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Experimental Investigation of Rockwell Hardness and Charpy Impact Test of Tungston Inert Gas (TIG) Welded Joint of Duplex Stainless Steel-2205 Specimen

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ABSTRACT

The main aim of my present work is to study and investigate the Hardness and Charpy impact strength of Tungston inert gas (TIG) welded joint of Duplex Stainless steel specimen. The Hardness and impact strength is most important factor in considering the transport of gases & liquid fluids over a long distance which is mostly carried in pipe lines and making huge pipe without joints is impossible. So, there is possible of making joints in pipes so, we prefer to have strong joints in pipes in which there is no possible way in leakages and in this present work we choose TIG welding and calculate its hardness & impact strength.

Keywords : TIG Welding, Charpy Impact Test, Hardness

Nomenclature:

ASTM – American society for Testing and Materials

I. INTRODUCTION

With the Modern Technological advancement, more structural materials are designed to carry heavier loads. Many structural parts need to be welded and the discontinuous parts of these structural materials need up to the mark of standard design to carry these loads. The hardness and impact strength are main determining factor to check whether material can withstand sudden loads. The Duplex Stainless steel-2205 is an austenite - ferrite alloy with the addition of Nickel, copper, chromium etc… It is designed to provide exceptional resistance to many corrosive environments. The nickel content is sufficient for resistance to chloride ion stress corrosion cracking.

Toughness of material in physical sense gives the energy a specimen can absorb when affected with sudden load until failure. Charpy Impact Testing is an ASTM standard method of determining the impact resistance of materials. An arm held at a specific height (constant potential energy) is released. The arm hits the sample. The specimen either breaks (or) the weight rests on the specimen. From the energy absorbed by the sample, its impact energy is determined which indirectly determines the toughness of specimen.

II. METHODOLOGY FOLLOWED IN PRESENT WORK

- Two Duplex Stainless steel Specimen of 55*55 mm were prepared for TIG welding
- TIG welding was carried out at 105A and current of 22V. The specimen is welded with non-consumable electrode to make it more effective than arc welding.

- The filling of Specimen was carried out with proper joining and removing impurities on the welded surface.
- After getting the required welded specimen, the notch was prepared of 2mm depth by means of shaper machine.
- The testing of welded joints first carried out in Rockwell Hardness Testing Machine and second it is carried out in Charpy Impact testing machine.

III. EXPERIMENTAL APPARATUS

A. GAS TUNGSTEN ARC WELDING (GTAW):

In the GTAW process, an arc is established between a tungsten electrode and the base metal(s). Under the correct conditions, the electrode does not melt, although the work does at the point where the arc contacts and produces a weld pool. The filler metal is thin wire that's fed manually into the pool where it melts. Since tungsten is sensitive to oxygen in the air, good shielding with oxygen-free gas is required. The same inert gas provides a stable, inert environment to protect the weld pool as it solidifies. Consequently, **GTAW is commonly known as TIG (tungsten inert gas) welding.** Because fluxes are not used (like SMAW), the welds produced are sound, free of contaminants and slags, and as corrosion-resistant as the parent metal. Tungsten's extremely high melting temperature and good electrical conductivity make it the best choice for a non-consumable electrode. The arc temperature is typically around 11,000° F. Typical shielding gasses are Ar, He, N, or a mixture of the two. As with GMAW, the filler material usually is the same composition as the base metal.

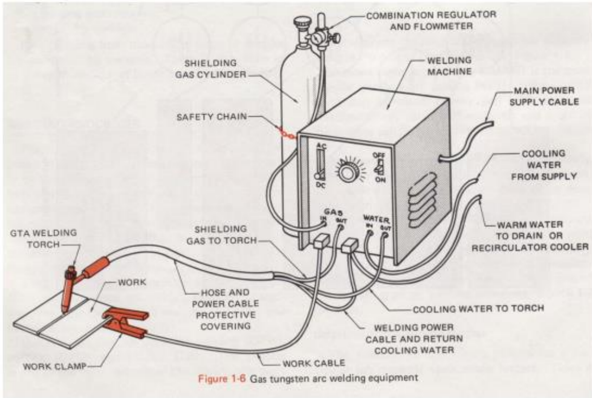


Figure 1. Gas tungsten arc welding equipment

GTAW is easily performed on a variety of materials, from steel and its alloys to aluminum, magnesium, copper, brass, nickel, titanium, etc. Virtually any metal that is conductive lends itself to being welded using GTAW. Its clean, high-quality welds often require little or no post-weld finishing. This method produces the finest, strongest welds out of all the welding processes. However, it's also one of the slower methods of arc welding.

Advantages :

- It is very clean welding process it can be used to weld reactive metals, such as titanium, Aluminium, magnesium and zirconium
- It is suitable for joining thin sections because of its limited heat inputs.
- No post welding is required.
- Highest Quality weld is obtained

Disadvantages :

- Deposition rate is low
- Required Shielding gas and need of highly skilled labour.

Image of Material After Welding :

(a)

(b)

Figure 2 (a)(b)

B. ROCKWELL HARDNESS TEST :

Stanley P. Rockwell invented the Rockwell hardness test. **This Hardness test uses a direct reading instrument based on the principle of differential depth measurement**. He was a metallurgist for a large ball bearing company and he wanted a fast non-destructive way to determine if the heat treatment process they were doing on the bearing races was successful. The only hardness tests he had available at time were Vickers, Brinell and Scleroscope. Here we measure Hardness at Scale B (steel ball indentor)

Figure 3. Rockwell Hardness Testing

Table 1

Rockwell Scale	Hardness Symbol	Indentor	Load(Kg)
A	HRA	Diamond Cone	60
B	HRB	1.6 mm Steel ball	100
C	HRC	Diamond Cone	150

Principle of Rockwell Hardness Test :

- Position the surface area to be measured close to the indenter.
- Apply the minor load and a zero reference position is established.
- The major load is applied for a specified time period (dwell time) beyond zero.
- The major load is released leaving the minor load applied
- The dial contains 100 divisions, each division representing a penetration of 0.002mm

Advantages :

- Easy & quick to test the material
- It is suitable for testing large product series.

C. CHARPY IMPACT TEST :

In simple words impact test can be said as Material which can resist sudden loads and heavier loading condition.

A metal may be very hard (and therefore very string and yet be unsuitable for applications in which it is subjected to sudden loads in service. Materials behave quite differently when they are loaded suddenly than when they are loaded more slowly as in tensile testing. Because of this fact, **impact test is considered to be one of the basic mechanical tests (especially for ferrous metals).**

The term brittle fracture is used to describe rapid propagation of cracks without any excessive plastic deformation at a stress level below the yield stress of the material. Metals that show ductile behavior usually can, under certain circumstances, behave in a brittle fashion. The stress needed to cause yield rises as the temperature falls. At very low temperatures, fracture occurs before yielding

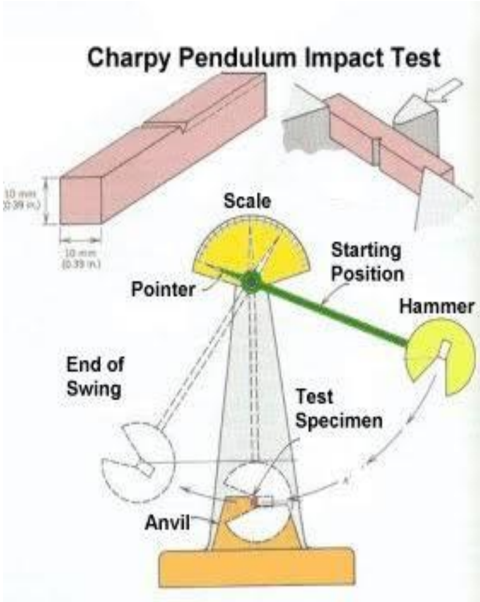


Figure 4. Charpy Pendulum

Impact Test Image of Material After Testing in Charpy Pendulum Impact Test :

IV. RESULTS

Hardness Value at Tig Welded Joint :

At 3-0 initial condition:

Table 2

APPLIED LOAD (kg-f)	HARDNESS VALUE AT WELDED JOINT	HARDNESS VALUE OF SPECIMEN
60	22	18
100	10	18
150	5	15
187.5	96	11
250	68	7

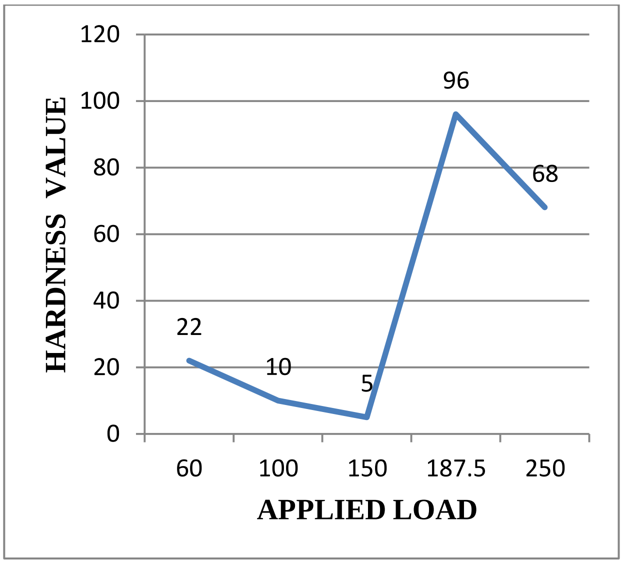
At 4-0 initial condition :

Table 3

APPLIED LOAD (kg-f)	HARDNESS VALUE AT WELDED JOINT	HARDNESS VALUE OF SPECIMEN
250	53	92

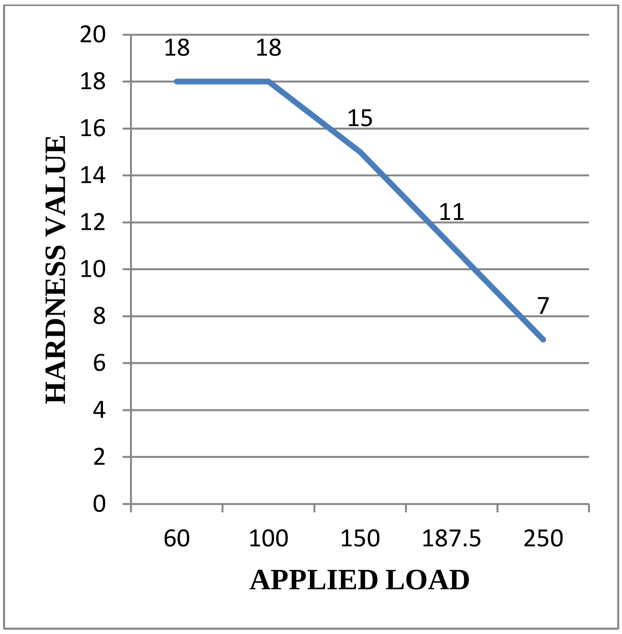
Graph For Rockwell Hardness :

For TIG welded Joint :



Graph1

For duplex stainless steel :



Graph 2

Values For Charpy Impact Test :

Table 4

INITIAL ENERGY BEFORE FRACTURE (E1) Joule	ABSORBED ENERGY AFTER FRACTURE (E2) Joule	ABSORBED ENERGY OF SPECIMEN (E2-E1)
146	295	149 joule

V. OBSERVATION

- Tungston inert gas welding have been successfully executed in joining two specimens.
- Charpy impact testing machine is used in calculating the impact strength of specimen.
- Rockwell Testing Machine is used in calculating Hardness of Specimen.
- From Rockwell Hardness Testing it is clear that hardness value at welded joint is nearly equal and greater to that of specimen
- From Charpy impact test it is clear that Material undergoes ductile fracture and can withstand applied heavier loads.

VI. CONCULSION

From the Values obtained from both Rockwell Hardness and Charpy Impact testing we can conclude that

- Welding can been Perfectly achieved with proper filling of specimen joints and removing impurities as which is important factor in achieving proper welding. As perfect welding can withstand heavy loads.
- From Rockwell Hardness testing it is clear that hardness of our material and welded joints are up to our required mark.
- From **Charpy Impact test it is clear that 149 Joule is the Absorbed energy when hammer is made hitted by the specimen but TIG welded joint is strong as it undergone ductile fracture. So, it is clear that it can be used in heavier carry goods like automobile, pipe lines etc…**

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