Investigation of Mechanical Properties of Carbidic Ductile Cast Iron

R.Rajvel[1], S.Mahendran[2], R.Pradeep Kumar[3]

[1,2,3] *Assistant Professor, Department of Mechanical Engineering, SNS College of Engineering, Coimbatore – 641 107*

***Abstract*: The objective of the present work is to increase the wear resistance for long life of applications. It is found that increase in the carbides in an alloy which resulted in to enhancement in hardness and wear resistance. The wear resistance was evaluated by testing in accordance with ASTE International Committee G-99 Standard. An improved performance of wear resistanceis obtained by increasing the content of chromium in the carbidic ductile cast iron. The results are discussed based on the influence of chromium content on the casting.**

***Keywords:* carbidic ductile iron, Annealing, chromium, Microstructure.**

I. INTRODUCTION

Cast irons are primarily used in many industrial applications including automobiles due to lower cost and superior combination of properties such as thermal conductivity, good vibration damping properties with good wear resistance and mechanical properties. Components in automobile such as clutch, brakes, Cylinder liners and piston rings are made of cast iron and many of these application require good resistance of aggressive forms of sliding wear [2]. Now a days the use of carbidic ductile iron is increasing because of its excellent combination of high abrasion resistance and good impact toughness compared to other materials with similar wear resistance. It is less expensive and tougher than 18% chromium white iron and it can replace Mn steel at an equal or lower cost.

II. EXPERIMENTAL PROCEDURE

The samples were designated for impact, and hardness test were cut from the block of the Y-block and machined to 300mmx20mmx90mm. Heat treatment process is done to alter the physical and sometimes the chemical properties of the material. This process involves the use of heating or chilling, normally to the extreme temperatures, to achieve a desired result such as hardening or softening of a material[6]. This process includes annealing. Annealing is heating, maintaining certain time at a temperature and cool regularly after reaching the desired properties. It is a process where a work piece is deliberately exposed to a temperature-time-atmosphere process in order to reach certain desired properties.

Fig. 1 Carbidic Ductile Cast Iron –Y Block

In general the content of chromium in cast iron is about 0.8-1%.For our testing the content of chromium is made as 1.790% and heat treatment process is carried out. The addition of chromium leads to the increase in carbide content leading to decrease in machinability and increase in wear resistance and hardness. Further the annealing process is carried to increase in machinability. High carbide content results in increase in strength, wear resistance and hardness. The chemical composition of the carbidic ductile iron includes 2.52%Si, 0.365Mn% , 0.061% P, 0.026% S, 1.790% Cr.3.65%C.

2.1 Micro Structural Examination:

The chemical composition of the alloys was measured by mean of spark emission spectrometer with a DV6 excitation source. Metallographic sample preparation for optical microscopy examination was conducted with standard cutting and polishing techniques and etching with 2% natal [3].

2.2 Mechanical Tests:

The determination of Rockwell hardness of a material involves the application of a minor load of 300kg load (HRC) on B- scale for a sample with a dimension of 65mmx25mmx15mm. The minor load establishes zero position. The major load is applied and then removed while still maintaining the minor load, the depth penetration from a dial, on which a harder material gives a higher number. The readings are taken from the perpendicular surface, because convex surfaces have lower reading. The abrasion wear resistance was evaluated by performing the "Pin On Disc Abrasion Test"[1]. The test was carried with the velocity of 1.0 m/s and distance of 500 m with a load of 26.43 N. The speed is about 239 RPM and 80mm track diameter for the sample of 10mm diameter and 35mm length.

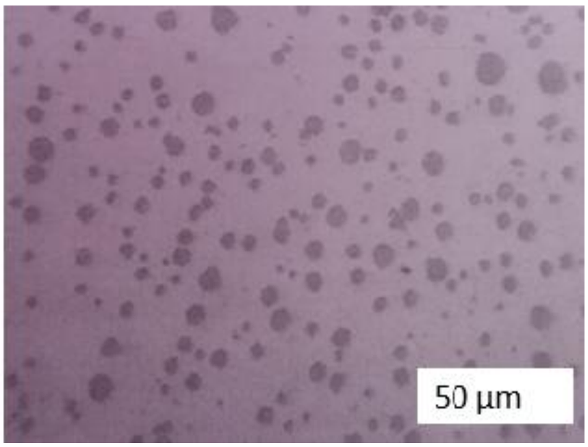
III. RESULTS AND DISCUSSION

3.1 Micro Structure:

3.1.1 Nodular Analysis ASTM 247-67:

Table . Nodule Analysis ASTM 247-67

FIELD	TOTAL	NODULE	NODULE_PERCENT	PER_MM_SQR	MAX_AREA	MIN_AREA	MAX_PERI	MIN_PERI	SIZE_RAN
Field 1	449	333	92.76	156.5273	4445.983	27.701	368.811	24.774	6



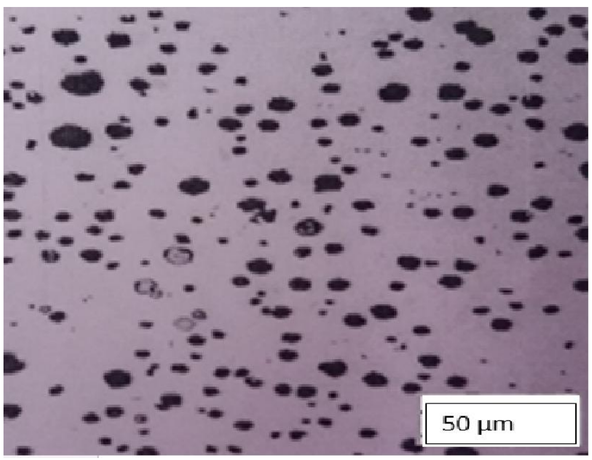


Figure 2. Nodule Analysis ASTM 247-67

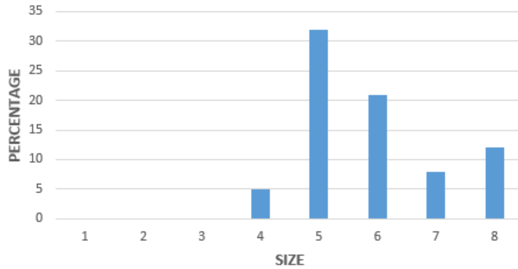


Figure 3 (a)Percentage of Nodule Size Distribution

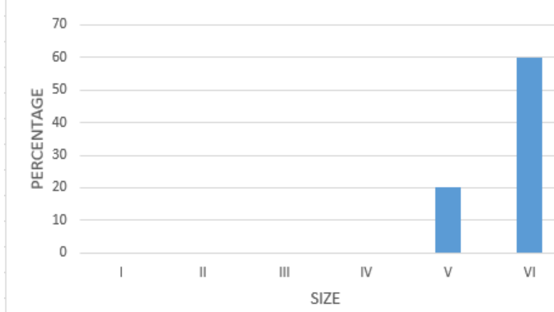


Figure 3 (b) Percentage of Nodule Type Distribution

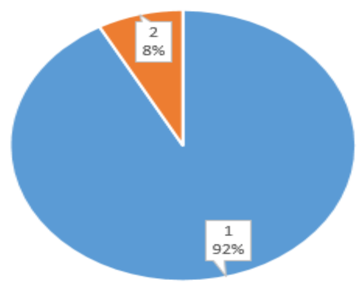
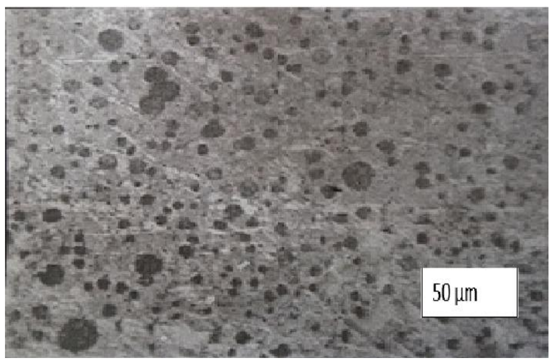


Figure 3 (c) 1-Nodule, 2-Non Nodule Distribution

CDCI was produced by ductile cast iron which contains carbides and the microstructure examination was shown in figure 2. The nodular percent is about 92.76 shown in figure 3c (1) and the remaining is non nodular. The maximum and the minimum area and perimeter of the nodule is given in the table 4. The nodule size and type distribution are shown in the figure 3 (a) and (b).

3.1.2 Phase and Volume Analysis ASTM E562 & E1245



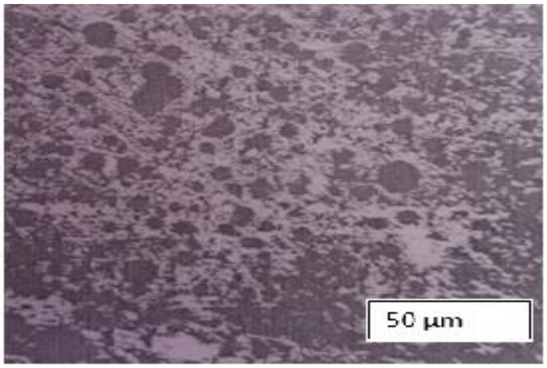


Figure 4. Phase and Volume Analysis ASTM E562 & E1245

S.NO	NAME	AREA	AREA_PER
1	FERRITE	1402022.161 Micron Sqr	65.902
2	PEARLITE	725401.662 Micron Sqr	34.098

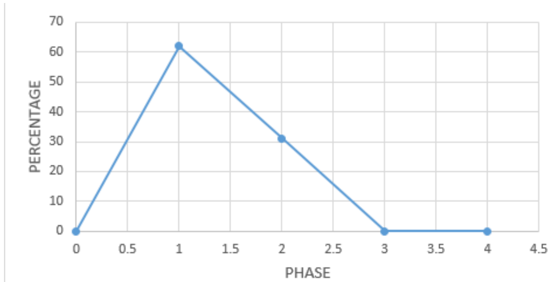


Figure 4 (a) Phase Analysis

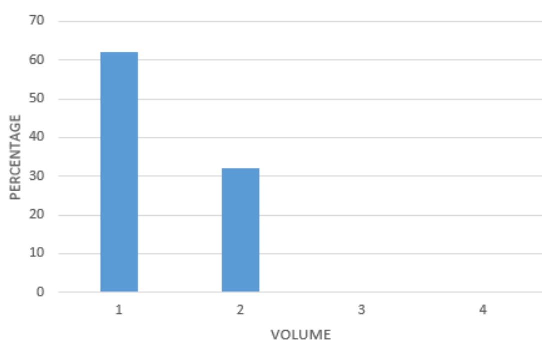


Figure 4 (b) Phase Analysis

The area percentage of ferrite is about 65.902 and the content of pearlite is about 34.098 with their corresponding areas as 1402022.161 micron Sqr and 725401.662 Micron Sqr is shown in the figure 4 (a) and (b).

3.2 Mechanical Properties:

3.2.1 Hardness Test:

The Rockwell hardness on B- scale was determined for the sample. Bulk hardness is determined for the average of three measurements was about 190. The Vickers micro hardness also determined and the micro hardness was estimated in the region of carbide, ferrite and pearlite. Carbides are precipitated throughout the sample. It is observed that the hardness of the material is 187-197 with the corresponding tensile strength of 625.72 N/mm^{2}and yield strength is 397.421 N/mm^2. The elongation of the material is 11.35%.

3.2.2 Wear Resistance:

The pin on disc experiment was conducted with the above mentioned parameters and the resultant graph is obtained as shown in figure 5. A wear resistance of 68 microns is obtained for the sample of 10mm diameter and 35mm length. At the above instant the frictional force was about 9.8N which is shown in the figure 6.

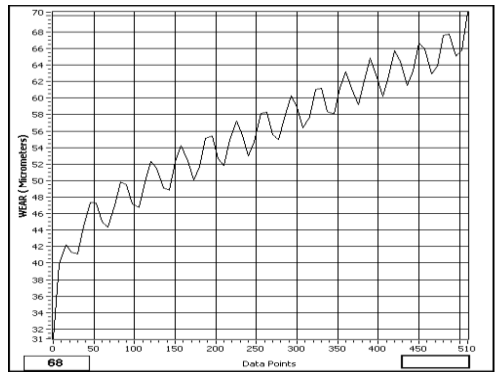


Figure 5Wear Resistance

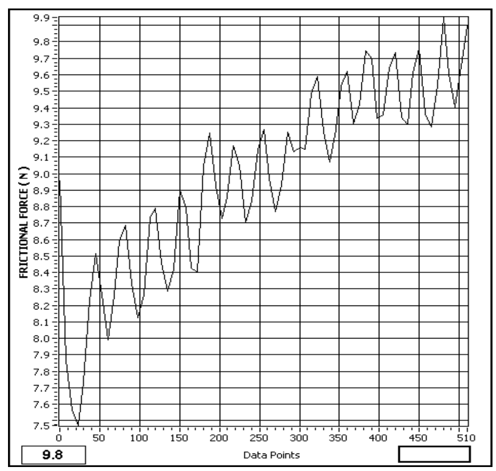


Figure 6. Frictional Force

From our analysis, on increasing the content of chromium up to 1.790% the Strength of the material is about 625.72N/mm^2 which further increases the hardness to 197.

IV. APPLICATIONS OF CADI IN REAL PARTS

The carbidic ductile cast iron finds its application on material handling equipment such as conveyors, shaft of IC engines, Earth mover component, soil aerator, centrifugal pump component, cylinder liner, agricultural and mining machinery, equipment bucket loader. the carbidic ductile cast iron obtained has high wear resistance which can be further implemented for the production of automobile parts[4][1].

V. CONCLUSION

Carbidic ductile cast iron with different amount of carbide can be obtained on using chromium as the main element. The material obtained is naval to the casting industries. Further after testing these material can be used for development of automobile parts. The presence of chromium about 1.790% will increase the Hardness up to 197 which will further increase the tensile strength to 625.72 N/mm^{2}and the wear resistance of material also increased to 68 microns which is higher than normal casting.

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