

# Investigation on Mechanical Properties of TIG Welded Joint and its Efficiency

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## ABSTRACT

This work mainly pertains to improvement in the mechanical properties of IS 2062 steel plates welds through gas tungsten arc welding (GTAW) process. TIG (Tungsten inert gas) welding are well known welding techniques, that are being used in industries in the current age. Mild steel was the only commonly used material in TIG welding. Mild steel is the first material consumption. The comparison is done on the basis of the mechanical properties of the welded joint of TIG welding. This study is done on mechanical testing and non-destructive tests (DPT and radiography tests) of TIG welding on IS 2062 Mild steel plates.

**KEYWORDS:** Mild steel, IS 2062, TIG & non-destructive test.

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## 1. INTRODUCTION

Welding is a fabrication process that materials, usually metals or thermoplastics, by causing fusion. In addition to melting the base metal, a filler material is typically added to the joint to form a pool of molten material (weld pool) that cools to form a joint that is usually stronger than the base material. Pressure may also be used in conjunction with heat, or by itself, to produce a weld. The factors affecting the welded joint strength is mainly based on type of joint, joint strength, no of joints to the joined, moisture presented in air and atmospheric conditions.

The mild steel joining process is easy when compared to other conventional metallic materials and mild steel is advantageous material and its coefficient of expansion is finite.[1].

## 2. LITERATURE REVIEW

### 2.1 Tungsten Inert Gas (TIG) Welding:

In TIG welding method, the arc is struck between small gap of non-consumption in tungsten electrode and the work piece in a shield of inert gases (Argon, Helium). Figure 1, represents the TIG welding processes.

Filler material is applied for matching the similar work pieces. Generally, DC arc is used with tungsten as the

negative pole (DCEN). The excessive heat is generated at the tungsten electrode if this is used as anode.

**Ahmetdurgutlu et.al [2]** Investigation the effect of hydrogen in argon as shielding gas for TIG welding of 316L austenitic stainless steel. They used current 115A welding speed 100 mm/min and gas flow rate 10 l/min for welding of 4mm thick plate. For all shielding media, hardness of weld metal is lower than that of HAZ and base metal. Penetration depth, weld bead width and mean grain size in the weld metal increase with increasing hydrogen content, The highest tensile strength was obtained for the sample welded under shielding gas of 1.5%H-Ar.

**Ahmed Khalid Hussain et.al [3]** Investigating the effect of welding speed on tensile strength of the welded joint by TIG welding process of mild steel of 4mm thickness. The strength of the welded joint was tested by a universal tensile testing machine. Welding was done on specimen of single V butt joint with welding speed of 1800-7200 mm/mi. From the experimental results it was revealed that strength of the weld zone is less than base metal tensile strength increases with reduction of welding speed.

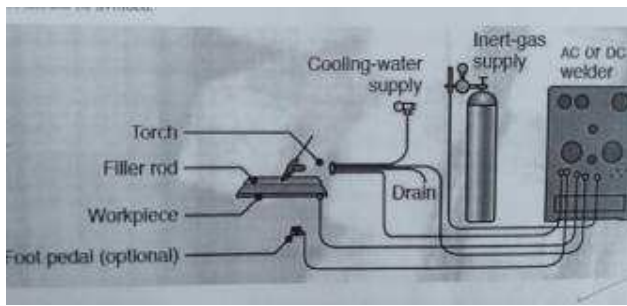


Fig 1: TIG welding testing apparatus.

### 3. MATERIALS AND METHODOLOGY

The extended form of IS 2062 mild steel is considered for the present work. It has a thickness of 6mm and width of 20mm. The physical and mechanical properties of IS 2062 are represented in table 1.

Table 1: Physical and mechanical properties of IS 2062 steel.

| Element             | Tensile Strength in Mpa | Yield Stress (<20 mm) | Yield Stress (20-40 mm) | Yield Stress (>40 mm) | % Elongation at gauge length 5.65 S0 | Bend Test (min)               |
|---------------------|-------------------------|-----------------------|-------------------------|-----------------------|--------------------------------------|-------------------------------|
| Carbon Steel IS2062 | 410                     | 250                   | 240                     | 230                   | 23 min                               | 3t* (t* is 3 times thickness) |

In this investigation, leeb hardness test of Dry Penetrant Test (DPT), radiography, bending and tensile tests have been done on welded joints by TIG welding. The joined mild steel workpieces are shown in figure 2.



Fig 2: DPT tested specimen.

Table 2: Hardness test of welded joint.

| Type of welding | Hardness of weld region (HRB) |
|-----------------|-------------------------------|
| TIG             | 45                            |

Different types of tensile properties of welded mild steel IS 2062 were illustrated such as yield strength, ultimate tensile strength, and percentage elongation. For each condition 5 specimens were tested and average properties of welded joints are considered for the investigation. The above said properties are shown in following table 3.

Table 3: Mechanical properties of welded joint.

| Type of joint | Yield Strength (MPa) | Ultimate Tensile Strength (MPa) | Elongation (%) |
|---------------|----------------------|---------------------------------|----------------|
| TIG           | 83.3                 | 144.80                          | 21             |

This study also intended to know the welded joint failures by using non-destructive tests (DPT & radiography tests). The liquid penetrant welded zone is clearly represented in the figure 4. Also values of liquid penetrant test were represented in table 4

Table 4: LPT preparation values for MS sheet.

| Time            | Minimum | Maximum | Temperature |
|-----------------|---------|---------|-------------|
| Dwell Time      | 5       | 10      | 28          |
| Developing Time | 2       | 5       | 28          |
| Drying Time     | -       | -       | -           |
| Emulsification  | -       | -       | -           |

### 4. RESULTS AND DISCUSSION

In this investigation, leeb hardness testing has been done on leeb hardness test machine as shown in figure 3.

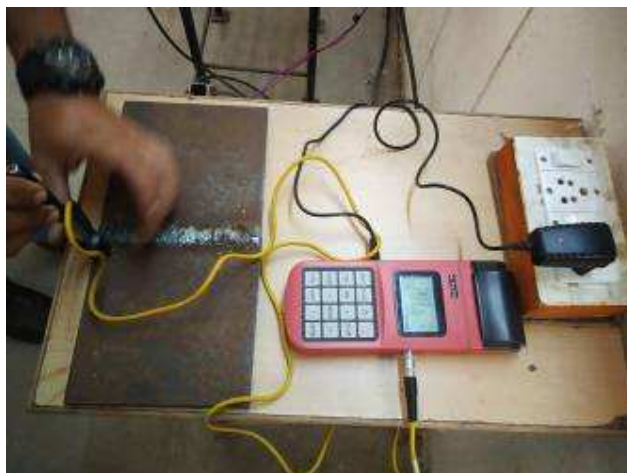


Fig 3: Leeb hardness testing machine.

And the value of hardness in the welded region is represented in the following table 2.



Fig 4: LPT testing for MS sheet.

One of the radiography tested welded zone sample is represented in table 5 and it is observed in figure 5.

Table 5: Radiography observation values for MS sheet.

|                      | TIME | TEMPERTURE | SOLUTION |
|----------------------|------|------------|----------|
| DEVELOPER            | 5Min | 22 C       | -        |
| STOP BATH            | 5Min | 22 C       | -        |
| FIXER                | 5Min | 22 C       | -        |
| RINSING WATER        | 5Min | 22 C       | -        |
| WEETING AGENT DRYING | 5Min | 22 C       | -        |



Fig 5: Radiography defected zones for welded MS sheet zones.

## 5. CONCLUSION

1. The joining of the two mild steel plates is done successfully IS 2062 rolled steel plates by using TIG welding process. Here the join of the metal used for the joint of butt joint. After the completion of the joining of the plates the work piece is subjected to the non-destructive testing of the inspection methods where the

TIG welding, leeb hardness test, dye penetrant testing, bending test, tensile test.

2. In the dye penetrant testing the defects found was incomplete fusion on the face side and lack of the penetration on the root side. On subjected the work piece of for leeb hardness test machine inspection was improper root and face penetration. Excess face penetration undercut and welded breed profile were encountered.
3. While using leeb hardness test the hardness of the metal is found at different positions i.e., at base metal, heat affected zone, weld pool at top middle and bottom positions. In the tensile test where the work piece is pulled from the sides to know the elongation to be 23%, yield load to be 103.950 KN. On performing the bend test the load corresponding value of the deflection on both the sides of the specimen were checked and found the maximum load for which the failure of the specimen will not occur is 12.5 KN.
4. After performing all these test on the work piece it can be concluded that the joint is good in the performance.

## 6. REFERENCES

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