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WELD STRENGTH TESTING

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Abstract - *High strength steels are widely used for making frames in automobile industries. And there is a demand on lightweight designs of these structures with increased structural performance where the welds become more sensitive to failure. We intend to do our project on Weld Testing of dissimilar pipes, Chromalloy, Mild Steel and Stainless Steel which found wide application in the field of automobile industries. In industries most commonly using welding is GTAW (Gas Tungsten Arc Welding) which uses non-consumable tungsten electrode. The dissimilar pipes are joined using two different filler rods. The weldment are subjected to tensile testing and compression testing to find the yield point and breaking point by using the Universal Testing Machine. The three dissimilar pipe combination is compared and the best combination is selected.*

Key Words*:* **TIG Welding, Tensile Testing, Compression Testing, Chromoly, Mild Steel, Stainless Steel, Filler Rod.**

1. INTRODUCTION

Welding is a process of permanent joining two materials (usually metals) through localized coalescence resulting from a suitable combination of metallurgical conditions, filler material and also depending upon the combination of metals a wide range of welding processes has been developed.

1.1 Principles of GTAW

Gas Tungsten Arc Welding (GTAW), also known as tungsten inert gas (TIG) welding is a process that produces an electric arc maintained between a non-consumable tungsten electrode and the part to be welded. The Heat-affected Zone, the molten metal and the tungsten electrode are all shielded from atmospheric contamination by a blanket of inert gas fed through the GTAW torch. Inert gas (usually Argon) is inactive or deficient in active chemical properties. The shielding gas serves to blanket the weld and exclude the active properties in the surrounding air.

1.1.1 Working of GTAW

In the TIG Welding process, an arc is produced in between the non-consumable tungsten electrode and work piece which is to be joined. The arc so produced creates an intense heat that melts the two metal pieces and fuses them together to form a strong weld by the use of a filler metal. The weld so formed exhibits the similar properties of the base metal. A shielding gas environment is used to prevent the weld from atmospheric contamination.

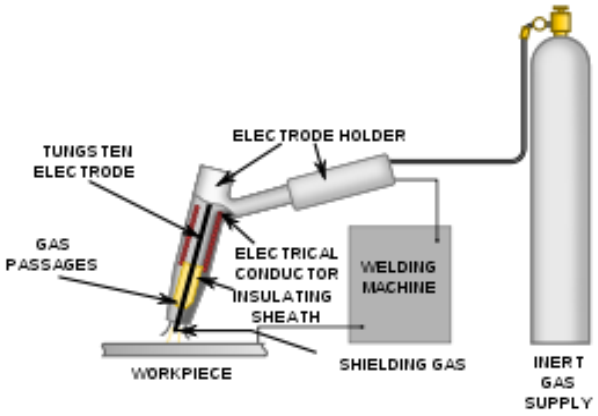

Fig 1.1 Gas Tungsten Arc Welding

In the TIG welding process or Gas Tungsten Arc Welding, the welding torch is connected to a constant current welding power supply and shielding gas source. With the help of the constant current supply, the electric arc is produced between the electrode and two metal work pieces which are to be joined. A filler metal is used to join the two metal pieces together. As the spark is struck, the filler metal is inserted in the cavity, and due to intense heat, the filler metal melts and fills the cavity between the two metal pieces and forms a strong weld. A shielding gas (He or Ar) is used to protect the weld from atmospheric contaminations. As the arc is produced, simultaneously the shielding gas also starts to spread near the weld area and avoids the weld to combine with atmospheric air and protect it from contaminations. The welding is performed by a highly-skilled operator. The operator has better control over the weld. He can use both hands to control heat generated and filler metal. From one hand he controls the arc produced and with the other hand he controls the feed of filler metal.

1.2 Universal Testing Machine

A Universal Testing Machine (UTM) is used to test both the tensile and compressive strength of materials. Universal Testing Machines are named as such because they can perform many different varieties of tests on an equally diverse range of materials, components, and structures. Most UTM models are modular, and can be adapted to fit the customer's needs. Universal Testing Machines can accommodate many kinds of materials, ranging from hard samples, such as metals and concrete, to flexible samples, such as rubber and textiles.

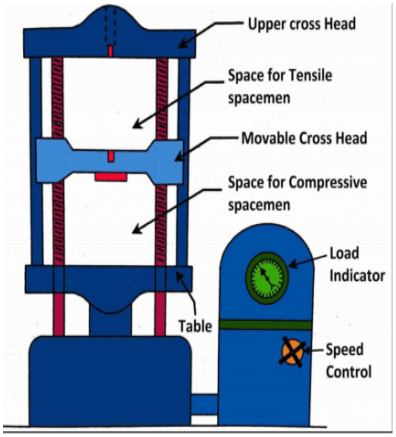

Fig 1.2 Universal Testing Machine

This diversity makes the Universal Testing Machine equally applicable to virtually any manufacturing industry. The UTM is a versatile and valuable piece of testing equipment that can evaluate materials properties such as tensile strength, elasticity, compression, yield strength, elastic and plastic deformation, bend compression, and strain hardening. Different models of Universal Testing Machines have different load capacities, some as low as 5KN and others as high as 2,000KN.Tests can also be performed in controlled environmental conditions. This is achieved by placing the Universal Testing Machine into an environmental room or chamber.

2. Material Selection

2.1 AISI 4130 Chromoly

4130 steel is a family of SAE steel grades, as specified by the Society of Automotive Engineers (SAE). Alloying elements include chromium and molybdenum, and as a result these materials are often informally referred to as chromoly steel (common variant stylings include chrome-moly, cro-moly, CrMo, CRMO, CR-MOLY, and similar). They have an excellent strength to weight ratio and are considerably stronger and harder than standard 1020 steel. The chemical composition of 4130 Chromoly steel are given in Tables.

TABLE 2.1: Chemical Composition of Chromoly 4130

Element	% Composition by Weight
Iron	97.3 - 98.22
Carbon	0.28 - 0.33
Chromium	0.8 - 1.1
Manganese	0.7 - 0.9
Molybdenum	0.15 - 0.25
Phosphorus	0.035
Silicon	0.15 - 0.35
Sulphur	0.04

TABLE 2.2: Tensile Testing of Chromoly 4130

Test Parameters	Values
Ultimate Tensile Strength	629 MPa
Yield Strength	544 MPa
% Elongation in 50 mm GL	26.6 %

2.2 Stainless Steel (SS 304)

Type 304 stainless steel is a T 300 Series Stainless Steel austenitic. It is defined as a Chromium-Nickel austenitic alloy. Grade 304 is the standard "18/8" stainless that you will probably see in your pans and cookery tools. It has a bright shine due to a high level of chromium and nickel. It is highly corrosive resistance. The chemical composition and tensile strength are given in Tables.

TABLE 2.3: Chemical Composition of SS 304

Element	% Composition by Weight
Carbon	0.032
Manganese	1.28
Phosphorus	0.013
Silicon	0.42
Sulphur	0.006
Nickel	8.2

TABLE 2.4: Tensile Testing of SS 304

Test Parameters	Values
Ultimate Tensile Strength	515 MPa
Yield Strength	205 MPa
% Elongation in 50 mm GL	40 %

2.3 AISI 1018 Mild Steel

AISI 1018 mild/low carbon steel(non-alloy) has excellent weldability, produces a uniform and harder case and it is considered the best steel for carburized parts. AISI 1018 mild/low carbon steel offers a good balance of toughness, strength and ductility. The chemical composition and the tensile strength are given in tables.

TABLE 2.5:Chemical Composition of AISI 1018 Mild Steel

Element	% Composition by Weight
Iron	98.81-99.26
Carbon	0.14-0.20
Manganese	0.60-0.90
Phosphorus	0.040
Sulphur	0.050

TABLE 2.6: Tensile Testing of AISI 1018 Mild Steel

Test Parameters	Values
Ultimate Tensile Strength	420 MPa
Yield Strength	350 MPa
% Elongation in 50 mm GL	15 %

3. TEST PREPRATION

The basic test for determination of material behavior is the tensile test and Compression test. Generally, it is carried out using a round specimen. When determining the strength of a welded joint, also standardized flat specimens are used. Here, we make use of Ultimate Testing Machine for obtaining the Yield stress and Ultimate tensile strength of the welded pipes mentioned below,

TABLE 3.1

Metal combination	Filler Rod
Chromoly Vs Mild Steel	Mild Steel
Chromoly Vs Stainless Steel	Stainless Steel
Mild Steel Vs Stainless Steel	Mild Steel
Mild Steel Vs Stainless Steel	Stainless Steel

4. TEST RESULT

Table 4.1: Tensile test Result

Sl. No	Sample	Tensile strength (MPa)	Yield stress (MPa)	Elongation (%)	Fracture location
1	MS - Cr	425.04	297.51	9.20	Outside weld
2	SS -Cr	336.19	284.93	11.82	Outside weld
3	MS -SS(SS filler)	218.84	211.61	8.66	Outside weld
4	SS - MS(MS filler)	224.67	213.42	8.36	Outside weld

Table 4.2: Bending Test Result

Sl. No	Sample	Bending Load in KN
1	MS - Cr	1.93
2	SS - Cr	2.01
3	MS - SS (SS Filler)	2.49
4	SS - MS (MS Filler)	2.87

5. CONCLUSIONS

As we have studied that dissimilar welded joints have more strength so we are here to find the weld strength of different combination of materials with different filler rods. The combinations are Chromoly Vs Ms (MS filler), Chromoly Vs SS (SS filler), SS Vs MS (MS filler), MS Vs SS (SS filler).

From the above combinations we have found that the **Chromoly Vs Mild Steel (MS filler)** has the high tensile strength 425.04 MPa and yield strength 297.51 MPa. So the above mentioned combination has high weld strength.

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