 7. Radiography Test On 15CDV6 welded specimen

The welded specimens are made into rectangular shape, size of 300X20X16.3mm dimensions as per ASTM 370 standard on CNC cutting machine. Hydraulic Universal Testing Machine is used to carry out tension test to determine the tensile properties and to study about the mechanical behavior welded material.

III. Results and Discussion

The tensile tests were conducted under the UTM for all welded specimens. The fig. 8 and fig. 9 shows the stress versus strain diagram for typical specimens. The table V and Table VI give the experimental values of silent features of stress –strain diagram. It can be observed, by comparing the values of both the tables, we can understand that load carrying capacity and % of elongation of specimen's without copper coated filler wire is greater than the of specimen's with copper coated filler wires.

TABLE. V. Tensile Test Results welded specimen of TIG welding process with Copper Coated filler wire

Properties	Sample No:1	Sample No:2	Sample No:3
Max. force (kN)	216.72	221.74	220.26
Tensile strength, Mpa	1,065.958	1,073.692	1,066.526
Elongation, %	21.34	22.26	17.86
Proof stress, Mpa	864.7878	887.7548	863.6411

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TABLE. VI. Tensile Test Results welded specimen of TIG welding process without Copper Coated filler wire

Properties	Sample No:4	Sample No:5	Sample No:6
Max. force (kN)	220.5	220.82	217.96
Tensile strength, Mpa	1,088.685	1,081.435	1,069.412
Elongation, %	14.92	16.32	17.6
Proof stress, Mps	907.4840	938.9221	919.2741

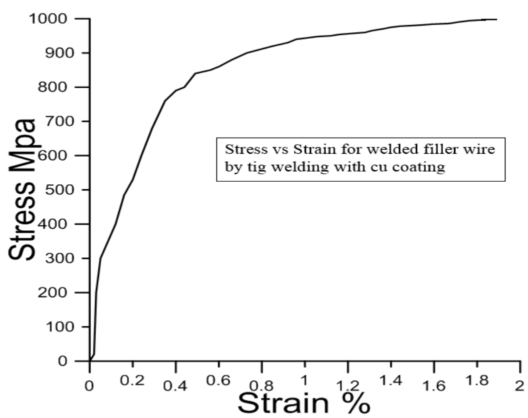

Fig. 8. Stress – Strain diagram of welded steel plaes by TIG welding using Cu coated filler material

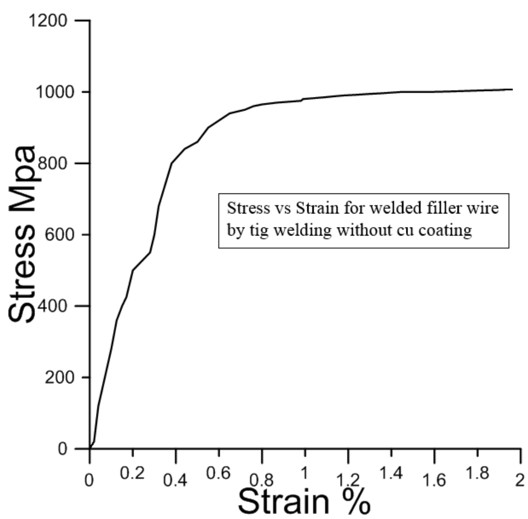

Fig. 9. Stress – Strain diagram of welded steel plaes by TIG welding using without Cu coated filler material

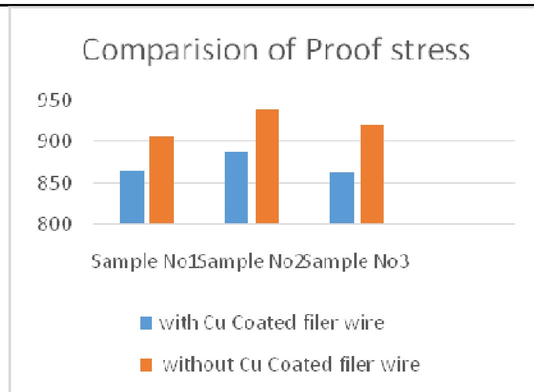

Fig. 10. Bar chart comparing proof stress value of both kinds of specimens

CONCLUSION

The copper coating on the filler wire are used only for the purpose of storage such that the filler wires are protected from the formation of rust and during welding the copper coating is removed.

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