A Review on Gas Carburizing a Novel Heat Treatment Process

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Abstract - Heat treatment process is modification of grain size of steel component by either heating or cooling process so that the strength of steel can be changed known as heat treatment process. It main aim to improve the mechanical property or a combination of different mechanical property so that the metals and alloys will be more useful serviceable and safe for definite purpose. But we are focusing on hardness and change in microstructure. Heat treatment by using gas carburizing chamber is the feeding of carbon on a low carbon work material by control heating and cooling by using various gasses such ethane methane and carbon monoxide with the application of pressure to attain desired mechanical properties. The following operating such as furnace temperature, soaking time, cooling time where taken from optimization of Taguchi technique and design of experiment. In this we are quenching media as polyethylene glycol 200.

Key Words - Gas Carburizing Chamber, Heat treatment, Taguchi Technique.

I.INTRODUCTION

Steel is an alloy of iron and carbon. If the percentage of carbon in iron is less than 2.0 then it is called steel On the basis of percentage of carbon there are two type of steel, if the percentage of carbon is in range of 0-0.83% then it is called Hypo Eutectoid steel and if percentage of carbon is in range between 0.83-2.0 % is called Hyper Eutectoid steel. Low Carbon steel are difficult to hardened because they cause low carbon contain so that iron-carbide volume is very less so that the obtain hardness in low carbon steel phase hardening is employed by incorporating carbon or nitrogen environment to the outer envelope iron carbide or iron nitride phase will be form and it will turn as hard. It is a type of case hardening heat treatment process where case part is hard and core part is soft. It is carried out a high temperature usually above 925^0C. Hardness it concerned with the property such as resisting to, scratching, deformation, etc. That is also means the ability to cut another material. There are the various test by the means of which we can measure hardness such Brinell hardness test (BHN), Rockwell hardness test (HRN), Knob hardness test, Vickers hardness test (HV)

II. HEAT TREATMENT PROCESS

"Heat treatment is the process in which the combination of heating, soaking and cooling of metals and alloys is carried out with respect to time to achieved desired mechanical and physical properties"

- Heat treatment should be done at half of the melting point of the metal
- Holding at this temperature for some periods and cooling up to room temperature.

III. OBJECTIVE OF HEAT TREATMENT

- To increase hardness wear resistance and cutting ability of material
- To increase other mechanical and physical property
- To reduce or eliminate unnecessary internal stress because internal stresses lead to brittle failure of component
- By reducing internal stresses the material can be converted into corrosion resistivity
- Case hardening is also possible by addition of C, N etc. So as to increase wear resistance surface hardness corrosion resistance etc

IV. TECHNIQUE OF HEAT TREATMENT

A. ANNEALING – In annealing process the specimen is heated the upper critical temperature and is cooled in furnance (varying slow cooling) so that the removal of residual stress and ductility of hardening component .

a) Type of annealing
b) Full annealing
c) Stress relief annealing
d) Process annealing

e) Spheroid annealing

B. NARM0LIZING - The process consist o heating to just above the upper critical for hypo eutectoid steel and above upper critical temperature for hyper eutectoid steel by 50^0C. In this process theirs is loss in ductility material and improve the strength and machine.

C. HARDENESS - The conventional hardening process consist of heating the steel above upper critical temperature for hypo eutectoid steel and above lower critical temperature for hyper eutectoid steel by 10^0C. It increases the hardness.

D. TEMPERING - The process consist of heating the hardened components to temperature between 100-700 degree holding at temperature for 1-2 hrs and cools at room temperature usually in air. The high internal stress produce due to hardening are likely to cause cracking of component if tempering is delayed therefore tempering should immediately done after hardening.

E. CASE HARDENING OR SURFACE HARDENING - Many industrial application require a harder outer surface of material called case and relatively soft tough inside called as core

A- CARBURIZING : Diffusion of carbon in outer surface of steel at certain temperature

METHOD OF CARBURIZING	SOURCE OF CARBON	MEDIUM	TEMPERATURE –RANGE(° C)
Solid carburizing	Charcoal, Barium carbonate	Steel Material surrounded with charcoal powder	800-900
Liquid carburizing	Cyanide	Cyanide bath	885-900
Gas carburizing	Methane, Propane and Carbon monoxide	Steel, Material is heated in presence of carbon mono-oxide	850-900

V. NEED OF GAS CARBURUISING

Gas carburizing Process is a process of surface chemistry that increases a components case depth hardness by diffusing carbon on the surface layer to enhance wear and tiredness. The rate of diffusion depends on the atmosphere's alloy and carbon potential. Care must be taken to assure that at any point, there is an adequate carbon present in the atmosphere to achieve the alloy's carbon atom acceptance rate. Depending on the material being processed and the criteria for use, gas carburizing and other surface chemistry treatment can be done in batch or continuous furnaces.

VI. LITERATURE SURVEY

1. N.V Diwakar, et al.it is found that the nitride steel is better than the EN-19 steel in diesel engine cam shaft by induction hardening methods which increase the surface hardness of the steel. After the induction hardening EN-41B steel and EN-19 steel is followed by hardening test which include hardness test and impact test which is followed by charpy test which predict that hardness of nitride test increases instead of EN-19 steel and Rockwell hardness test also predict that hardness of nitride steel instead of EN-19 steel. Hardness test shows the result that the nitride steel has 45% higher hardness than EN-19 steel and 38% higher toughness than EN-19 steel. [12]

2. V.K.Murugan, Dr.P.Koshy Mathews the objective of case study is to eliminate the variance caused by undesired process parameter which effect the field performance and characteristics of the process in this Taguchi technique is use to improve the process parameter by orthogonal array technique and calculating the S/N ratio which gives the optimal process parameter of case hardening process of C-15 steel to gate low force value and smaller the better characteristics. In this Taguchi method effectively obtain optimal heat treatment parameter for C-15 steel and also minimizes the number of experiment which influence the heat treatment parameter on experiment result and each parameter.[11]

3. Osman Asi, Ahmet Cetin Can it is found that the fatigue strength of the gas carburized SAE 8620 steel is a function of case depth i.e. by varying case depth and carburizing time fatigue strength can increase or decrease. It is found that bending fatigue strength of gas carburized specimen was decrease with increase in a case depth due to increase in internal oxidation and also case depth is inversely proportional to the hardness. Case depth is defined as the distance below the surface where hardness was equal to 550HV. Internal oxidation is the process of oxide formation away from the material surface through diffusion of oxygen within the material.[7]

4. Tsilla bensabath, Hurbret Monnier the aim of the research is to eliminate or detect the formation of polycyclic aromatic hydrocarbon which is ten rings structured which is toxic in nature. To eliminate further study is done to minimize the formation of ten ring unsaturated hydrocarbon in heat treatment process which emit during carburizing process .This is gasses in nature if the worker gate comes in contact with it will effects the skin of worker or it hazardous for them to eliminate this unsaturated hydrocarbon benzenopyrene further optimization also done on the formation of ph by comparing ethylene and propane than it is concluded that the ethylene is more suitable than propane.[8]

5. Bulan Abdullah[a], Ahmed Jaffara[a], It is found that by this author is, A case hardening method and it is also known as paste carburizing. It consists of sodium carbonate, barium carbonate and water are mixed for conduct treatment on mechanical properties of ASTM A516 low carbon steel at temperature 700^0c to 800^0c. The three different test apply on samples the tensile test, hardness test (Rockwell) and microstructure standard test. If the temperature increase of these treatment then, effect on the mechanical properties of low carbon steel and improve the hardness and tensile strength of steel and carburized layer produced on the surface of substance and we compared the carburized and un-carburized samples to get the final result.[1]

6. Dr. Y.D. Venkatesh, Srinivas Athreya, this author is found that by using Taguchi method is a statistical method and it is design development process developed by Taguchi and Konishi. The number of experiments are used for developing and improving the quality of good manufactures like ANNOVA, design of experiment, lathe facing operation, orthogonal array, signal to noise ratio, full factorial design, Taguchi method etc. And various types of steps involved. Taguchi method can be applied for any other kind of problem and provides simple, systematic and efficient methodology for optimizing the process parameters. The main purpose of Taguchi method is used for optimization of process parameters and improving the quality of manufactures goods or products.[2]

7. Pulla Sammaiah[a], M. Sneha[a], It is found the effect of heat treatment and machining process for deposition of Al_2O_3 nano-particles on steel, the nano-particles deposition system (NPDS) is a novel method of powder deposition on metal by used of various different types methods in industry and the purpose of nano- particles are used for improve the surface properties with the help of deposition. The different size nano particales for improve the surface characteristics of Al_2O_3 Nano-particles on metal by using heat treatment and machining process. Due to deposition temperature is lowered after machining process and achieved changes in hardness on steel and surface roughness is low after deposition. Coating thickness is at the time of machining and molecular bonding during temperature generated between Al_2O_3 and mild steel and microstructures show after coating thickness. In experimental work, two processes used are machining and heat treatment process then get results are changes in hardness and surface roughness.[3]

8. Sharidah Azuar Abdul Azis, Iswadi Jauhari, Nor Wahida Ahamad The main aim of the research it is found that carburizing layer thickness rang from 25µm to 65µm and surface hardness rang from 340HV to 1512HV. The surface properties and wear behavior of carburized duplex stainless (DSS) are studied using the method of presser ca rburizing (PC)..It is prove that the surface properties and wear behaviour of (DSS) can be enhance appreciably via (PC) process using fine grain microstructure ,in this paper extended to investigate and exploit the external force factor. The worm surface the specimen is examined using FE-SEM elucidated the modes of the wear process. Indicates that the surface is composed of microcrystalline grain of carbide formation on top of the surface. The production carbides expand in the over-
saturated austenite and form iron carbides. These may be associated on the surface with a higher rate of carbon diffusion. As a result, carbides formed are responsible for the intense hardness of up to 1500HV.[5]

9. S.Krishnamoorthi, D.Dinesh, R.Karthikeyan, G.Manikandan, The main aim of this paper is selected material was medium carbon steel. Also they are selected three level of temperature below the melting point that is 800^0, 900^0, 1000^0. There for they are select process on heating 800^0C temperature in one hour and 900^0 heating 1.15 hours also 1000^0 heating 1.30 hours. They are using Taguchi method with the L9 array with 3^{rd} level and 4^{th} factor, before heating that hardness is 477.33BHN of material in this process the cooling substance was water, salt water and oil using coolant. They got after heating hardness of material is 62 and same temperature in coolant in depth in salt water they got hardness 73BHN also depth in oil and they got hardness 67BHN. And also heating on also 900^0 with coolant oil hardness value is 70BHN and also salt water they got hardness value is 64BHN, and coolant with water hardness value is 75BHN. There for they using different temperature and different coolant used and get different result by array method in mini tab by Taguchi techniques.[4]

10. Yuksel sarikaya, etc all [6] the main aim of this paper to shows that the approximate solution of fick's second equation can be used also applied activated complex theory to the diffusion process. Possible formation of the activation complex and it's thermodynamics behaviour respect to parameter micro-hardness gradient is cased from the concentration gradient of carbon atoms in the steel. The micro-hardness value can therefore be used in the approximate solution of the second law of the fick's. Vickers carburized layer micro-hardness profile is used for different temperatures as the hardness arising from the absorption of carbon atoms in to the carburized surface .[6]

11. K.o.frindley et all [16] this paper contrasts linear elastic fracture mechanics (LEFM) based models that predict a decrease in crack growth rate in front of the crack tip due to stress/ strain induced transformation of martensite. Fatigue crack propagation rate model were developed for gas-carburized steel with quenching and tempering after carburized. Also volume expansion reduced in stress intensity ahead of the crack tip. They are consider low cycle for fatigue region simple (LEFM), in this way reduce martensite also intensity the model result relative to the experiment result are not easily based by selection of parameter.[16]

12. Kazeem O.Sansui, Esther in this they have performance different heat treatment on the AISI 1040 steel. AISI 1040 samples were prepared through annealing at 950^0C, stress annealing at 950^0C, normalizing at 899^0C and tempering at 316^0C. Refining the grain size of steel can improve the mechanical properties such as yield strength, hardness, and ductility. The soaking time of annealing 950^0C is 1hr 90min, stress annealing, normalising and tempering for 2hr.It is found that the strength annealed sampled is greater than of the other heat treatment process and the tempered change of the material properties reduce the strength. The tempered sample is smaller in the strength received of all other-heat treated. Also there is change in the microstructure of the material after heat treated in the sample of tempered at 316^0C ferrite grain is more dominating than which means the material has high ductility or elongation percent where in case of annealed 950^0C is more dominating than the ferrite grain that why this is hardest of all sample. Sample annealed at 950^0C has the highest corrosion rate.[10]

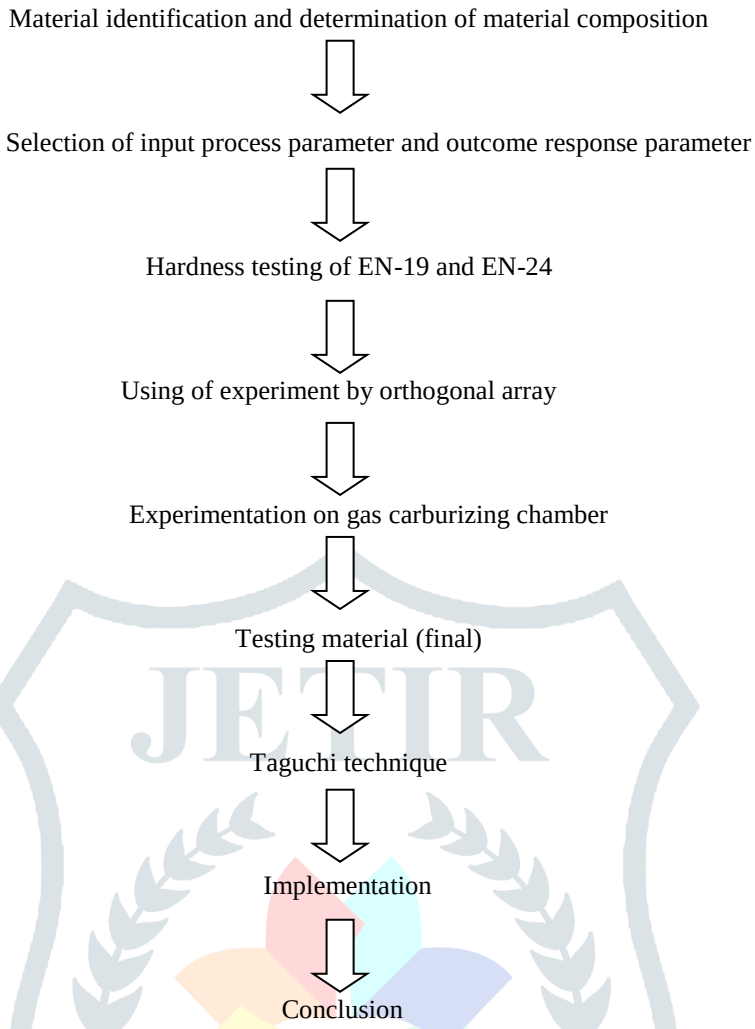
13. Jun Wang, Zhen Li, Danqi Wang in this paper they looked for the thermal stability of the AISI-316L Austenite stainless steel by low-temperature carburization. Austenitic stainless steel highly resistant to corrosion and high concentration of interstitial solute are highly beneficial for mechanical properties and corrosion resistance. It is also found that exposing the material to temperature up to 650K can be highly beneficial for the service life and also it does cause any reduction in the carbide precipitation and can the depth of carbon present by the factor 2.Exposing the material to high temperature can also decrease the surface hardness.[9]

14. Ajay Kumar, Pof.A.R.Ansari the main intension of this study to know the effects of heat treatment mainly quenching followed of tempering method and microstructure of heat treatment of sample and hardness of medium carbon steel. They are used Taguchi method and Taguchi design of experiment, the study is done on the muff -furness at three difference temperature, heat treatment duration and quenching medium temperature. After that the quenched specimen goes for tempering operation at 650^0 after that hardness is calculated by Rockwell hardness testing and Taguchi techniques is followed by orthogonal array. Where S/N ratio of difference parameter of heat- treatment process the study concluded that hardness got above testing parameter is 39.25 recorded L9 orthogonal Array.[13]

15. P.W. Mason and P. S. Prevey, Lambda Research[6] three iteration designed experiment and analysis were used to determine optimal thermal treatment for minimizing retained austenite content while maximizing Rockwell hardness (HRC) in ASIS 52100 bearing steel. Experiment variable chosen for this study included the austenite and tempering temperature, tempering time and cold treatment were seen to have greatest effect on austenite content while austenite and tempering had the greatest influence on hardness.[14]

16. Vimal B Patel, Smith D Purikh, Aim of this paper to investigating the effect of heat treatment on steel material by using Taguchi method and heat treatment. The material select the EN-31 is the ferrous spring steel with high carbon content used for manufacturing component of vehicle engine. The heat treatment experiment is carried out by using austenite temperature, quenching media and tempering temperature with three different levels. Then achieved change in hardness of material increase due to the percentage of increase and strength will increase. Taguchi method and ANNOVA are used to find the for heat treatment process. After that process of material show the result of hardness then calculate S/N ratio for each material and ANNOVA required for heat combination of parameters. Finally better hardness is achieved at austenite temperature 870^0 C, tempering temperature for 270^0 C and water quenching media and result of S/N ratio is 36.2583. Oil quench is better for EN-31 material is proved by tensile test and quenching media is most important for heat treatment with contribution of 95.66% by ANNOVA calculation. [17]

VII. METHODOLOGY



VIII. CONCLUSION

In this we have studied different paper and found that in each of the paper they have performed. different heat treatment process on different material by varying different parameter such as heating temp ,so asking time ,cooling time and using Taguchi method (for optimization) and look for the change in property before and after the heat treatment. It is found that in mostly all heat treatment process the change in property come in the favour of optimization.

IX. REFRENCE-

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