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"TRIBOLOGICAL BEHAVIOUR AND HEAT TREATMENT ON HARDNESS BEHAVIOUR OF SPHEROIDAL GRAPHITE IRON"

Md. Mustafa Ali [1], Arun Patel [2]

[1] M. Tech. Student, Department of Mechanical Engineering, NRI Institute of Information Science & Technology, Bhopal, India

[2] Professor, Department of Mechanical Engineering, NRI Institute of Information Science & Technology, Bhopal, India

ABSTRACT

Surface properties needs to be changed, keeping the properties of base material as same. Especially, sometimes hardness is of utmost importance and needs to be enhanced. This paper deals with carburized and non-carburized ductile iron samples for evaluation of hardness. Hardness of ductile iron samples are also evaluated after erosive wear, taking into consideration, the parameters like impact angle of erosion particles, pressure of particles and standoff distance of the nozzle during the wear test. It is observed that the tribological properties of material enhances with infusion of carbon atoms on surface or due to strain hardening caused by erosive wear.

Key Words: *Sand, Erosion, Wear, Hardness, Parameters, Particle, Pearlite, Austenite, Stand off distance, I/P angle, pressur.*

I. INTRODUCTION

Erosive wear can be defined as the process of metal removal due to impingement of solid particles on a surface. Erosion is caused by a gas or a liquid, which may or may not carry, entrained solid particles, impinging on a surface. When the angle of impact is small, the wear produced is closely analogous to abrasion. When the angle of impact is normal to the surface, material is displaced by plastic flow or is dislodged by brittle failure.

As we know there is a little bit of steel in everybody life. Steel has many practical applications in every aspects of life. Steel with favourable properties are the best among the goods. The steel is being divided as low carbon steel, high carbon steel, medium carbon steel, high carbon steel on the basis of carbon content.

Low carbon steel has carbon content of 0.15% to 0.45%. Low carbon steel is the most common form of steel as it's provides material properties that are acceptable for many applications. It is neither externally brittle nor ductile due to its lower carbon content. It has lower tensile strength and malleable. Steel with low carbon steel has properties similar to iron. As the carbon content increases, the metal becomes harder and stronger but less ductile and more difficult to weld.

The process heat treatment is carried out first by heating the metal and then cooling it in water, oil and brine water. The purpose of heat treatment is to soften the metal, to change the grain size, to modify the structure of the material and relive the stress set up in the material. The various heat treatment process are annealing, normalizing, hardening, austempering, mar tempering, tempering and surface hardening.

Case hardening is the process of hardening the surface of metal, often low carbon steel by infusing elements into the metal surface forming a hard, wear resistance skin but preserving a tough and ductile applied to gears, ball bearings,

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railway wheels.

As my project concerned it is basically concentrate on carburizing which is a case hardening process. It is a process of adding carbon to surface. These are done by exposing the part to carbon rich atmosphere at the elevated temperature (near melting point) and allow diffusion to transfer the carbon atoms into the steel.

II. LITERATURE REVIEW

***S.O. Omole et al* [2018]** They were characterized using optical metallurgical microscope and they contained pearlitic-ferritic matrix structure. They were subjected to wear test at room temperature based on pin-on-disk operation. Fracture surfaces and the wear track were studied using scanning electron microscope and found that the fracture surfaces majorly consist of fibrous with little cleavage fracture pattern in some samples. Wear mechanism is delimination with adhesive wear behaviour. The specific wear rate was found to decrease with increasing hardness of the material and coefficient of friction of the ductile irons during test.

***Prabhukumar Sellamuthu et al* [2018]** The nodule count of ADI decreases and the nodule size increases with an increase in the austempering temperature. Decreases in hardness and strength were found when there was an increase in austempering temperature, from 300 to 360 ◦C. This could be due to the coarsening of the microstructure at elevated temperatures, which is observed in optical and scanning electron microscopic images. With an increase in austempering temperature from 300 to 360 ◦C, elongation as well as impact toughness gradually increases.

Ezekiel H. Asonaminasom [2018] Investigation of optimum carburizing temperature and holding time on bi-nano additives treatment of AISI5130 steel was presented in this study. AISI 5130 steel of 100 kg mass of 0.35% carbon content was buried in pulverized additives consisting of palm kernel and coconut shell using egg shell as an energizer. Four sets of 150 150 150 mm^3 steel boxes packed with additives mixed at varying weight ratio of 50:30:20 and sixty-four pieces of 20x20x5 mm^3 AISI 5130 steel were case hardened using muffle furnace (2500°C max capacity) at respective temperatures and time of 950, 1000, 1050, 1100°C and 60, 90, 120, 180 min.

Tohru Nobuki et al [2017] In this study, we produced alloyed ductile cast iron samples containing V (0.1 %), Al (0.1 %) + Cr (0.1 %) and Al (0.1 %) + V (0.1 %). The iron nitride (γ'-Fe_4N) formed on the surfaces of the nitride samples, and the iron complex nitrides (ε-$Fe_{2-3}N$) formed on the surfaces of the nitro-carburized ones. As a result, comparing with the same alloying content, the tensile strength and elongation of the nitro-carburized samples show the higher value than that of nitride ones. The micro-Vickers hardness tends to decrease with increase in distance from the sample surfaces. From the viewpoint of the nitride method, the hardness of nitride samples shows the higher value than that of the nitro-carburizing samples. Also, the maximum micro-Vickers hardness of nitrided layer at distance of 0.03 mm from sample surfaces increased with the increasing practical depth of nitrided layer.

***S. Gupta et al* [2016]** The slurry erosion resistance of the cryotreated Cr-Mn-Cu iron is well comparable to that of cryotreated high chromium iron. Not only higher hardness but improved corrosion resistance contributes to better slurry erosion property. It is evident from the SEM images of the worn out surfaces that, the predominant mechanism of material removal during slurry erosion is by ploughing. In as-cast irons cracks are formed around the matrix leading to spall formation. In case of cryotreated iron matrix being harder, no preferential erosion between matrix and carbides are occurring and hence a smoother worn out surface is revealed.

III. EXPERIMENTATION

The experimental procedure is be listed as:

1. Specimen preparation
2. Heat treatment
3. Erosion test
4. Hardening Measurement

The specimen was heated to a temperature of 850 deg Celsius and above. At 850 deg Celsius the specimen was held for 2 hour Then the furnace was switched off so that the specimen temperature will decrease with the same rate as that of

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the furnace. An Air jet erosion test rig was used to test erosive wear of target materials in the present investigation. Angular (irregularly shaped) silica sand was used as impact particles. The specimens were mounted into the test stage directly below the nozzle with using different stand of distance (distance between tip of the nozzle to surface of the specimen) and also Samples were eroded with silica sand at different impingement angles (i.e. 30˚, 45˚, and 60˚). The room temperature erosion test facility used in the present investigation. The setup is capable of creating a uniform erosive situation for evaluating erosion wear resistance of the prepared SG iron samples. Dry silica sand is used as the erodent. The particles fed at a constant rate are made to flow with compressed air jet compressor to impact the specimen, which can be held at various angles with respect to the flow direction of erodent using a swivel and an adjustable sample clip. The samples were cleaned in acetone, dried and weighed to an accuracy of ±0.1mg accuracy using a precision electronic balance. The surface of material eroded in the test rig for 10 min and weighed again to determine the weight loss. The procedure is repeated for all samples. The rig consists of an air compressor, a particle feeder, and an air particle mixing and accelerating chamber. The compressed dry air is mixed with the erodent particles, which are fed at a constant rate from a conveyor belt-type feeder in to the mixing chamber and then accelerated by passing the mixture through a tungsten carbide converging nozzle of 5 mm diameter. These accelerated particles impact the sample, and the sample could be held at various angles with respect to the impacting particles using an adjustable sample holder.

IV. VICKERS HARDNESS TESTER

The samples were tested for hardness measurement. Vickers Hardness test was carried out at room temperature before and after erosion to measure the hardness of the SG iron samples. The load was applied through the diamond indenter for 10 seconds during testing of all the treated and untreated samples.

V. RESULTS

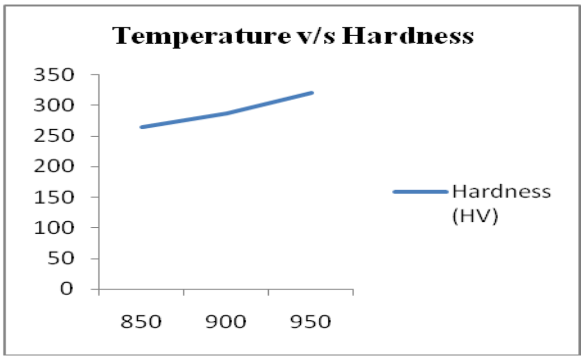
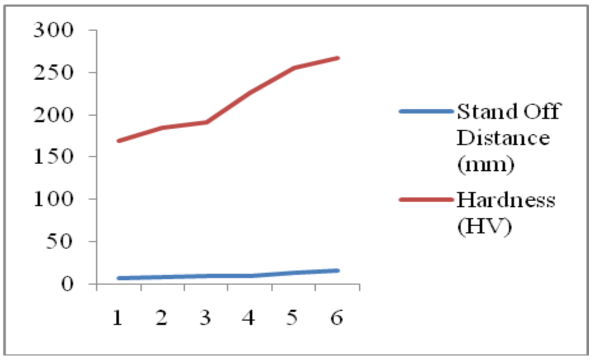


Fig. 1 Temperature v/s Hardness for carburised samples

SG iron samples are heated on 850, 900 and 950 degree celcius. Vickers hardness of the sample is measured at different temperature to check the carbon penetration and the enhancement of the carbon atom in samples so as to increase the hardness.



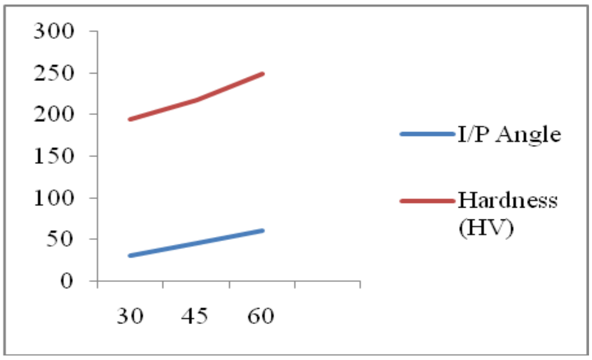


Fig. 2 Standoff Distance v/s Hardness for erosive wear

Fig. 3 I/P angle v/s Hardness for erosive wear

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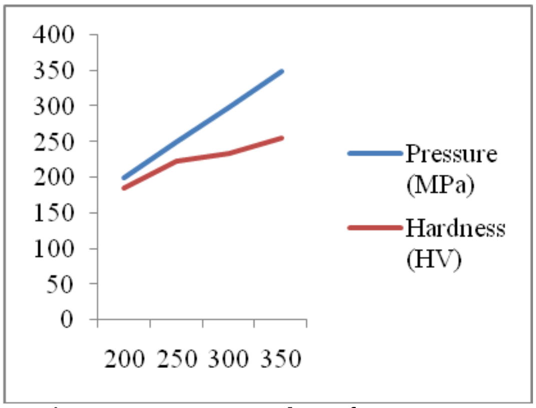

Fig. 4 Pressure v/s Hardness for erosive wear

SG iron samples are tested on erosive wear test rig at different parameters like stand off distance, I/P angle and pressure of the erodent on the samples. Hardness due to various erosive wear parameters are compared with the carburised samples and results are drawn regarding the hardness of the SG iron samples.

VI. CONCLUSION

Hardness of the ductile iron is compared by carburizing the surface of the sample and eroding the surface. Ductile iron is carburized at 850^{0}C, 900^{0}C, 950^{0}C for 1 hour and Vicker's hardness is measured. The hardness value of the sample ranges from 265 HV to 327 HV.

Ductile iron sample is eroded with the help of silica particles (650 µm average diameter, sample size: 25mm x 25mm x 5mm) with stand-off distance, Impact angle and Pressure being the variables of the experiment. Hardness of eroded surface varied from 175 HV to 270 HV with different values of stand-off distance, Impact angle and Pressure of the jet of erodent.Hardness values of the sample are compared with as received hardness values of sample i.e. 125 HV to 145 HV. It is observed that the hardness of the ductile iron can be enhanced with the help of carburizing due to penetration of carbon atoms in the surface or by erosion due to strain hardening of the material.

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