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A Review on Mechanical and Wear Properties of Heat Treated Steel

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Abstract— This Review Paper describes effects of heat treatment on various material by varying process parameters and by using different types of heat treatment process. The heat treatment includes heating & cooling operations or the sequence of two or more such operations applied to any material in order to modify metallurgical structure and alter its physical, mechanical and chemical properties. This Review paper shows progress and research in the field of heat treatment process. Different types of heat treatment processes such as annealing, normalising, nitriding, hardening, tempering carburising used & available in recent time. This paper deals with important progress work on heat treatment and its process parameters.

Key words: Heat treatment, deep cryogenics, wear properties, mechanical properties, ntriding

I. INTRODUCTION

The heat treatment includes heating and cooling operations or the sequence of two or more such operations applied to any material in order to modify its metallurgical structure and alter its physical, mechanical and chemical properties. Usually it consists of heating the material to some specific temperature, holding at this temperature for a definite period and cooling to room temperature or below with a definite rate. Annealing, Normalizing, Hardening and Tempering are the four widely used heat treatment processes that affect the structure and properties, and are assigned to meet the specific requirements from the semi-fabricated and finished components. Steels being the most widely used materials in major engineering fabrications undergo various heat treatment cycles depending on the requirements. Also aluminum and nickel alloys are exposed to heat treatment for enhancement of properties.

II. LITERATURE REVIEW

C. Medrea et all presented mechanical and structural properties of AISI 1015 carbon steel nitrided after warm rolling. They showed Nitriding of the steel after warm rolling gives a hard surface layer which presents a significant improvement of wear resistance. In the same time, the core preserves its fine grain microstructure with improved tensile properties as compared to untreated pieces. Nitriding of steel after warm

rolling leads to increased wear resistance of parts made from low carbon steel and implicitly to increasing their lifetime. [1]

L. Ceschini et all focuses on the dry sliding behaviour of Low temperature carburising (LTC)-treated AISI316L austenitic stainless steel against several counter materials (AISI316L, LTC-treated AISI316L, hard chromium or plasma-sprayed Al2O3–TiO2). They showed that the LTC produced a hardened surface layer (C-supersaturated expanded austenite), which improved corrosion resistance in NaCl 3.5% and increased wear resistance, to an extent which depends on both normal load and counter material. It has been obtained that the LTC did not improve the behaviour in terms of friction. [2]

H. Sert et all investigated wear behaviour of cam spindles made of five different surface treated nodular cast iron (GGG50) and induction hardened CK45 steels. They used PVD–TiN-coated, both borided and PVD–TiN-coated, only hardened, both hardened and PVD–TiN-coated and only borided spherical graphite cast iron and induction hardened CK45 in experiment. They were conducted wear behavior of two type of steel to observed using cam wear mechanism under unlubricated and six different surface treatments. From experiments, they come to concluded that the surface treatments increased the wear resistance of GGG50 material. [3]

Enver Atık et all investigated effects of conventional heat treatment and boronizing on SAE 1010 and SAE 1040 structural steels, D2 tool steel, and 304 stainless steel. They took various heat treatment process like carburisation, nitriding, transformation hardening and boronizing to the specimens for investigated layer thickness, corrosion and wear strength. They found that the 3. Hardness value results show that there was not a linear relationship between hardness values and wear and that high values of hardness affect the wear negatively in D2 and 304 steels. They found that the micro hardness values, corrosion resistances and wear strengths of borided specimens were higher than for other specimens. In this tribological system, it has been found that wear strengths were not directly related to the layer thicknesses, hardnesses and corrosion resistances. [4]

Senad Dizdar et all presented introductory investigation of friction and wear behavior of low alloyed chromium sintered steels as sintered and as nitrided. They have been gained from experiment that the nitrided cylinders experienced safe wear at 1000 MPa and scuffing at 1100 MPa at 2.5 m/s. At 0.5 and 0.1 m/s at least up to 800 MPa the wear was mild, as sintered chromium cylinders showed scuffing at pressure lower than 320 MPa and limited wear at 0.5 and 0.1 m/s. [5]

Michelle C.S. Duarte et all investigated the influence of individual and sequential plasma carburizing and nitriding treatments on the frictional behaviour and wear resistance of an austenitic stainless AISI 316L steel. They showed that the excellent wear resistance achieved after a sequential plasma surface treatment triode plasma nitriding (TPN) at 450 °C for 5 hours; triode plasma carburizing (TPC + TPN) compared to those of individual treatments (either TPN or TPC). They found that the high hardness at the surface (provided by TPN) and a smooth decrease in hardness towards the bulk (provided by TPC). [6]

Foad Farhani et all investigated on effects of deep cryotreatment on mechanical properties of 1.2542 tool steel. They investigated three sets of specimens like first two sets of untreated specimens, for studying the effect of some hardening parameters on the metal properties, and a third set consisting of cryotreated specimens. Soaking and tempering temperatures were kept constant at -196 0C and 200 0C, respectively. Different cryotreatment cycles were implemented by varying soaking time (24, 36 and 48 h) and tempering duration (60, 120 and 180 min). In order to ensure optimum treatment conditions, time gaps between various treatment steps were kept to minimum. Results show that two cryotreatment cycles consisting of: (i) 36 h soaking at _196 _C and 1 h tempering at 200 0C, and 48 h soaking at -1960C and 2 h tempering at 200 0C produce the best effects in the cryotreated 1.2542 tool steel specimens, namely 32–36% increase in tensile strength, 9–12% increase in hardness, and 12–35% improvement in ductility. [7]

T. Slatter et all carried out research work for cryogenic processing on wear on the impact wear resistance of low carbon steel and lamellar graphite cast iron. They carried out test using a bespoke, reciprocating hammer type impact wear test-rig. The total number of impacts applied to a particular specimen ranged from 4500 to 72,000. They recorded wear scar produced on each specimen and the nature of any wear features and debris. Selected specimens were further analysed to investigate the microstructural transformation between the cryogenically processed specimens and those that had been left untreated. They suggested that cryogenic processing can have a positive effect on the impact wear resistance of Fe–C alloys. [8]

R. Thornton et all investigated to effects of cryogenic processing on the dry sliding wear performance and microstructural features of five common engineering materials. They have been worked on the wear performance of a pearlitic low carbon steel brake material, as well as AISI A2, D6 & M2 tool steels. They used Optical and scanning electron microscopy of selected specimens indicated a range of changes due to deep cryogenic treatment including graphite flake degradation and pearlite refinement in cast iron and low carbon steel. Macro- and microhardness testing revealed no significant changes in any of the materials except for the low carbon steel tested, in which measured improvements were judged to be as a result of the refinement of the pearlite matrix due to deep cryogenic treatment. They found that the deep cryogenic treatment caused improvements in the wear resistance of tool steels treated in their annealed condition most consistently in the case of AISI M2 steel (26–31%) but also in the cases of AISI A2 (13–26%) and D6 steels (5–30%). [9]

Paolo Baldissera et all carried out experiment to effects of deep cryogenic treatment on static mechanical properties of 18NiCrMo5 carburized steel. They had comparison between the results given by different sequences of DCT and tempering performed after the conventional case hardening. The results point out substantial hardness increases (from +0.6 HRC to +2.4 HRC) for all the cryotreated groups and a remarkable enhancement of the tensile strength (+11%) in one case, indicating that different sequences and DCT parameters must be considered depending on the application requirements. They observed that Slight but significant enhancements of the Young modulus have been measured during the tensile tests of all the cryotreated groups, suggesting the need of further microstructural investigations focused on this aspect. [10]

III. CONCLUSION

From the literature review, it has been found that the several researchers have been worked on carburizing process to investigated on wear resistance and some of the researcher has been worked to investigated various material like stainless steel and carbon steel material, also work has been being through some chemical process. It has been seen from literature that the very less work carried out on EN41B which is low carbon steel with heat treatment of nitriding. So it has been decided to work on EN41B steel through nidtring.

IV. REFERENCES

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