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A Review Study on Experimental Investigation of Annealing Heat Treatment Process on SS 316 and Mild Steel Joint by SMAW Process

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ABSTRACT

This paper presents a review of the recent work done on annealing of dissimilar metal welded by SMAW, with the focus on improvement of microstructure and mechanical properties of specimen. Annealing is used in industry to improve the desired mechanical properties of metal such as increasing machinability, strength of material, hardness and removing stress from metal. The papers for investigation in this work were considered from 2010 to date 2021. A total of 20 research papers were chosen for our consideration after an in-depth examination of several such papers. In this paper covers the all the technical aspects which affect the quality of SMAW welded and annealed joint. Effect on all the types of joint configuration is studied. All the technical aspects of heat treated all material is covered. Effect on material quality of basic parameters like annealing temperature, heat treatment process, welding Current, welding Voltage has been studied. Finally, the area on which further more research can be carried out are identified.

Key words: Annealing, Post weld Heat treatment (PWHT), different heating temperature, dissimilar metal welding, shielded metal arc welding (SMAW), gap between two plate and Plate thickness

INTRODUCTION

Heat treatment process is a series of operations involving the Heating and cooling of metals in the solid state. Its purpose is to change a mechanical property or combination of mechanical properties so that the metal will be more useful, serviceable, and safe for definite purpose. By heat treating, a metal can be made harder, stronger, and more resistant to impact, heat treatment can also make a metal softer and more ductile. No one heat treating operation can produce all of these characteristics. In fact, some properties are often improved at the expense of others. in being hardened, for example, a metal may become brittle.

ANNEALING: Annealing is process of softening the material such as carbon steel or metal to make it less brittle by heating it to a particular temperature, maintaining it at that temperature for a particular duration and then Cooling it slowly to normal temperature at a particular rate.

QUENCHING- Quenching process is carried out to harden steel to increase wear resistance and increase the cutting ability of steel. This is done by heating metal at above its recrystallization temperature but below its melting temperature and then rapid cooling of a heated metal in a quenching medium such as water, oil or air in order to obtain desirable material properties.

NORMALISING- Normalizing is a heat treatment process that is used to make a metal more ductile and tough after it has been subjected to thermal or mechanical hardening processes. Normalizing involves heating a material to an elevated temperature and then allowing it to cool back to room temperature by exposing it to room temperature air after it is heated. This heating and slow cooling alters the microstructure of the metal which in turn reduces its hardness and increases its ductility.

TEMPERING: Tempering is process which is used to increase the toughness of iron based alloys. Tempering is usually done after hardness to reduce some of the excess hardness. Tempering is done by heating the metal to some temperature below the critical temperature and allowed to cool in air gradually. Type of tempering is low temperature tempering, medium temperature tempering, high temperature tempering.

LITRATURE SURVEY

A. **The Effects of Shielded Metal Arc Welding (Smaw) Welding On The Mechanical Characteristics With Heating Treatment inn S45c Steel**

In this paper the study aimed (1) to analyze the mechanical Characteristics of S45C steel with heat treatment and without heating treatments and (2) to analyze the temperature of heating treatment which could result in the maximal strength of S45C steel after the welding process. After welding one specimen was not heat treated and three specimen were heat treated in which one was heat treated at 150C, second at 250C and third at 300C. Here four types of tests were performed such as tensile test, impact test, hardness test, microstructure test.

The highest value of 300C heat treated specimen was found in the tensile test. In impact test The lowest value was found in 300C heat treated specimen and lowest value were non heat treated specimen. The highest value were found in hardness test at 300C. Microstructure test showed changes in microstructure in the heat treated sample.

B. Correlation between Process Variables in Shielded Metal-Arc Welding (SMAW) Process and Post Weld Heat Treatment (PWHT) on Some Mechanical Properties of Low Carbon Steel Welds

The main purpose of this research was that to find correlation between the welding current & mechanical properties of weld metal, and find the effect of post weld heat treatment on weld metal. Low carbon steel was used in this research which was also given a chemical composition test (round bar). Varying welding currents of 100 A, 120 A, 140 A were used with a terminal voltage of 80 V. Total of 360 welding samples were prepared out of which 120 specimen were created by using 100A current, 120 specimen were created by using 120A current, 120 specimen were created by using 140A current. Welding specimen created by using 100A current which out of 5 specimen were not heat treated, 5 specimen were normalized at 590°C, 5 specimen were normalized at 600°C, 5 specimen were normalized at 620°C, 5 specimen were normalized at 640°C, 5 specimen were normalized at 660°C, 5 specimen were normalized at 700°C. The procedure was repeated for 120A and 140A. Here three types of Test hardness test, tensile test, impact test were performed.

The result show that 1) There is correlation between the welding current and mechanical properties of weld metal. As the current increases the hardness and strength increases but impact strength reduces. 2) Post welding normalizing heat treatment operation reduces the weld metal hardness and strength but increases the impact strength. As the normalizing temperatures increases the hardness and strength continuously reduces while impact strength increases.

C. Effect of preheating on the hardness and microstructure in Shielded Metal Arc Weldments of A283 B

The objective of the present investigation was to measure hardness & micro etching testing of A283B low carbon steel welded joint. This process involved welding with SMAW using two different electrodes E7016 & E6013. Before welding all the metal pieces were pre heated at 500°C. A283B low carbon steel thickness 8mm, size (100x200) mm, groove V with an angle of 90º depth of 6mm, gap (2x2) mm were kept. Samples A1, A2, A3, A4 were welded using electrode E7016 with current 130A, 140A, 150A, 160A and Samples B1, B2, B3, B4 were welded using electrode E6013 with current 130A, 140A, 150A, 160A. A total of two investigations Macro etching test and hardness test were conducted.

According to the result of the Macro etching test the width of HAZ was 160A more then 130A, 140A, 150A. The maximum hardness in the result of the hardness test is in the area of the weld metal, after that in HAZ area.

D. Effect of Heat Treatments on the Mechanical Properties of Welded Joints of Alloy Steel by Arc Welding

In this paper the effect of heat treatment on steel 20 (c-0.22-0.25), steel12khn (c-0.12-0.14), steel321 (c-0.09) have been explained. During the study all steel plate were joined by SMAW using electrode E 8013. After welding the samples were heated to 500°C and cooled in the furnace. The tensile test, impact test, hardness test and microstructure test were investigated.

According to the result of tensile test the tensile value of heat treated specimen of steel 20 and steel 12khm was found to be higher as compare to non heat treated specimen. And a higher tensile value were found in the non heat treated specimen of steel321 as compared to heat treated specimen. The hardness value of steel 20 and steel 321 were higher in HAZ area as per the value obtained from hardness test. When steel were higher value in fusion zone as compared to HAZ and base metal area. The microstructure test showed a dendritic structure in the welding zone.

E. EFFECT OF POST-WELD HEAT TREATMENT ON THE MICROSTRUCTURE AND MECHANICAL PROPERTIES OF ARC WELDED MEDIUM CARBON STEEL

This study includes investigation of the effect of various heat treatment like annealing, normalizing and hardening on low carbon steel (c-0.32%). 16mm thick carbon plate was welded by v groove butt joint using SMAW. Annealing heat treatment was made by heating the weldment pair to 900°C and holding at this temperature for 30 minutes. Afterwards, they were furnace cooled. normalizing was done on one of the pair in which the specimens were heated to 900°C and held for 30 minutes after which they were air cooled. In quenching heating the specimens to 900°C and holding at this temperature for 30 minutes. It was then quickly removed and plunged into a bucket of tap water. In this study microstructure, tensile, impact and hardness test were done.

Quenching produce a fine grain structure with a very hard, strong and very brittle weldment. Hardness of HAZ decreases after normalizing heat treatment. It is a little less than that before normalizing. PWHT (especially normalizing) improved mechanical properties of weldment. Hence normalizing heat treatment is recommended as the best heat treatment among the PWHT techniques. Tensile strength of the weldment increases after normalizing and quenching operations. Full annealing modifies the grain structure and improves ductility and toughness with appreciable reduction in strength and hardness of the weldment as compared to the as-welded weldment. PWHT reduces hardness of weld joint. Hardness of medium carbon steel increases after welding

F. Effects of shield metal arc welding techniques on the mechanical properties of duplex stainless steel

The study has compared the effects of shielded metal arc welding process on some mechanical properties of duplex stainless steel (c-0.02-0.05%).

In this process Two post thermal heat treatments were adopted

1)stress relieve annealing

This treatment was done by heating the samples from ambient temperature up to 600°C, and then soaked at this temperature for 30 minutes. After which they were removed from the furnace and air cooled back to ambient temperature.

2)quenching and tempering

Samples, that had been previously stress relieved were again heated to the temperature of 900°C and remained at this temperature for 30 minutes, they were then quickly removed and plunged into a can of engine oil or Neem oil at room temperature. The quenched samples were tempered slowly by reheating them to 300°C and allowed to soak for 30 minutes, after which they were removed from the furnace and allowed to cool to room temperature in air.

Here five samples B, B1, B2, B3 and C were taken. Sample B was welded by SMAW method, sample B1 was welded by SMAW and quenched in neem oil (heat treated), sample B2 was welded by SMAW and quenched in engine oil(heat treated), sample B3 was welded by SMAW and underwent stress relief heat treatment, C was as received. In this study microstructure test, tensile test, impact test, hardness test were done. The microstructure of the as received sample shows a fine grain boundary. The result of the tensile test show that highest tensile strength in sample C, then sample B, B2, B3 and

B1. The percentage elongation was highest in sample C, then in B2, B3, B1 and B. In the result of the impact test the highest value in sample C then in B2, B1, B3 and B. Hardness test result show that in sample C have a highest value and in heat treated sample the highest value in HAZ(B, B3, B2, B1) area as compare to fusion zone(B, B3, B1, B2).

G. EFFECT OF HEAT TREATMENT ON TENSILE STRENGTH, HARDNESS AND MICROSTRUCTURE OF AZ61A MAGNESIUM ALLOY

In this paper Investigations were carried out to find the effects of heat treatment on tensile strength, hardness and microstructure of 6mm thick AZ61A magnesium alloy. The AZ61A Mg alloy sample is heat treated at the temperature of 260C (500 F) and allowed it cool slowly in the furnace itself for various soaking timings such as 120 min, 240 min and 360 minutes as per Stress relief annealing Std. In this study microstructure test, tensile test, hardness test and tensile test in ANSYS software were done.

The microstructure showed larger grains. The spheroidized particle and discontinues precipitate were distributed in the magnesium matrix. Whereas the microstructure of after heat treatment, the grains are loosely arranged, the hardness was slightly decreased. The ultimate tensile strength & 0.2% proof strength of AZ61A magnesium alloy was increased to the value of 313.35 MPa & 217 MPa by furnace heat treatment, The ultimate tensile strength and 0.2% proof strength was increased by increasing the soaking time. After heat treatment, Brinell hardness of the AZ61A Mg alloy decreased to the value of, before heat treatment 72.7 BHN, after heat treatment 68 BHN. Experimental results are compared with the computational results (ANSYS). Both numerical and experimental results were almost closer to each other.

H. Study of effects of Heat treatment on the Hardness and Microstructure of Welded Low Carbon Steel Pipes

This paper reports investigations made on the effects of annealing heat treatment on the micro-structural and mechanical property of (0.078% C) low carbon steel pipe weld. The specimen used is a low carbon steel pipe (Φ32mm, 2mm thick and 600mm long). The specimen was cut into four pieces of equal sizes (150mm long) and welded together in pair. Two pair(sample) of low carbon steel were joined by electric arc welding (current= 140A, voltage=80V, electrode=2.5mm). one specimen was heated at 850C and leaved in furnace to cool down for 24hr. two test hardness and microstructure test were conducted.

Hardness test results showed that the hardness value of non heat heated sample was higher than analyzed sample. Most of the samples analyzed in the microstructure test were black hence reducing hardness and increasing toughness and ductility.

I. ANALYSIS OF DISSIMILAR WELDING OF AUSTENITIC STAINLESS STEEL TO LOW CARBON STEEL BY TIG WELDING PROCESS

In the current study, the effect of heat treatment on the dissimilar metal welding of austenitic stainless steel (AISI 304L(5mm thick)) and low carbon ferritic steel (AISI 1005(5mm thick)) using

Tungsten Inert Gas (TIG) welding process was investigated with a view to minimize and/ or eliminate the previously reported danger of inhomogeneous hardness distribution experienced across the fusion zone. In this study AISI 304L austenitic stainless steel and AISI 1005 low carbon ferritic steel were welded using 2.5mm diameter ER 309L austenitic filler metal by tig welding. After welding, heat treatment of the welded samples were carried out at different intercritical temperatures of 750°C, 800°C and 850°C, and holding time of 30 and 60 minutes at each temperature, followed by air cooling.

The best homogenization of the fusion zone was found to occur at normalizing temperature of 7500C and holding time of 30 minutes, where the deviation of micro hardness values were found to be minimum without damage to the base alloy hardness.

J. Study The Effect of Filer Material on Microstructure of Welding the Carbon Steel in Shielded Metal Arc Welding

The purpose of this work is to study the mechanical and metallurgical properties of carbon steel plates welded by two types of fillers using a shielded metal arc welding (SMAW). The carbon steel plate material was of type ASTM A283-C with a thickness of 6mm. The electrodes were of type E7018 and E309-16 with a diameter of 3.2mm. A butt welding configuration was used with a gap of 2mm with a process parameters of welding current = 100A, voltage = 26V. The welded palates were tested by a tensile test, microstructure test, scanning electron microscope (SEM) and X-ray diffraction (XRD) test. The results refer that the tensile strength of similar filler metal achieved better results than dissimilar filler metal, the microstructure test of welding by E7018 gives the welding zone similar to the base metal, the SEM test showing the microstructure of weld metal when welding by E7018 & E309-16 consist of a mixture of the filler metal and the base metal is about 90% and 20% respectively, The XRD examination showed the base metal of carbon steel having the ratio of the Fe element is high, when welding by E7018 having the ratio of the Fe and Cr are high, and when welding by E309- 16 having the ratio of the Ni was high.

K. Full-annealing and its effect on the Mechanical Properties of Alloy 304H Stainless Steel

Investigate the effect of annealing on the mechanical properties of alloy 304H stainless steel and how the mechanical properties can be improved with a view of improving its service life and optimizing engineering usage. Sixteen (16) samples of the alloy were used. Twelve (12) samples were annealed at three different temperatures of 950°C, 1000°C and 1050°C inside a muffle furnace. At each temperature four samples were heat-treated inside the muffle furnace for 30 minutes. The result showed that the yield strength decreased from un-annealed sample to annealed samples at 950°C with a value of 504.8MPa and increased at 1000°C with a value of 610MPa and a decrease of 323.8 MPa was obtained at 1050°C. Also, the ultimate tensile strength showed an increase from 950o C with a value of 826.3MPa to 1000°C with a value of 930MPa but there was a slight decrease at 1050°C for all samples. The ultimate tensile strength at 1000°C with a value of 930MPa was the highest in all the samples. The annealed samples at 1000o C had the highest percentage elongation of 13.57% which shows an increase in the ductility of the material. The hardness of the material decreased from 157.25 BHN at 950°C to 134.00BHN at 1000°C. An increase to 169.50BHN was however obtained at 1050°C.

Thus, full-annealing of alloy 304H stainless steel at 1000°C increases in ductility as hardness decreases.

L. Effects of Heat Treatment on the Mechanical Properties of Rolled Medium Carbon Steel

Investigations were carried out to study the effects of heat treatment on the mechanical properties of rolled medium carbon steel. The material used in this study was 12mm diameter rolled medium carbon steel bars(c-0.35%). Medium carbon steel bar were heat treated. Heat treatment details is given below.

Q= steel bar were heated to 830°C, soaked for 20 minutes and quenched in water, L1= this quenched steel bar(Q) were heated to 745°C, soaked for 20 minutes and quenched in water or L2= This quenched steel bar(Q) were heated to 735°C, soaked for 20 minutes and quenched in water, T=850°C and then 745°C or 735°C (L1 or L2) heat treated specimens are re-heated to 480°C soaked for 30 minutes and then cooled in air. Total seven specimen (Q+Q+L1+T, Q+Q+L2+T, Q+L1+T, Q+L2+T, L1+T, L2+T and non heat treated specimen) were prepared for testing.

From the findings, the steel developed by Quenching + Quenching + Lamelarizing + Tempering (Q+Q+L1+T) process at a lamelarizing temperature of 745°C has the highest ultimate tensile strength and yield ratio of 79% with excellent combination of impact strength, ductility and hardness which is very attractive for structural use.

M. Mechanical properties study of copper/stainless steel dissimilar weld joints

The objective of the present investigation was to measure the mechanical properties of dissimilar weld joints of copper to stainless steel 304, fabricated using Tungsten inert gas (TIG) welding process. As-welded specimens were heat treated to a temperature of 650 °C for 1h, 2h and 3h. Tensile strength and micro hardness measurements were made to analyze the effect of post weld heat treatment on the mechanical properties of dissimilar weld joints of copper and stainless steel

N. Investigation of the Effects of Various Heat Treatment Processes on Microstructure & Hardness with Respect to Corrosion Behavior for Carbon Steels

In this paper, the effect of heat treatment on microstructure and mechanical properties of EN -31(c-0.95%) and EN-8(c-0.38%) carbon steel were studied. Three types of heat treatment annealing, oil quenching, tempering were used. A total of 6 samples were used, EN -31 had A1, A2, A3 and EN-8 had B1, B2, B3. Sample A1 and B1 were annealed at 780°C for 16hour. Sample A2 and B2 were oil Quenched at 880°C for 2hour 20minut. Sample A1 and B1 were Tempered at 250°C for 1hour 25minut. The hardening temperature for EN-31 varies from 820°C - 860°C whereas the hardening temperature for EN-8 varies from 750°C - 900°C. The mechanical properties such as the hardness and tensile strength among three pssess, the oil quenching sample possess highest hardness and the annealed sample possess highest elongation. Microstructure observation sow that EN-8 have (Normal: as rolled structure of Pearlite & Ferrite are observed. Annealed: well distributed Pearlite in ferrite matrix. Oil quenched: martensitic structure. Tempered: tempered martensitic.) And EN-31 have (Normal: Pearlite & ferrite. Annealed: Pearlite & ferrite. Oil quenched: martensitic structure. Tempered: tempered martensite.)

O. Effect of heat treatment on microstructure behavior and hardness of EN 8 steel

In this experimental work, effect of heat treatment methods on hardness and microstructure of EN 8 steel(C-0.36-0.44%) is compared and discussed. The specimen was 22mm round bar and 11mm length. The sample have four heat treatment annealing, normalizing, quenching, tempering were done. In the process of annealing two sample were heated 820ºC and held for 45 minutes. Then furnace is shut off and samples are left inside the furnace until the temperature dropped down to 480ºC. Then furnace door is opened and the samples are cooled to room temperature. In the process of normalizing Two samples are taken and heated to 850ºC then the samples were held for 2 hours. After soaking for 2 hours, the furnace was switched off and samples were taken out to cool to room temperature. In the process of quenching two samples are heated to 850 ºC in the muffle furnace and held for 30 minutes. After holding for 30 minutes, furnace is shut off and the furnace door is opened to allow the samples to cool inside, till the red heat is gone. The samples are then cooled rapidly by submerging them in an oil bath, and quenched to room temperature. In the process of tempering one heat-treated sample from each set (i.e. annealed, normalized and quenched) were then tempered. In tempering, the samples were reheated to 300ºC in the muffle furnace and then soaked for 1hour. Then, the furnace was switched off and samples were taken out to air cool to room temperature.

It is seen that tempering leads to a decrease in hardness. This is actually desirable, as low hardness and good toughness will be beneficial for machining purposes, as cutting forces and specific energy required will be less. However, sometimes, reduced hardness leads to accelerated wear, in some applications, which is not desired. So, it is recommended that EN 8 steel should be tempered after normalizing. The microstructure consists of finer grains and hardness decreases, but not by much, which ensures good machinability.

P. Analysis The Effect of Preheating and Post heating Temperature Variation on SMAW Welding ASTM A53 Steel against Micro Structure and Corrosion Rate Prediction

The purpose of this study was to determine the effect of preheating and post heating temperature variation on micro structure and prediction of corrosion rate on weld joint of ASTM A53 steel using the SMAW process (Butt Joint Single V– Groove). ASTM A53 medium carbon steel (C-0.3%) (200 mm x 150 mm x 10 mm) and E-7016 electrode were used for welding. 55 ampere was used for 1st welding layer and for 2nd, 3rd and 4th layer 95 ampere was used. 22 volt was used for 1st welding layer and for 2nd, 3rd and 4th layer 23 volt was used. Preheating temperature variation are 100°C and 200°C and Post heating temperature variation are 200°C, 250°C and 300°C were used to improve the microstructure and corrosion resistance.

In the micro structure, welding specimen with a 150°C preheating temperature and 300°C post heating temperature have the highest percentage of pearlite structure in the base metal, HAZ and weld metal area than the other specimen with 35% on base metal, 36% on HAZ and 38% on weld metal. In the corrosion rate prediction test, welding specimen with a 150°C preheating temperature and 300°C post heating temperature have the lowest corrosion rate nominal with 0,01 mmpy. So we can conclude that the percentage of pearlite is inversely proportional with the corrosion rate nominal. The highest pearlite percentage we get, the lowest corrosion rate nominal we get.

Q. IMPROVEMENT OF WELDMENT BY POST WELD HEAT TREATMENT OF LOW CARBON STEEL

The purpose of this study was to determine the effect of post heating temperature variation on hardness and microstructure of A588 Grade steel plate(C-0.05-0.3%) using the Laser beam welding process. In this research after welding A588 steel plate(1x1x0.2cm) was heated 850C and soaked for 2 hour. After that specimen were air quenched, water quenched and furnace quenched.

The laser welded water quenched sample has the highest hardness of 381 HVN, at the weld zone than furnace quenched sample has a hardness of 315 HVN. The hardness of the laser welded Water quenched sample is increased by 23% than that of air quenched sample and 16% than that of furnace cooled samples. The PWHT water quenched samples has both pearlite and ferrite structure with small inclusions of carbide precipitate in forms of round small pits, which is spread all through the surface. PWHT process rate of cooling also place a major role on deciding the strength of the weld joint.

R. Effect of Post Welding Heat Treatment on the Mechanical Properties of Welds of AISI 1040 Medium Carbon Steel

In this paper, the effect of heat treatment on mechanical properties of AISI 1040 steel (c-0.39 were studied. Each of the sample groups was labeled as sample group 1- 5, sample groups 2, 3, 4 and 5 were subjected to normalizing, annealing, hardening and tempering post welding heat treatment. For Normalizing, the sample groups 2 were austenitized in a muffle furnace at temperatures of 700, 675, 650, 640 and 630 °C and subsequently cooled in an open air for 60 minutes. After, sample groups 3 were annealed by heating the samples in a muffle furnace at temperatures of 700, 675, 650, 640 and 630 °C and subsequently cooled/held in the furnace for 60 minutes. Sample groups 3 were hardened by heating the sample group to 700, 675, 650, 640 and 630°C) and rapidly cooled with cold water outside the furnace. Sample groups 4 were subjected to higher tempering temperatures of 700, 675, 650, 640 and 630°C. Sample group 1 was however not subjected to any heat treatment process. Impact test was performed on samples 1 and 5, tensile test on samples 2, 3 and 1 and Rockwell hardness test on samples 4 and 1.

The result shows that the higher the tempering temperature the higher the energy absorbed. Annealing tensile test shows that the percentage elongation increases with temperature. the result obtained from the tensile test shows that the percent elongation increases with temperature for the normalized specimen. hardness test indicates that the As-welded pair 1 shows a considerable hardness due to the non-uniform distribution of the welding heat across the cross sectional area of the HAZ, causing non uniform cooling and coarse micro structure). Pair 4 shows a high hardness.

S. Effect of PWHT on Mechanical Properties of High Temperature and Pressure Resistant Nuclear Power Plant Steel Welded with SMAW and GTAW Methods

This research aims at effect of Post Welding Heat Treatment (PWHT) on mechanical properties of 2.25Cr1Mo (P22) high temperature and pressure resistant nuclear power plant steel(16mm thickness) welded(V groove) with GTAW (gas tungsten arc welding) and SMAW (shielded metal arc welding). In GTAW & SMAW, voltage 15v and current 120A were used. EN ISO 3580-A electrode were used in SMAW and EN ISO 21952-A filler road were used in GTAW. Pre-heating was applied to the materials to be welded at 200°C before welding processes. Welding processes of materials were performed at room temperature. After welding processes, post weld heat treatment (PWHT) was applied at 750ºC for 2 hours.

After PWHT process, tensile strengths of both steels welded with GTAW and SMAW, were decreased. The results of the bend tests, no sample was damaged performed before and after the PWHT. According to the hardness values of welded samples measured before and after PWHT; After the PWHT, the hardness values of SMAW welded sample, HAZ, welded region and base region were observed to decrease. On the other hand, after PWHT, the hardness increase in the welded region and the base region of the GTAW welded sample and the hardness decrease in HAZ were detected.

T. Study of Mechanical Properties and Change in Microstructure of Alloy Steel EN24 under various Heat Treatment Process

The purpose of this study was to improve mechanical property and hardness in EN24 by various heat treatment process (stress relieving, normalizing and hardened & tempered). Specification of specimen were Gauge length-55 mm, Gauge diameter- 10 mm, Total length- 175 mm, Diameter of Grip - 18 mm. In the process of normalizing specimen was heated at 900°C held at that temperature for 2hour. In the process of hardening & tempering specimen were heated at 900°C held at that temperature for 2hour then quenched in oil after that heated at 600°C held at that temperature for 1hour then air cooled. In the process of stress relieving specimen were heated at 650-670°C for a soaking time span of 2 hours, after this the furnace was switched off and the specimen was cooled inside the furnace itself. Four specimen were used for testing (non heat treated, stress relieved, normalized, hardened & tempered).

Stress relieving process increase in tensile strength, hardness, yield load, breaking load in compared with the base metal. The failure load and tensile strength of the specimen after normalizing were found greater than base metal (before heat treatment) and stress relieved samples but less than hardened and tempered samples. The tensile strength and hardness values were more for the hardened & tempered specimens but its % elongation was found less. After different treatments there is a change in matrix/phase structure. These cause changes in the mechanical properties of alloy steel EN24

CONCLUSION

After read above research paper we have found that so many researches has been done on the various effect of different heat treatment (annealing, normalizing, quenching, tempering) on the mechanical properties(tensile strength, Bending, elongation, hardness and fatigue limit and modulus of elasticity) of different metals like (stainless steel, mild steel, duplex stainless steel, medium carbon steel, low carbon steel, ASTM A53 steel, EN 8 steel, EN -31, stainless steel 304, 304H stainless steel, ASTM A283-C, AISI 304L, AZ61A magnesium alloy, S45C, A283B, steel321 and with different thickness). The effect of preheat treatment and post-heat treatment with different temperature on the similar (ss to ss, MS to MS,) and dissimilar (ss to ss, MS to low carbon) welded joints which joined by different welding process have been studied. From all the above mentioned research papers and other studies it has been observed that there is a research gap. The effect of heat treatment on mechanical property of SS316 and Mild Steel welded joint had not been studying. Thus my future work is based on this research gap is continued.

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