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DEPARTMENT OF CHEMICAL ENGINEERING & TECHNOLOGY
(CENTRE OF ADVANCED STUDY & DST DEPARTMENT UNDER FIST)
INSTITUTE OF TECHNOLOGY
(Varanasi – 221005)
(Established by Parliament by Notification No.225 of 1916)

Message

Scientific discoveries and advancement affect our lives by providing new policies and regulations that provide broad national direction and by new products that enhance our lives. Technology and engineering translate scientific knowledge into action. At the same time, technological innovations often require further research into materials, devices and processes. Engineers use the knowledge of science, mathematics, economics and appropriate experience to find suitable solutions to the problems and helps in creating an appropriate mathematical model for analysis.

This special issue on Engineering and Technology 2012 of Anvikshiki brings together the latest developments in technology and gives a base for the future work to be done in respective areas.

I wish the journal to be a great success.

Bhawna

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Message

I express my sincere gratitude to the editorial board of prestigious journal ANVIKSHIKI for believing in my technical competencies and choosing me as a reviewer of special issue on Engineering and Technology 2012. I understand that with great role comes great responsibilities. I will try to fulfill this highly valued responsibility with best of my technical knowledge and human values. This journal has been a guiding beacon for scientific community for numerous years & has gained the prestige due to it's original & rich articles. The contribution of ANVIKSHIKI in field of scientific research is immense.

I wish for the phenomenal success of special issue on Engineering and Technology,2012 of ANVIKSHINKI.

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Editorial Note

As my nomination as an Subject Expert and Editor for this Special Issue on Engineering & Technology 2012, I have worked a lot to make it successful. I do whatever task is at hand to the best of my ability. I take pride in my work and give hundred percent every time. For those submissions that were not suitable for publication, we tried to let authors know very quickly of our decision, giving them a chance to submit their manuscript to another journal if they so desire. I am fully aware that the prestige and quality of an ANVIKSHIKI Journal depends upon the altruistic participation of reviewers and the fairness and promptness with which the review process is conducted. In this regard, I wish to express my sincere gratitude to all board members for their nice cooperation and sustained effort. However, because of the increased number of submissions and the diversity of research fields involved, we have a difficult task ahead of us requiring a more rapid tempo of review. At the same time, from now on the authors themselves should assume their own inescapable responsibilities. The editor will return immediately any manuscript that is incomprehensible to reviewers on account of substandard grammar and syntax.

Finally, it is a pleasure to thank my Editor in chief for their nice cooperation and valuable suggestion. Now, we all look forward to embarking in a journey that can take ANVIKSHIKI on to the next plateau of excellence.

I hope you will enjoy reading this issue and we welcome your feedback .

With best regards,

Jyoti Prakash

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Best regards,

Dr. Maneesha Shukla.

Editor in chief,

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A list of non-standard **Abbreviations** should be added. In general, non-standard abbreviations should be used only when the full term is very long and used often. Each abbreviation should be spelled out and introduced in parentheses the first time it is used in the text. Only recommended SI units should be used. Authors should use the solidus presentation (mg/ml). Standard abbreviations (such as ATP and DNA) need not be defined.

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WELDABILITY AND SPECIAL CHARACTERISTICS OF MILD STEEL – A REVIEW

JYOTI PRAKASH*, S.P.TEWARI** AND BIPIN KUMAR SRIVASTAVA***

Declaration

The Declaration of the authors for publication of Research Paper in The Indian Journal of Research Anvikshiki ISSN 0973-9777 Bi-monthly International Journal of all Research: We, *Jyoti Prakash, S.P.Tewari and Bipin Kumar Srivastava* the authors of the research paper entitled WELDABILITY AND SPECIAL CHARACTERISTICS OF MILD STEEL – A REVIEW declare that , We take the responsibility of the content and material of our paper as We ourself have written it and also have read the manuscript of our paper carefully. Also, We hereby give our consent to publish our paper in Anvikshiki journal , This research paper is our original work and no part of it or it's similar version is published or has been sent for publication anywhere else.We authorise the Editorial Board of the Journal to modify and edit the manuscript. We also give our consent to the Editor of Anvikshiki Journal to own the copyright of our research paper.

Abstract

weldability is a complicated property, as it encompasses the metallurgical compatibility of the metal or alloy with a specific welding process, its ability to be welded with mechanical soundness, and the capacity of the resulting weld to perform satisfactorily under the intended service conditions. The weldability of steel depends primarily on its hardenability and this, in turn, depends largely on its composition . Steels with carbon content under 0.3% are reasonably easy to weld, while steels with over 0.5% are difficult. The higher the carbon equivalent, the higher the hardenability, the more difficult the steel is to weld, and the more susceptible the microstructure is likely to be to hydrogen cracking. If welding under high restraint, extra preheat may need to be applied. Some high carbon steels and low alloy steels may also need a post weld stress relief or tempering. Carbon has the greatest effect on the hardenability of steel, but other alloying elements may be added to increase its hardenability. The addition effectively reduces the critical cooling rate and the temperature at which the austenite to martensite transformation takes place, making it easier for martensite to form at slower cooling rates. This paper highlights the weldability and some other characteristics of mild steel.

Keywords: Weldability, Hardenability, Carbon equivalent, Hardness, strength

1. Introduction

Welding technology has obtained access virtually to every branch of manufacturing; to name a few, ships, rail road equipments, building construction, boilers, launch vehicles, pipelines, nuclear power plants, aircrafts, automobiles, pipelines. Welding technology needs constant upgrading and with the widespread applications of welding, [1]. Due to the intense concentration of heat source of welding, regions near weld line undergo severe thermal cycles. The thermal cycles cause non-uniform heating and cooling in the material, thus generating inhomogeneous plastic deformation, residual stress and a wide coarse grained region in the weldment [2,3,4]. Generally, welding is the preferred joining method and

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most common steels are weldable. When steel is welded, it is heated; the heated portion has a micro structure that is different from that of the base metal and is called the Heat Affected Zone (HAZ) [5,6].During welding, rapid heating and cooling take place which produce severe thermal cycle near weld line region. Thermal cycle cause non uniform heating and cooling in the material, thus generating harder heat affected zone, residual stress and cold cracking susceptibility in the weld metal and base metal [7,8,9,10]. Bayraktar *et al.* have studied the Grain growth mechanism during the welding of interstitial free steels. Observations in the welded joints indicate the presence of very large grains near the fusion line and these are oriented along the directions of the heat flow[11]. Concerning the welding of low carbon steels, it has been shown that the grain coarsened zone (GCZ) and heat affected zone (HAZ) are very critical since embitterment is concentrated in these areas [12]. It is also known that the final microstructures and mechanical properties of welded steel depend on some parameters like percentage of carbon and presence of others elements such as sulfur or phosphorus. Low carbon steels that have less than 0.25% carbon, display good welding ability, because they can be generally welded without special precautions using most of the available processes. Concerning the previous studies related to the welding of low carbon steel, there are limited publications [12-18]. For example, Gural *et al.* [12] have studied the heat treatment in two phase regions and its effects on microstructure and mechanical strength after welding of the low carbon steel. On the other hand, Eroglu and Ak-soy [13] investigated the effect of initial grain size on microstructure and toughness of intercritical heat-affected zone of low carbon steel.

2. Weldability of Steel

Weldability is a term used to describe the relative ease or difficulty with which a metal or alloy can be welded. weldability is a complicated property, as it encompasses the metallurgical compatibility of the metal or alloy with a specific welding process, its ability to be welded with mechanical soundness, and the capacity of the resulting weld to perform satisfactorily under the intended service conditions. Low carbon steels containing <0.15% carbon and <0.6% manganese generally have good weldability, as the composition is too lean to give any significant hardening effect during welding. However, steels with <0.12% carbon and low levels of manganese can be prone to porosity, although they are not susceptible to hydrogen cracking. Steels with carbon contents between 0.15 and 0.3% carbon and up to 0.9% manganese have good weldability, particularly those with carbon content below 0.22% These are mild steels and rarely present problems, as long as impurity levels are kept low. They are all weldable without preheat, using any of the common welding processes. Those at the top end of the composition range, above about 0.25% carbon, may be prone to cracking under certain circumstances. They may be welded using any of the common welding processes, but are best welded with a low hydrogen process such as MIG or low hydrogen consumables. Thick sections may require preheating to reduce the cooling rate.[19]

2.1 Effect of Welding Parameters on the Peak Load and Energy Absorption of steel Welds

To ensure and maintain structural integrity of finished component under a wide range of operating conditions, for example a crash situation, the remotest possibility of producing even one or two defective welds in a critical component needs to be eliminated. These requirements, coupled with uncertainties about weld quality due to the difficulty of applying nondestructive tests to spot welds, are responsible for the practice of making more spot welds than what is actually needed for maintaining structural integrity. A modern vehicle contains 2000 to 5000 spot welds. Around 20% to 30% of these spot welds are due to uncertainty of the quality of spot welds[20]. Weld performance characterizations normally refer to static and dynamic strength. Tensile shear test is the most usual test for evaluating spot weld mechanical behavior under static condition both because of its simplicity and because many of spot welded structures are designed to bear tensile-shear loads. Figure 1 shows typical tensile-shear test load-displacement curve for a spot weld, schematically. Most researchers have used peak load (*P*max), extracted from load-displacement plot, to describe spot weld mechanical behavior. However, as Zhou et al. [21] mentioned, maximum energy (*W*max) corresponding to peak load should be used to describe spot weld mechanical behavior, more precisely. *W*max shows spot weld energy absorption capability and the higher the *W*max, the higher the weld reliability is under impact conditions such as accidents.

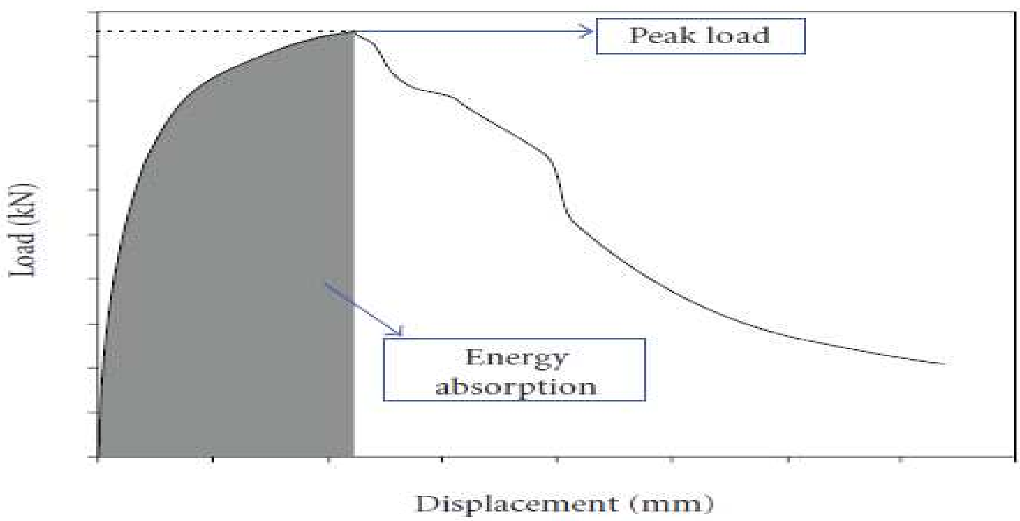

Figure 1 *Schematic of tensile-shear test load-displacement curve*

2.2 Shielding gases for welding of mild steel(Refer to BOC Manual [22])

2.2.1 MAG welding : MAG welding is the most common process for welding carbon and low alloy steels. The high productivity obtained by this semi-automatic process makes it ideally suited to the construction and manufacturing of steel structures and components. Argon-based gas mixtures are commonly used to weld carbon and low alloy steels. These mixtures contain additions of active gases, oxygen and/or carbon dioxide to improve welding performance. How much of these active gases is added depends on the application.

CORGON 10 : A good general purpose shielding gas for use in dip, pulse and spray transfer. The amount of spatter and slag islands produced by this mixture are low making it ideal for applications where minimum post welding cleaning is required

*CORGON 552 :*This three component shielding gas is designed predominantly for welding th1nner materials. The addition of oxygen increases arc stability minimizing the amount of spatter. This makes the product ideal for welding components that are painted or powder coated after welding.

*CORGON 18 :*CORGON 18 produces welds with very good penetration and Sidewall fusion, especially when welding thicker materials This mixture performs very well in both dip and spray but is on the upper limit of CO content for pulse weld1ng

*CORGON 1252 :*A PREMIER, three-component mixture designed for maximum performance. Ideal for semi-automatic, automatic and robotic applications, the gas produces smooth flat welds with good penetration and sidewall fusion as well as low spatter. Welding speeds are high over a wide range of welding conditions, making it the first choice product when productivity is important.

*CORGON 10He30 :*This is a PREMIER argon, carbon dioxide mixture to which 30% helium has been added, increasing the fluidity of the weld. Allowing even faster welding speeds than those base shielding gases makes it ideal for mechanized and robotic welding applications.

2.2.2 Flux-cored and metal- cored arc welding

Flux-cored arc welding and metal cored arc welding processes are similar to MAG welding, except that the welding wires are tubular and contain flux powders and/or metal powders rather than being solid Consumable manufacturers blend their wires to suit one or two shielding gas mixtures; check which are recommended before commencing welding.

*CO_2 :*This gas is suitable for use with many brands of flux cored wire. Generally produces more spatter and particulate fume.

*CORGON 25 :*For use with flux-cored wires recommended for use with ‘mixed gas’. In general it gives lower fume and spatter levels than pure carbon dioxide

*CORGON 10 :*Generally recommended for use with metal-cored wires. The relatively low level of carbon dioxide in the mixture produces fewer surface slag islands and lower oxide inclusions than shielding gases with higher carbon dioxide levels.

2.2.3 TIG welding

TIG welding is not commonly used for carbon steels, but it is used more for welding low alloy steels where high precision Joints and excellent surface finish are more important than high productivity. Since the TIG process uses a non consumable tungsten electrode, which is susceptible to damage by oxidizing gases, for TIG welding these steels are usually limited to pure argon or argon/helium mixtures.

ARGON: Argon is the most common gas for TIG welding both carbon and low- alloy steels. Arc initiation is easy but welding speeds are relatively slow

*VARIGON He30 and He50 :*The addition of helium to argon creates a more fluid weld with better penetration, improved fusion and faster welding speeds. The higher helium mixtures should be used on thicker-section materials. These mixtures are widely used on automatic welding s tations where high welding speeds are the pr i mary concern.

MISON Ar : The addition of small amounts of NO can lower the emission of ozone from the arc compared with using pure argon.

2.3 Factors Influencing weldability [19]

In terms of avoiding weldability problems, particularly hydrogen cracking, when welding carbon or low alloy steels there are several factors that demand consideration. These include the amount of hydrogen generated by the welding process or consumable, the heat input into the weld, the combined thickness (heat sink) of the joint, and the level of preheat applied to the components prior to welding. Joint configuration and restraint are also important factors when considering weldability.

2.3.1 Welding Heat Input

The heat input from the welding process plays a major role in the heating and cooling cycles experienced by the weld and parent plate during welding. For a given plate thickness, a high heat input is likely to result in a slower cooling rate than a low heat input, and will therefore produce a softer microstructure in the HAZ that is less prone to hydrogen cracking.

Heat input 'Q' may be calculated as:

$$Q = \frac{k \times V \times I \times 60}{S \times 1000} \quad kJ/mm \qquad \text{..............}(1)$$

where 'V' is arc Voltage (V), 'I' is welding current, and 'S' is welding speed in mm/min.

'k', the thermal efficiency factor for the welding process, to give an energy input that takes the efficiency of the welding process into account. Typical thermal efficiency factors are:

'k' = 1.0 for submerged arc welding

'k' = 0.8 for MIG / MAG, MMA, flux-cored and metal-cored arc welding

'k' = 0.6 for TIG and plasma welding

2.3.2 Hardenability and Hardness

To become harder, steel must undergo a phase change. The starting point is austenite, so the steel must first be heated into the austenitic temperature range .Austenite, quenched rapidly, will be transformed into martensite, a hard but brittle phase .A slower cooling rate will promote formation of bainite and other softer phases Cooled even more slowly, a soft structure of ferrite plus cementite called pearlite, results.

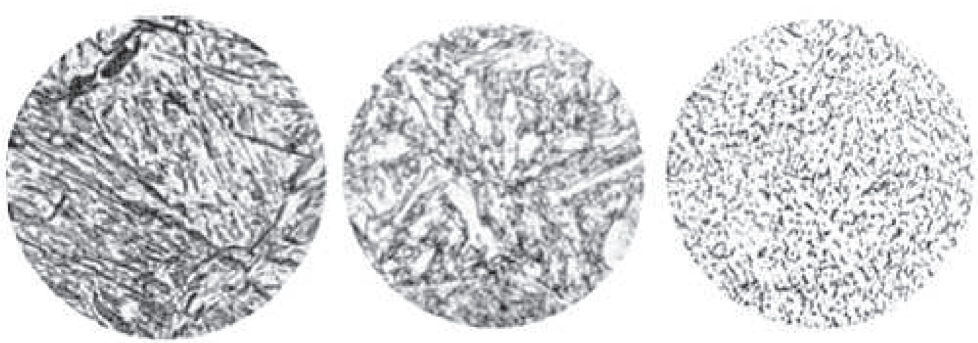

Figure 2 *Martensite, Tempered Martensite and Heavily Tempered Martensite*

2.3.3 Carbon Equivalent

Carbon has the greatest effect on the hardenability of steel, but other alloying elements may be added to increase its hardenability. The addition effectively reduces the critical cooling rate and the temperature at which the austenite to martensite transformation takes place, making it easier for martensite to form at slower cooling rates. Alloying elements that have the greatest influence on the hardenability of steel are manganese, molybdenum, chromium, vanadium, nickel, copper and silicon, but they have a much smaller effect than carbon. The effect of these elements on the tendency to form HAZ martensite, and hence the likelihood of hydrogen cracking, is expressed conveniently as a carbon equivalent (CE). This basically describes the influence of each element on hardenability in terms of the effect that carbon has. There have been many different formulae derived to express carbon equivalent, but the one quoted here is the International Institute of Welding (IIW) equation that is applicable to carbon steel and is widely used:

$$\text{Carbon equivalent (CE)} = \%C + \frac{\%Mn}{6} + \frac{(\%Ni + \%Cu)}{15} + \frac{(\%Cr + \%Mo + \%V)}{5} \quad \ldots\ldots\ldots\ldots\ldots(2)$$

The equation is only valid for certain maximum percentages of each element and these percentages can be found in the technical literature. The carbon equivalent is used mainly for estimating preheat. Preheat is necessary to slow down the cooling rate sufficiently to reduce hardening in the HAZ of welds in susceptible carbon and low alloy steels.

2.3.4 Weld and HAZ Cracking

With steel, poor weldability often manifests in a reduction of the resistance of the steel to cracking after welding.

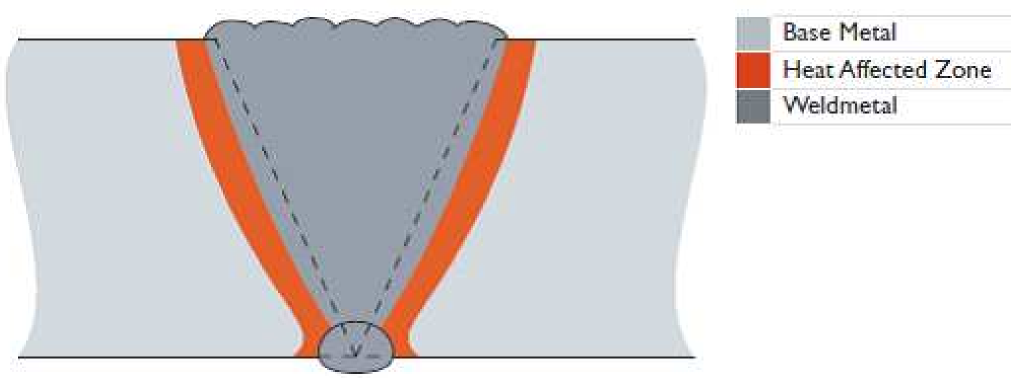

Figure 3 *Weld and HAZ Cracking*

The main causes of cracking in steel are:

- High levels of carbon and other alloy elements, resulting in brittle zones around the weld
- High cooling rates after welding increasing the hardness, which increases the susceptibility to cold cracking
- Joint restraint preventing contraction after welding, leading to cracking
- Hydrogen in the weld bead or HAZ, leading to hydrogen induced cold cracking
- Contaminants like sulphur and phosphorus, resulting in solidification cracking
- Lamellar tearing due to inclusions layering during rolling, resulting in deterioration of the through-thickness properties

3. Modes of Fatigue Failure [23]

Several modes of fatigue failure are:

Low/High-Cycle Fatigue: This fatigue process covers cyclic loading in two significantly different regions , with different physical mechanisms of failure. One region is characterized by relatively low cyclic loads, strain cycles confined largely to the elastic range, and long lives or a high number of cycles to failure, traditionally, this has been called “high-cycle fatigue.” The other region has cyclic loads that are relatively high, significant amounts of plastic strain induced during each cycle, and short lives or a low number of cycles to failure. This region has commonly been called “low-cycle fatigue” or cyclic strain-controlled fatigue. The transition from low- to high-cycle fatigue behavior occurs in the range from approximately 10,000 to 100,000 cycles. Many define low-cycle fatigue as failure that occurs in 50,000 cycles or less.

Thermal Fatigue: Cyclic temperature changes in a machine part will produce cyclic stresses and strains if natural thermal expansions and contractions are either wholly or partially constrained. These cyclic strains produce fatigue failure just as though they were produced by external mechanical loading. When strain cycling is produced by a fluctuating temperature field, the failure process is termed “thermal fatigue.”

Corrosion Fatigue: Corrosion fatigue is a failure mode where cyclic stresses and a corrosion- producing environment combine to initiate and propagate cracks in fewer stress cycles and at lower stress amplitudes than would be required in a more inert environment. The corrosion process forms pits and surface discontinuities that act as stress raisers to accelerate fatigue cracking. The cyclic loads may also cause cracking and flaking of the corrosion layer, baring fresh metal to the corrosive environment. Each process accelerates the other, making the cumulative result more serious.

Surface or Contact Fatigue: Surface fatigue failure is usually associated with rolling surfaces in contact and results in pitting, cracking, and spalling of the contacting surfaces from cyclic Hertz contact stresses that cause the maximum values of cyclic shear stresses to be slightly below the surface. The cyclic subsurface shear stresses generate cracks that propagate to the contacting surface, dislodging particles in the process.

Combined Creep and Fatigue: In this failure mode, all of the conditions for both creep failure and fatigue failure exist simultaneously. Each process influences the other in producing failure, but this interaction is not well understood .Fatigue is tested on fixtures that are unique to the application. Such tests should account for all modes of failure, including thermal and the presence of corrosive elements.

4. Hardening Treatment of Steel

Direct Hardening: Through hardening is applied to medium and high carbon parts that possess sufficient carbon content for hardening through the entire depth of the part. The parts are heated and quenched (cooled) to fix the structure of the part in a hardened state.

Indirect Hardening: Case hardening (or indirect hardening) is applied to low-carbon content steel parts to increase surface hardness. During case hardening, carbon molecules are introduced to the part via solids, liquids, or gases in a process known as carburizing. The molecules penetrate the surface of the part, forming a casement, which is identified by the case depth (x) and surface hardness (y).More exacting specifications will identify an effective case (z) or a specific hardness requirement at a particular depth. Case hardness cannot be measured effectively using a Rockwell test. Readings must be taken from a cross section of the part using a micro hardness tester [23]

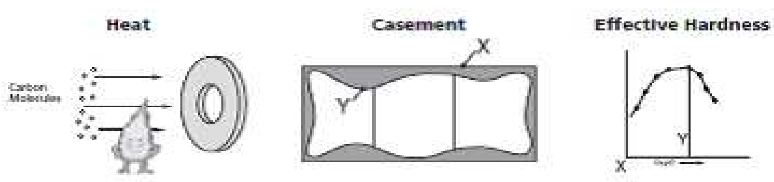

Figure 4 *Case hardening of mild steel*

Carburizing: A process in which carbon is introduced into a solid iron-base alloy by heating above the transformation temperature range while in contact with a carbonaceous material that may be a solid, liquid, or gas. Carburizing is frequently followed by quenching to produce a hardened case.

5. Different Types of mild steel

*1018 Mild Steel :*Alloy 1018 is the most commonly available of the cold-rolled steels. It is generally available in round rod, square bar, and rectangle bar. It has a good combination of all of the typical traits of steel - strength, some ductility, and comparative ease of machining. Chemically, it is very similar to A36 Hot Rolled steel, but the cold rolling process creates a better surface finish and better properties.

A36 Mild Steel : ASTM A36 steel is the most commonly available of the hot-rolled steels. It is generally available in round rod, square bar, rectangle bar, as well as steel shapes such as I-Beams, H-beams, angles, and channels. The hot roll process means that the surface on this steel will be somewhat rough. 1018 - this means that it will bend much more quickly than will 1018. Finally, machining this material is noticeably more difficult than 1018 steel, but the cost is usually significantly lower.

*1144 (Stress proof-equivalent) steel :*This material is actually pretty cool, at least for steel. It is a higher-strength alloy than 1018 or A36, but in addition has improved ductility as well. The chief feature of 1144 steel, however, is that it has very low distortion or warpage after machining due to a combination of its chemistry, method of manufacture, and heat treatment. Finally, 1144 is relatively easy to machine, with a machinability rating of 83% of AISI 1212 steel.

12L14 free machining steel: This alloy has lead added to the mix in order to enhance its machinability. In fact, it is rated with a machinability of 160% of AISI 1212 steel. The addition of lead does, however, reduce the strength of this alloy, although it is generally stronger than 1018.

A653 Galvanized Steel: Galvanized steel is simply hot rolled steel to which a zinc coating has been applied for protection against corrosion.

A366/1008 Steel: This alloy is generally used for “commercial quality” cold rolled steel sheet. It is known for its very good formability and comparatively high strength. It has a very good surface finish that is far superior to hot rolled A36.

A513 (alloy 1020-1026) Steel: This alloy is generally used for DOM tubing. Its higher carbon content means higher strength, but lower weldability and machinability.

*8620 Alloy Steel :*This material is characterized by a hard outer surface, combined with a ductile interior for higher strength.

5.1 Stress – strain behavior of mild steel[24]

The stress-strain curve for steel is generally obtained from tensile test on standard specimens as shown in Fig.(5) The details of the specimen and the method of testing is elaborated in IS: 1608 (1995). The important parameters are the gauge length ‘Lc’ and the initial cross section area So. The loads are applied through the threaded or shouldered ends. The initial gauge length is taken as 5.65 (So) 1/2 in the case of rectangular specimen and it is five times the diameter in the case of circular specimen. A typical stress-strain curve of the tensile test coupon is shown in Fig.(6) in which a sharp change in yield point followed by plastic strain is observed. After a certain amount of the plastic deformation of the material, due to reorientation of the crystal structure an increase in load is observed with increase in strain. This range is called the strain hardening range. After a little increase in load, the specimen eventually fractures. After the failure it is seen that the fractured surface of the two pieces form a cup and cone arrangement. This cup and cone fracture is considered to be an indication of ductile fracture. It is seen from Fig.(6) that the elastic strain is up to e_y followed by a yield plateau between strains e_y and

e_{sh} and a strain hardening range start at e_{sh} and the specimen fail at e_{ult} where e_y, e_{sh} and e_{ult} are the strains at onset of yielding, strain hardening and failure respectively.

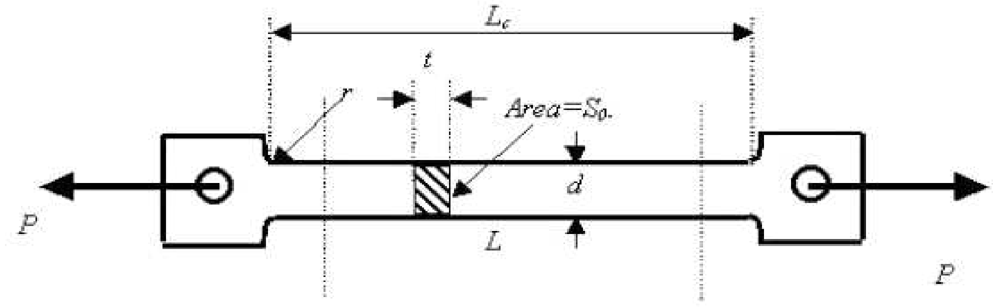

Figure 5 *Standard tensile test specimen*

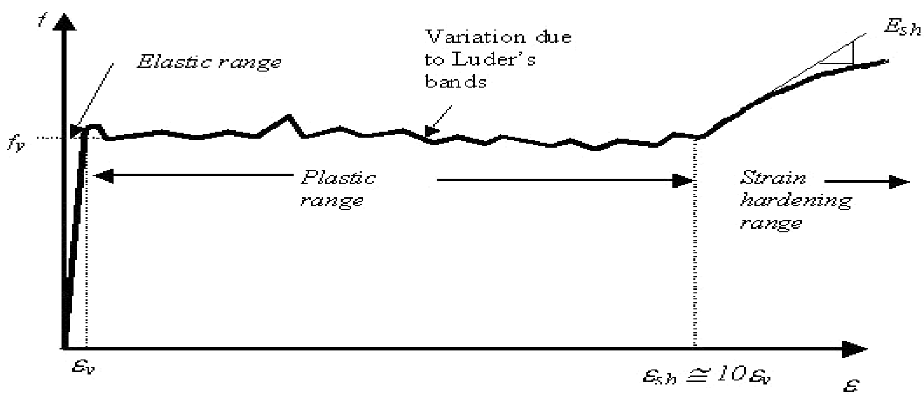

Figure 6 *Stress Strain curve for mild steel*

Depending on the steel used, åsh generally varies between 5 and 15 åy, with an average value of 10 åy typically used in many applications. For all structural steels, the modulus of elasticity can be taken as 205,000 MPa and the tangent modus at the onset of strain hardening is roughly 1/30th of that value or approximately 6700 MPa.

5.2 Notch toughness

There is always a possibility of microscopic cracks in a material or the material may develop such cracks as a result of several cycles of loading. Such cracks may grow rapidly without detection and lead to sudden collapse

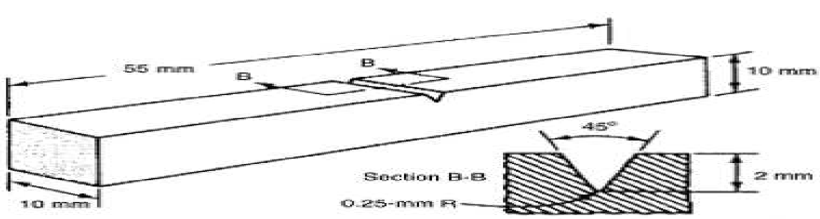

Figure 7 *Test specimen for notch toughness test*

of the structure. To ensure that this does not happen, materials in which the cracks grow slowly are preferred. Such steels are known as notch-tough steels and the amount of energy they absorb is measured by impacting a notched specimen with a heavy pendulum as in Izod or Charpy tests. A typical specimen used is shown in Fig.(7).

5.3 Mechanical and wear properties of mild steel

The investigation on the mechanical and wear properties of iron and steel component under different condition have been made by a number of workers. Most of these investigation had been made on analysis of wear properties a very few studies were made including both the mechanical and wear properties under the same parameters and conditions.*Celik* et al [25] studied the high temperature abrasive wear behavior of an as cast ductile iron and reported that the high temperature tensile properties were affected by dynamic strain aging. Serrated flow was observed in the temperature range between 100 and 300 °C. In this temperature regime, tensile strength values were almost invariable. Above 400 °C, increase of temperature decreased the tensile strength. Minimum ductility was observed at 500 °C. At 600 °C, higher ductility was observed than that of 500 °C. he also concluded that after the increase in wear resistance at 50–100 °C, abrasive wear resistance decreased with increasing temperature. Dynamic strain aging caused improvement of abrasion resistance. The highest resistance to abrasive wear is observed at temperature range between 50 and 100 °C. At this temperature range ductile iron exhibited more than 15% higher abrasion resistance than room temperature. *Izciler and Tabur* [26] on his study of abrasive wear behavior of different case depth gas carburized AISI 8620 gear steel concluded that in respect with microstructures, samples subjected to longer periods of gas carburizing exhibit greater case depth. *Khusid* et al [27] on his work studied the Wear of carburized high chromium steels and reported that Carburization raises the abrasive wear resistance and allows significant suppression of the adhesion phenomena under dry sliding. *Luo* et al [28] studied the effects of microstructure on the abrasive wear behavior of spheroidal cast iron and reported that the wear resistance of spheroidal grey cast iron was inferior to that of steel with a similar matrix. Quenched structures were more resistant to abrasion than the austempered structures. In addition, the wear performance of quenched iron and steel samples were reported to be better than austenized at higher temperature . The results of an experimental investigation carried out by *Akdemir* et al [29] on Impact toughness and microstructure of continuous steel wire-reinforced cast iron composite and reported that absorbed energy of the gray cast iron increases basically with adding the ductile reinforcement. Also absorbed energy of the composite decreases with decreasing test temperature since the steel wire in the composite looses its ductility and behaves as a brittle material as the test temperature was decreased. *Baldissera and Delprete* [30] studied effects of deep cryogenic treatment (DCT) on static mechanical properties of 18NiCrMo5 carburized steel and concluded that The soaking time parameter shows a strong influence on the hardness increase induced by the pre-tempering DCT and, under the assumption that the microstructural mechanism involves the entire process further improvements could be possible with a prolonged DCT exposure. *Kayali* et al [31] on his work of high Temperature Tensile and Abrasive Wear Characteristics of As-cast Ductile Irons reported that At entire temperature range pearlitic ductile iron exhibited higher strength and lower ductility than ferritic ductile iron. *Kumar and Gupta* [32,33] carried out extensive studies on low stress abrasive wear characteristics of carburized mild steels, and heat tested medium carbon and alloy steels. The authors found that the hardness and abrasion resistance of carburized mild steels increased considerably with increase of carburization temperature and soak time; use of coal tar pitch and quenching oil on mild steel surface and its subsequent carburization in charcoal greatly improved the wear resistance of carburized mild steel. *Bepari* et al [34] studied the effects of Cr and Ni addition on the structure and properties of carburized low carbon steels and found that both Cr and Ni promote the formation of retained austenite in carburized and hardened steel, Cr being more effective. *Wang and Lei* [35] observed that wear resistance increased in following order: spherodized carbide, martensite, bainite and lamellar pearlite. The result also indicated that the difference in wear resistance of various microstructures were caused by the differences in their thermal stability, resistance to deformation, resistance to nucleation and propagation of micro-cracks etc.

5.4 Steel composition and corrosion cracking

Corrosion failures in mild and low-alloyed steel can have great human and financial consequences. Typical examples include long periods of down-time of electricity boilers because of corrosion of the evaporator tubes and erosion corrosion in wet steam lines. In water-steam systems operating at high temperatures and pressures, Strain Induced Corrosion Cracking (SICC) is a very common corrosion phenomenon. Pressure vessels, such as deaerators and wet steam lines, have been susceptible to SICC (Pastoors 1986, 1989 and 1990). Extensive research on stress relieving of welds and the influence of water chemistry was undertaken but the influence of steel composition usually was neglected. Elements that found to be beneficial in preventing these types of failures are included in Table 1.

T A B L E 1 *Elements for preventing failure*

Type of failures	Beneficial elements in C-steels	Non beneficial elements	Failure mechanism
Boiler corrosion caused by chloride ingress under heat flux conditions	Mn, P, Cr and Mo		Formation of compressive stresses in the magnetite layer
Erosion corrosion in wet steam lines	Cu, Cr and Mo	C	Porosity of the magnetite layer
Nitrate Intergranular Stress Corrosion Cracking	Mo, Cr and Mn	Si, Cu and C	Intergranular corrosion
Strain Induced Corrosion Cracking (in deaerators)	Mo	C	Repassivation capacity on the crack tip

SICC (Strain Induced Corrosion Cracking): Deaerators in electricity power units showed Stress Corrosion Cracking rather often. Unfortunately, compositional data were available only for a limited number of steels;(Pastoors, Huijbregts 1992).

Chloride boiler corrosion: Under heat flux conditions and chloride contamination of the boiler water, ferrous chlorides can form under the scales on the steel tubes and cause severe corrosion (Huijbregts 1972, 1975,1977, 1981).

On load corrosion: High heat flux conditions combined with (too) high pH values often will result in alkaline boiler corrosion, (Huijbregts 1983).

Erosion corrosion: Erosion corrosion occurs often in wet steam lines, (Huijbregts 1977, 1981, 1982, 1985,1997).

SCC in carbonate environments: In district heating systems, the presence of carbonate in the oxide scale combined with a high pH value of the water system result in carbonate stress corrosion cracking, (Huijbregts 2002).

SCC in nitrate environments: In condensing waste gases with high concentrations of NO2, nitric acid and nitrates are formed resulting in intergranular SCC, (Leferink 2002).

5.5 Cyclic torsion in mild steel products

Cold forming is usually associated with the "work hardening" of the material being formed. The work hardening behavior of metals subject to complex processing paths is different from that in monotonic deformation. The results show that, after some initial hardening, there is a possibility that further deformation will cause softening in the material ("work softening"). Cold forming of metals usually causes their work hardening. The magnitude of this hardening depends on the area reduction, on the temperature and strain rate associated with the processing, and on the way the strain is imposed on the metal. Keeping all other variables constant, the work hardening of a metal submitted to a sequential straining under varying directions or of different natures is different from that resulting from monotonic straining. Changes in the way the material is deformed can alter the hardening rates and even cause strain softening of the metal[56-71] . Recent research results[72-74] show that cyclic straining influences in various ways the mechanical behavior of annealed and drawn metal bars. Annealed Aluminum submitted to cyclic torsion displays higher flow stresses than the annealed material. On the other hand, cyclic torsion softens previously drawn Aluminum. Cyclic torsion also softens steel bars previously drawn in one or two passes and hardens the initially annealed material. Experimental results indicate that the stress-strain curve and the work hardening coefficient (n) of steel drawn in two passes and submitted to cyclic torsion are similar to those for the material submitted to only one drawing pass. This is similar to the case of the Aluminum alloy 6063, where the cyclic torsion after two drawing passes eliminates the hardening associated with the second drawing pass. It is also observed for both materials that their Ultimate Tensile Strength (UTS) tends to remain unaltered by cyclic torsion, in the case of initially annealed material, whereas their Yield Strength (YS) is considerably increased by cyclic torsion. The YS and UTS of both previously drawn materials are decreased by cyclic torsion, with the exception of the YS of Aluminum drawn in a single pass. The decrease in these properties is more pronounced after two drawing passes than after a single drawing pass. Finally, cyclic torsion increases the Tensile Elongation to Fracture of drawn material and decreases this property for initially annealed material.

6. Discussions and Concluding Remarks

The current study indicates that when steel is welded, it is heated and the heated portion has a micro structure that is different from that of the base metal. Thermal cycle cause non uniform heating and cooling in the material, thus generating harder heat affected zone, residual stress and cold cracking susceptibility in the weld metal and base metal. Observation of some researchers in the welded joints indicate the presence of very large grains near the fusion line and these are oriented along the directions of the heat flow. Some researchers said that the grain coarsened zone (GCZ) and heat affected zone (HAZ) are very critical since embitterment is concentrated in these areas. Whereas some researchers found that the hardness and abrasion resistance of carburized mild steels increased considerably with increase of carburization temperature and soak time. Few of the researchers studied the effects of Cr and Ni addition on the structure and properties of carburized low carbon steels and found that both Cr and Ni promote the formation of retained austenite in carburized and hardened steel. The study of the previous work reviews states that a Corrosion failures in mild and low-alloyed steel specially Strain Induced Corrosion Cracking (SICC). Some researchers derived the theory that Changes in the way the material is deformed can alter the hardening rates and even cause strain softening of the metal . Recent research results show that cyclic straining influences in various ways the mechanical behavior of annealed and drawn metal bars. Amount of hydrogen generated by the welding process or consumable, the heat input into the weld, the combined thickness (heat sink) of the joint, and the level of preheat applied to the components prior to welding are the factors which influence the weldability .The highest resistance to abrasive wear is observed at temperature range between 50 and 100 °C. At this temperature range ductile iron exhibited more than 15% higher abrasion resistance than room temperature. Final microstructures and mechanical properties of welded steel depend on some parameters like percentage of carbon and presence of others elements such as sulfur or phosphorus.

7. References

[1] O.P. Khanna, *A text book of welding technology*, Dhanpat Rai Publications Ltd.,P3 (2006),.

[2] Teng, Tso-Liang, Chang, Peng-Hsiang, A study of residual stresses in multi-pass girth-butt welded pipes Internationa l Journal of Pressure Vessels and Piping 74: 59–70. (1997)

[3] Lee, S., Kim, B.C., Kwon, D., Correlation of microstructure and fracture properties in weld heat-affected zones of thermo mechanically controlled processed steels, Metallurgical Transactions A,(1992)

[4] Eigenmann, B., Schulze, V., Vo¨Hringer, O.,Surface residual stress relaxation in steels by thermal or mechanical treatment , Proceedings of the Fourth International Conference on Residual Stresses, Society of Experimental Mechanics, Bethel, Connecticut, Baltimore, MD, June 8–10 :598–607(1994)

[5] Q. Xue, D. Benson M.A. Meyers, V.F. Nesterenko E.A. Olevsky ,Constitutive response of welded HSLA 100 steel, Materials Science and Engineering A354 : 166_ 179 (2003)

[6] J. E. Ramirez, S. Mishael & R. Shockley ,Properties and Sulfide Stress Cracking Resistance of Coarse-Grained Heat- Affected Zones in V-Micro alloyed X60 Steel Pipe, Welding Research, welding journal : (2005)

[7] Tadashi Kasuya, Nobutaka Yurioka,Makoto Okumura ,Methods for predicting maximum hardness of Heat Affected Zone and selecting necessary Preheat temperature for Steel Welding,Nippon Steel Technical Report No.65,: (1995)

[8] Teng, Tso-Liang, Chang, Peng-Hsiang, , A study of residual stresses in multi-pass girth-butt welded pipes, International Journal of Pressure Vessels and Piping 74: 59–70 (1997)

[9] Lee, S., Kim, B.C., Kwon, D., Correlation of microstructure and fracture properties in weld heat-affected zones of thermo mechanically controlled processed steels, Metallurgical Transactions A,:(1992)

[10] Eigenmann, B., Schulze, V., Vo¨Hringer, O., Surface residual stress relaxation in steels by thermal or mechanical treatment, In Proceedings of the Fourth International Conference on Residual Stresses, Society of Experimental Mechanics, Bethel, Connecticut, Baltimore, MD,:598–607(1994)

[11] E. Bayaraktar, D. Kaplan, L. Devillers & J. P. Chevalier, Grain Growth Mechanism during the Welding of Inter-stitial Free (IF) Steels,Journal of Materials Processing Technology, Vol. 189, No. 1-3, , pp. 114-125.(2007)

[12] A. Gural, B. Bostan & A. T. Ozdemir, Heat Treatment in Two Phase Region and its Effect on Welding of a Low Carbon Steel, Materials and Design, Vol.28, No. 3, , pp. 897-903(2007).

[13] Eroglu & M. Aksoy, Effect of Initial Grain Size on Microstructure and Toughness, Materials Science and Engineering A, Vol. 286, No. 2, , pp. 289-297(2000).

[14] O. Grong & O. M. Akselsen, HAZ Grain Growth Me-chanism in Welding of Low Carbon Microalloyed Steels, Acta Metallurgica, Vol. 34, No. 9, pp. 1807-1815(1986).

[15] C. Thaulow, A. J. Paauw, A. Gunleiksrud & O. J. Naess, Heat Affected Zone Toughness of Low Carbon Micro-alloyed Steel, Metal Construct, Vol. 17, No. 2, pp. 94-99(1985).

[16] K. Ohaya, J. Kim, K. Yokoyama & M. Nagumo, Mi-crostructures Relevant to Brittle Fracture Initiation at the Heat-affected Zone of Weldment of Low Carbon Steel, Metallurgical and Materials Transactions A, Vol. 27, No. 9, pp. 2574-2582(1996).

[17] A. G. Olabi & M. J. S. Hashmi, The Microstructure and Mechanical Properties of Low Carbon Steel Welded Components after the Application of PWHT, Journal of Material Processing Technology, Vol. 56, No. 1-4, pp. 88-97(1996).

[18] E. M. Anawa & A. G. Olabi, Using Taguchi Method to Optimize Welding Pool of Dissimilar Laser-welded Components, Optics & Laser Technology, Vol. 40, No. 2, pp. 379-388(2008).

[19] *Mild steel,AU,IPRM 2007,* Section 8 : consumables,BOC manuals

[20] N. T. Williams & J. D. Parker, Review of resistance spot welding of steel sheets—part 1: modelling and control of weld nugget formation, International Materials Reviews, vol. 49, no. 2, pp. 45–75, (2004).

[21] M. Zhou, H. Zhang & S. J. Hu, Critical specimen sizes for tensile-shear testing of steel sheets,Welding Journal, vol. 78, no. 9, pp. 305s–313s, (1999).

[22] *Shielding gas manual,*BOC India limited

[23] *G.L. Huyett Engineering hand book* , Minneapolis, Kansas

[24] S.R.Satish Kumar & A.R.Santha Kumar, Design of Steel Structures, Indian Institute of Technology Madras

[25] Celik O., High temperature abrasive wear behavior of an as – cast ductile iron, wear, 258: pp. 189 – 193 (2005).

[26] Izciler M. & Tabur M. , Abrasive wear behavior of different case depth gas carburized AISI gear steel, Wear, 220: pp. 90 – 98(2006).

[27] Khusid B. M. & Khina B.B. , Wear of carburized high chromium steels, Wear, 165: pp. 109 – 112(1993).

[28] Luo Q., Xie J. & Song Y. , Effects of microstructure on the abrasive wear behavior of spheroidal cast iron, Wear, 184: pp. 133 – 137(1995).

[29] Akdemir A. , Kus R. & Simsir M. , Impact toughness and microstructure of continuous steel wire – reinforced cast iron composite, Material science and Engineering, (2009).

[30] Baldissera P. & Delprete C. , Effect of deep cryogenic treatment on static mechanical properties of 18NiCrMo5 carburized steel, Material and design, 30: pp. 1435 –1440(2009).

[31] Celik O., Ahlatci H. & Kayali E. S. , High temperature tensile and abrasive wear characteristics of As – cast ductile iron, ISIJ International, 43: 1274 – 1279(2003).

[32] Kumar M. & Gupta R. C. , Abrasive wear characteristics of carbon and low alloy steels for better performance of farm implements, Journal of material science and technology, 11: pp. 91 – 96(1995).

[33] Kumar M. , Studies on the abrasive wear of carburized mild steels , Trans. Indian Inst. Metals, 47: pp. 417 – 420.57(1994)

[34] Bepari M. M. A. & Haque M. N. , Effects of Cr and Ni addition on the structure and properties of carburized low carbon steels, Trans. Indian Inst. Metals, 53:pp. 509(2000)

[35] Wang Y. & Lei T. , Study of Wear behavior of cast iron, Wear, 194: pp. 44(1996).

[36] Ford, P., *“Fracture mechanics data and modelling of environmental assisted cracking of nickel alloys in high temperature water”*, Essen Conferenz Vortrag 7, (1995).

[37] Huijbregts, W. M. M. (1977a), *“Acid Corrosion Resistance of Boiler Steels”*, Materials Performance, Vol.16, No. 5, p. 23-27.

[38] Huijbregts, W. M. M. (1977b), *“On-load corrosion and laboratory test methods”*, Proceedings Eurocorr 77,Sept 1977, London, pp. 329-334.

[39] Huijbregts, W. M. M. (1981), Bestimmung der Korrosionsanfallichkeit von Verdampferrohren, VGB Kraftwerkstechnik Vol. 9, No 9, p. 773-782, (1981).

[40] Huijbregts, W. M. M. (1982), *“The influence of chemical composition of carbon steel on erosion corrosion in wet steam”*, Specialist’s meeting on corrosion erosion of steels in high temperature water and wet steam Les Renardieres, 11-12 May, 1982.

[41] HUIJBREGTS, W. M. M. (1983), *"Corrosion of unalloyed steels in different alkaline solutions at high temperatures and under high pressures"*, KEMA Scientific & Technical Reports, Vol. 1, No. 1, p. 1-9,1983.

[42] HUIJBREGTS, W. M. M. (1984), *"Erosion-corrosion of carbon steel in wet steam"*, Materials Performance,Vol. 23, No. 10, pp. 39-45, 1984.

[43] HUIJBREGTS, W. M. M. (1985), *"Deposition and erosion-corrosion rippling in boiler tubes"*, KEMA Scientific & Technical Reports, Vol. 3, No. 2, p33-41, 1985

[44] HUIJBREGTS, W. M. M., JELGERSMA, J. H. N. A., SNEL (1975), Der Einfluss von Warme transport, Ablagerungen und Kondensatorleckagen auf die Korrosion in Dampferzeugern, VGB Kraftwerkstechnik,Vol. 55, No. 1, pp. 26-39.

[45] HUIJBREGTS, W. M. M., SNEL, A. (1972), *"The protection effectiveness of magnetite layers in relation to boiler corrosion"*, 5th. International Congress on Metallic Corrosion, Tokyo.

[46] HUIJBREGTS, W. M. M., VENDERBOSCH, P. H., KOKMEIJER, E. (1992), *"Laboruntersuchungen nach Korrosionsermüdung im Zusammenhang mit Schaden in Speisswasserentgassen"*, VGB Kraftwerstechnik Vol. 72, No. 10, p. 908-913, 1992.

[47] HUIJBREGTS, W. M. M., UILHOORN, F., WELS, H. C.(1997), *"Erosion-corrosion in heat exchangers, the value of material specification"*, Euromat 1997, Maastricht,

[48] HUIJBREGTS, W., BEIJERS, A., LEFERINK, R., ZEIJSINK, A., PETERS, J., VERBEEK, P. & BILSEN., R. (2001), *"Carbonate stress corrosion cracking in district heating pipes"'* Eroheat & Power, Fernwarme International, June, pp 52-8.

[49] LEFERINK, R. G. I., HUIJBREGTS, W. M. M. (2002), *"Nitrate Stress Corrosion Cracking in waste heat recovery boilers"*, Anti-Corrosion Methods and Materials, Vol. 49, No. 2, pg. 118-126,(2002)

[50] LENZ, E, WIELING, N.(1986), Mediumseitige Einflussgrossen bei der dehnungsinduzierten Risskorrosion und Beispiele fur anwendungsbezogene Falle, VGB Kraftwerkstechnik, 66, Heft 5, Mai 1986.

[51] PARKINS, R. N.(1973), *"Environmental aspects of stress corrosion cracking in low strength ferritic steels"*, Stress corrosion cracking and hydrogen embrittlement of iron base alloys conference held at Unieux- Firminy (FR) June 12-16, 1973, Pg. 601-624.

[52] PARKINS R. N.(1980), *"Predictive approaches to stress corrosion cracking failure"*, Corrosion Science, 1980, Vol. 20, pg. 147-166.

[53] PASTOORS, J. T. W. (1986), Schade an Speissewasserentgassern und –behatern in niederlandischen Kraftwerken Samelband VGB Konferenz Krafywerkskomponenten, 1986, pg. 20-31.

[54] PASTOORS, J. T. W. (1989) *"In-service measurements related to Deaerator Cracking"*, VGB Kraftwerkstechnik, Nr. 7, Juli, 1989 pg. 642-646.

[55] PASTOORS H. (1990), *"Design, service conditions and deaerator cracking in Dutch utility boilers"*, The 1990 International Joint Power Generation Conference, Boston Massachusetts, Oct 21-25 1990; Proceedings Part: PWR-Vol. 12, pp. 57-63.

[56] ARMSTRONG PE, HOCKET JE, SHERBY OD. Large Strain Multidirectional Deformation of 100 Aluminum at 300K. Journal of the Mechanics and Physics of Solids. 1982; 30:37-58.

[57] BACKOFEN WA, Ghosh AK. Strain Hardening and Instability in Biaxially Streched Sheets. Metallurgical Transactions, 1973; 4:1113-1123.

[58] COFFIN LF, TAVERNELLI JF. The Cyclic Straining and Fatigue of Metals. Transactions of the Metallurgical Society of AIME. 1959; 215:784-807.

[59] LAUKONIS JV, GHOSH AK. Effects of Strain Path Changes on the Formability of Sheet Metals. Metallurgical Transactions. 1978; 9(A):1849-1856.

[60] LONGO WP, Reed-Hill RE. Work Softening in Dynamic Strain Aged Low Carbon Steel. Scripta Metallurgica. 1972; 6(9):833-836.

[61] POLAKOWSKI NH, PALCHOUDHURI A. Softening of Certain Cold-Worked Metals under the Action of Fatigue Loads. Proceedings, American Society for Testing and Materials – ASTM. 1954; 54:701-716.

[62] SILLEKENS WH, DAUTZENBERG JH, Kals JAG. Strain Path Dependence of Flow Curves. Annals of the College International pour la Recherche en Productique – CIRP. 1991; 40:255-258.

[63] THOMSEN EG. Stress-Strain Properties of Tough-Pitch Copper After Multi-Pass Drawing and Extruding. Transactions of the ASME - Journal of Engineering Materials and Technology. 1983; 105:178-181.

[64] WAGONER RH. Plastic Behavior of 70/30 Brass Sheet. Metallurgical Transactions. 1982; 13(A):1491-1500.

[65] WILSON DV, ZANDRAHMI M, ROBERTS WT. Effects of Changes in Strain Path on Work Hardening in CP Aluminium and an Al-Cu-Mg Alloy. Acta Metallurgica et Materialia. 1983; 38(2):215-226.

[66] RAUCH EF, GRACIO JJ, BARLAT F, LOPES AB, DUARTE JF. Hardening Behavior and Structural Evolution Upon Strain Reversal of Aluminum Alloys. Scripta Materialia. 2002; 46:881-886.

[67] BARLAT F, FERREIRA DUARTE JM, GRACIO JJ, LOPES AB, RAUCH EF. Plastic Flow for Non-Monotonic Loading Conditions of an Aluminum Alloy Sheet Sample. International Journal of Plasticity. 2003; 19:1215-1244.

[68] KUSNIERZ J, KUROWSKI M, BALIGA W. Strain Softening Effects in Microstructure of Twisted Pre-Deformed Copper Rods. Materials Chemistry and Physics. 2003; 81:548-551.

[69] PEETERS B, BACROIX B, TEODOSIU C, VAN HOUTTE P, AERNOUDT E. Work Hardening/Softening Behaviour of B.C.C. Polycrystals During Changing Strain Paths: II. TEM Observations of Dislocation Sheets in an IF Steel During Two-Stage Strain Paths and their Representation in Terms of Dislocation Densities. Acta Materialia. 2001; 49:1621-1632.

[70] LANGLOIS L, BERVEILLER M. Overall Softening and Anisotropy Related with the Formation and Evolution of Dislocation Cell Structures. International Journal of Plasticity. 2003; 19:599-624.

[71] GRACIO JJ, LOPES AB, RAUCH EF. Analysis of Plastic Instability in Commercially Pure Al Alloys. Journal of Materials Processing Technology. 2000; 103:160-164.

[72] AGUILAR MTP, CORREA ECS, MONTEIRO WA, FERREIRA NAM, CETLIN PR. Work Softening of Drawn Low Carbon Steel Bars. Materials Research. 2001; 4:87-91.

[73] CETLIN PR, AGUILAR MTP, CORREA ECS, VALLE PE, REZENDE JLL. Influence of Strain Path in the Mechanical Properties of Drawn Aluminium Alloy Bars. Journal of Materials Processing Technology. 1998; 80-81:376-379.

[74] CORREA ECS, Aguilar MTP, Monteiro WA, Cetlin PR. Work Hardening Behavior of Pre strained Steel in Tensile and Torsion Tests. Journal of the Materials Sience Letters. 2000; 19:779-781.

[75] *Dieter G E. Metalurgia Mecanica. 2 ed.* Rio de Janeiro: Guanabara Dois; 1981

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