Microstructure and effect of heat treatment on white cast iron A1 alloy

[1]Dhirendra Agarwal, [2]Prof.Neeraj Kumar, [3]Dr.A.K.Bansal
[1]Research Scholar, [1]Suresh gyan vihar university Jaipur, [2]H.O.D.Mechanical, [1]Suresh gyan vihar university Jaipur,
[3]Ex-Principal GWPC,Bharatpur
[1]Mechanical Engineering,
[1]Suresh gyan vihar university,jaipur, India

Abstract:
The present study essentially comprised a detailed investigation of certain newly designed Fe –Mn –Cr-Mo white irons ,containing 9.87% Mn-5.92% Cr -3.10% C,0.3%Mo .The investigation was aimed at developing corrosion resistant white cast irons having corrosion resistance similar to expensive highly alloyed Ni-Resist irons. The study comprised assessing the heat treatment response of the experimental alloys with a view to establish interactions between structures and properties .Hardness measurements, optical and scanning metallographic, quantitative metallographic, electron probe micro analysis and differential thermal analysis were carried out to correlate structure, properties and corrosion rate.

Key words **– Cementite, Gray, Malleable, Nodular**

I. INTRODUCTION

Cast irons are basically binary alloys of iron and carbon having carbon exceeding its maximum solid solubility in austenite but less than the carbon content of iron carbide however like steel cast irons have varying quantities of silicon manganese phosphors and sulphur silicon plays an important role in controlling the properties of cast irons and for this reason the term cast iron is usually applied to a series of iron carbon and silicon alloys cast iron can be classified into various classes depending upon the form of carbon matrix micros structure and application A simple classification would be to categorize them into general purpose and special purpose cast irons the former as the name suggests are cast irons used for general engineering applications and include gray irons malleable irons nodular irons and compacted graphite irons special purpose cast irons include white and alloy cast irons which are mainly used for applications demanding enhanced abrasion corrosion or heat resistance in present study corrosion resistant cast irons are of our interest.
Multiphase microstructure is useful only when the presence of the third phase directly or indirectly helps in reducing the corrosion rate .Alloying elements adds to the corrosion resistance by forming a passive film ,changing the matrix phase ,developing favorable morphology or by changing the electro-chemical behavior of the phase present .

II.EXPERIMENTAL PROCEDURE:

ALLOY PREPERATION

Pig iron,ferro-chrome ,ferro-manganese ,ferro-silicon, graphite powder ,electrolytic copper and mild steel scrap were used as raw materials for the preparations of the alloys A medium frequency induction furnace was used for the charge calculated .The molten alloy was cast into cylindrical rods of 25 mm diameter and rectangular strips of 10x20x100 mm size .X-ray fluorescence spectrometer was used for the chemical composition analyses.

Chemical analysis is given in Table 1.1

Alloy	C	S	P	Si	Mn	Mo	Cu
A1	3.10	0.041	0.27	1.77	9.87	0.3	0.0

III. SPECIMEN PREPERATION :

Cylindrical and rectangular samples of 8mm length were cut out from the cylindrical rods and rectangular strips respectively with the help of a cut-off wheal .Specimens so obtained were then subjected to grinding operation followed by emery paper polishing. Round samples were used for hardness measurement,metallography and compression testing whereas rectangular samples were used for corrosion study by weight loss method .

IV. HEAT TREATMENT:

Heat treatment involves heating to 800,850,900,950 and 1000^{0}C ,holding these temperatures for 2,4,6,8, and 10 hours followed by air cooling .A muffle furnace with the accuracy of ± 5^{0}C was used for heat treating the samples .Temperature was measured by using a platinum –platinum/rhodium (Pt-Pt/Rh) thermocouple.

V. METALLOGRAPHY:

Optical metal graphical examination was carried out on a Riechert –Jung MeF-3 microscope .Quantitative metallography was carried out on a LEITZ image analyzer at a magnification of 3000X Scanning electron microscopy was performed to see the nature of samples surfaces subjected to corrosion test .A Phillips 501 scanning electron microscope at an opening voltage of 15 KV was used .

VI.RESULT:

Specimens of alloy A1 was heat treated by air cooling from 800,900,950 and 1000^0C after holding for periods ranging from 2 to 10 hours with an interval of 2 hours .The alloy was subjected to these heat treatments to generate the different microstructures and to determine the effect of heat treatment on hardness of the as-cast alloys .Efforts were made to correlate the variation in the hardness values of generated microstructures to the compositions of the alloys and heat treatment schedules. Table 1.2 and Figures 5.1-5.7 show the effect of time and temperature on the hardness of these alloy .While the hardness values summarized in tables are the average values .Figure 5.1to 5.7 show the effect of heat treatment time on the hardness of the alloys A1 . Depict the effect of heat treatment temperature (800,850,900,950 and 1000^0Crespectively) on the hardness of the alloy as influenced by soaking periods (2,4,6,8 and 10 hours respectively) .

Effect of heat treatment on hardness Alloy A1
(At cast hardness =565 HV30)

S.No.	Temperature Deg.C	2 Hr.	4Hr.	6Hr.	8Hr.	10Hr.
1	800	523	521	513	499	484
2	850	505	501	484	476	470
3	900	501	498	484	472	467
4	950	469	464	464	448	448
5	1000	442	442	402	383	366

VII. CONCLUSIONS

On the basis of present study, it can be concluded that:

1. White cast irons based on Fe-Mn-Cr-Mo systems can be successfully used as corrosion resistant cast irons.
2. Better corrosion resistance, shown by the specimens heat treated from higher temperatures, is due to austenitic matrix coupled with less volume fraction of massive carbides.
3. Microstructures comprising of spherical and needle like carbides in addition to martensite,austenite and massive carbides attained in the specimens heat treated from lower temperatures and undesirable .
4. Massive carbides have a tendency towards rounding off on heat treating from temperature higher than 900^0C .
5. The volume fraction of massive carbides is lowest at 1000^0C ,10 hour heat treatment .Dispersed carbides coarsen with temperature and get dissolved at higher temperatures above 950-1000^0C .

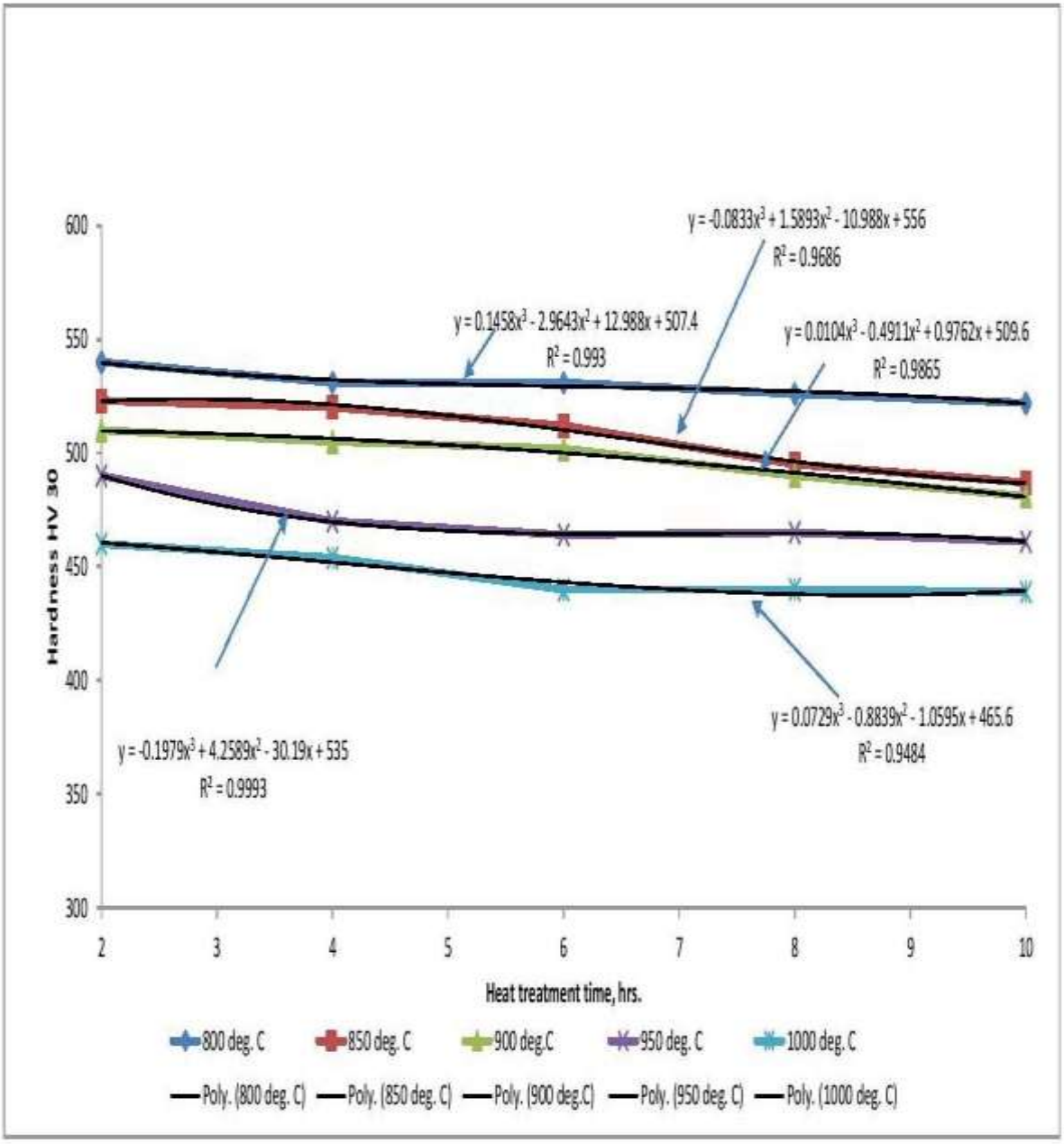

Figure 5.1: Effect of heat treatment time on hardness (base curves) Alloy A1

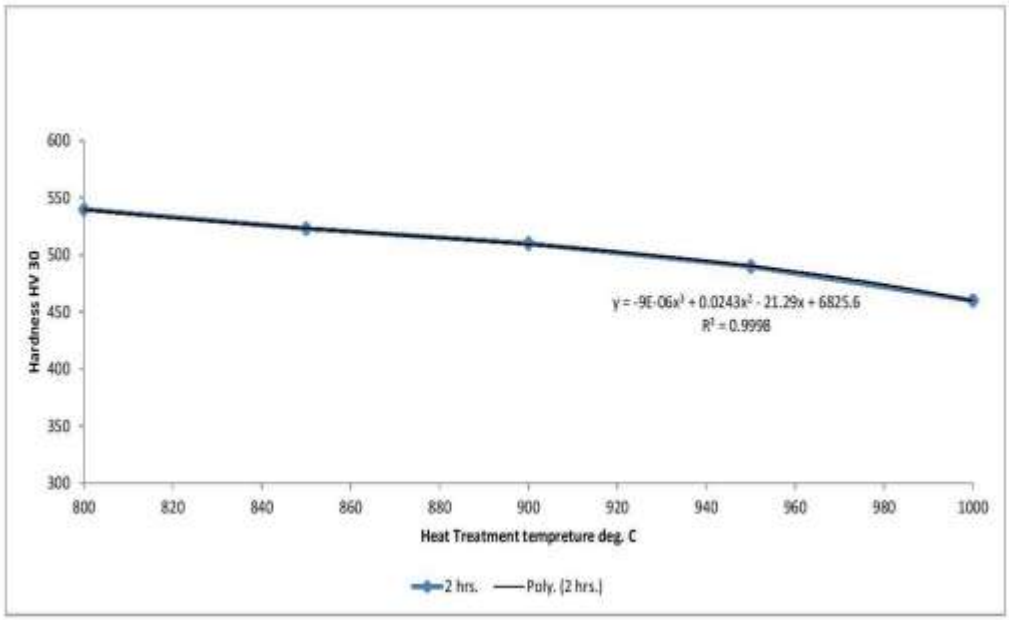

Figure 5.2: Effect of heat treatment temperature on hardness as influenced by h/t time (Alloy A1-2 hours)

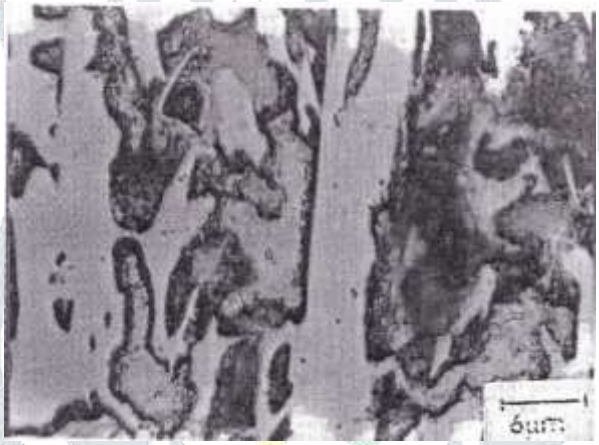

Figure 5.3 Alloy A1, as cast

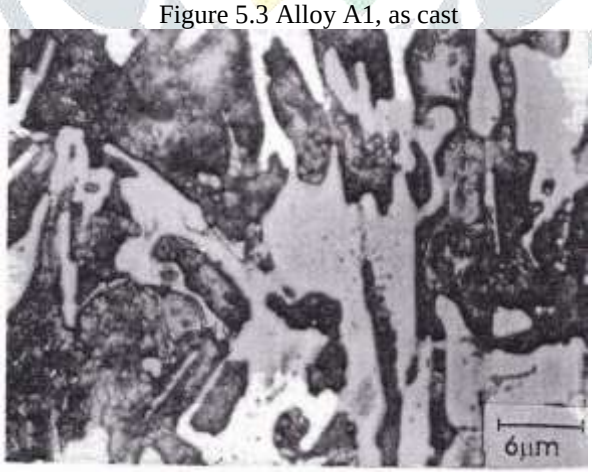

Figure 5.4 Alloy A1, 800°C, 6 hrs cast

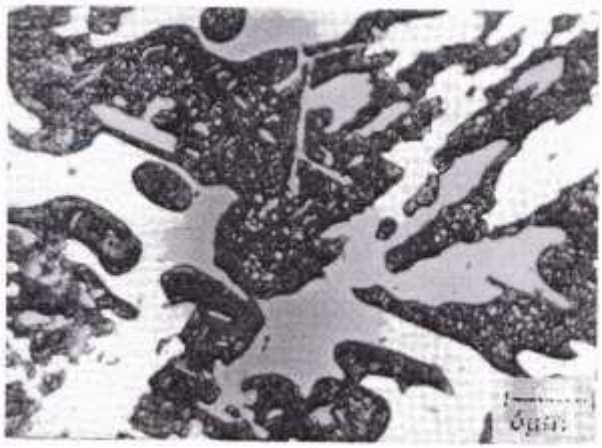

Figure 5.5 Alloy A1, 800°C, 10 hrs,

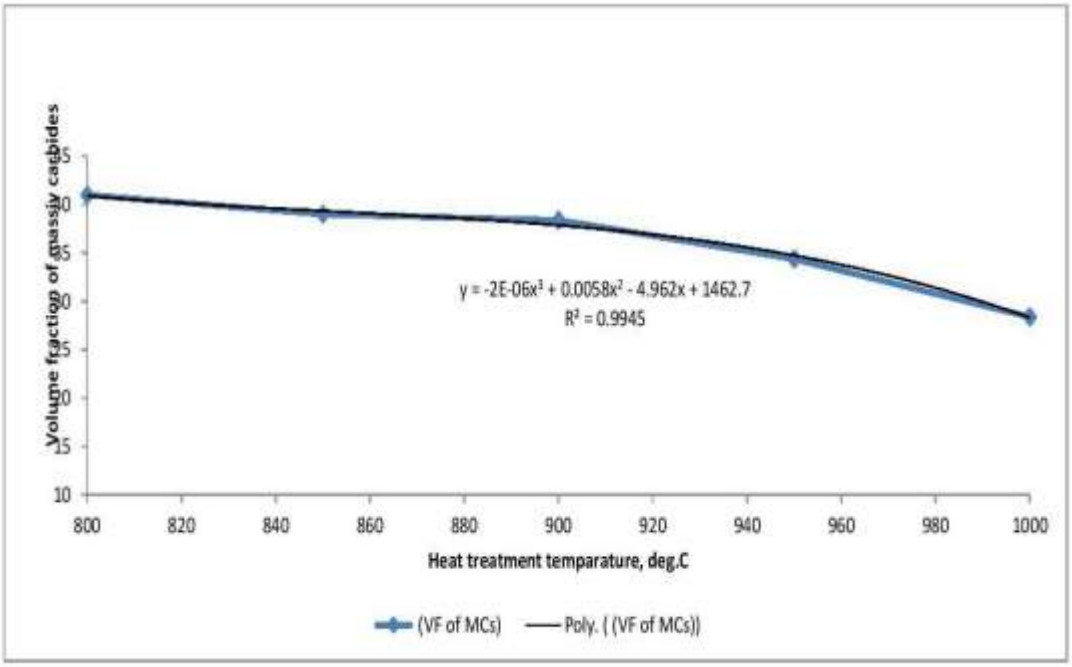

Figure 5.6: Effect of heat treatment on volume fraction of massive carbides (Alloy A1-2 hours)

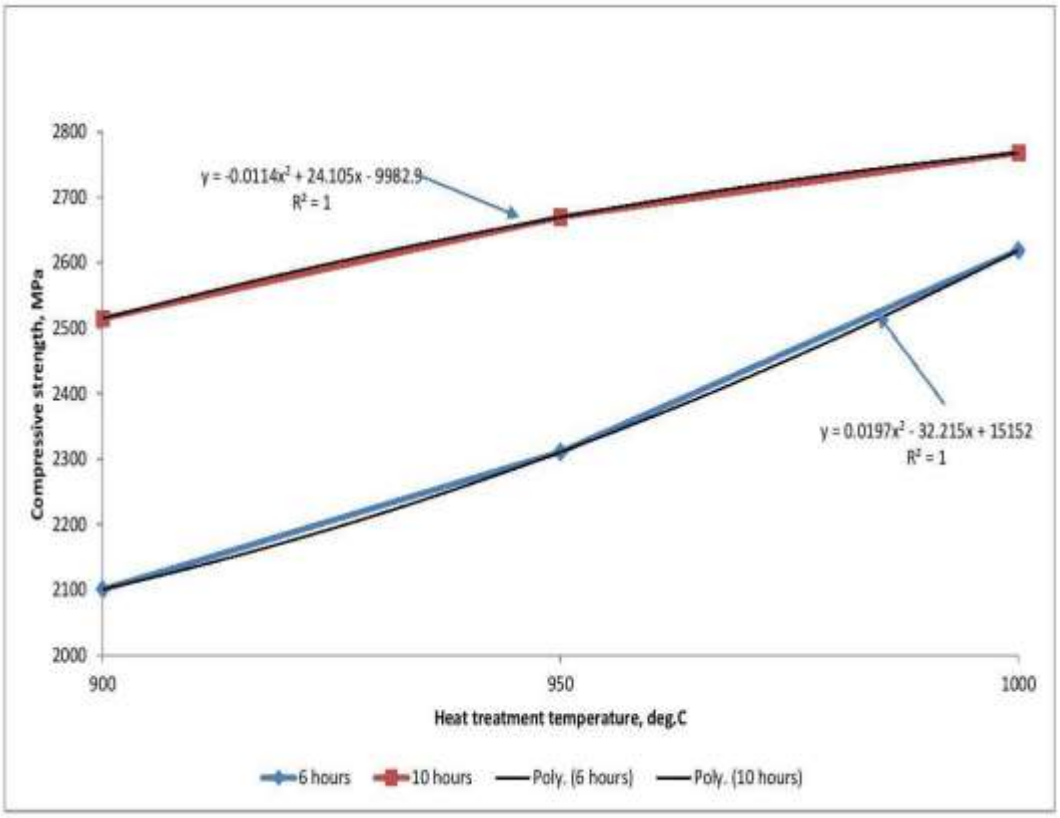

Figure 5.7: Variation of compressive strength with temperature as in influenced by soaking period of Alloy A1

References :

1. Metals HandBook, Vol.1, 9th edition, ASM, Metals Park, Ohio,1978, p. 3-9 & 75-96.

2. Angus, H.T., Cast Iron- Physical and Engineering Properties,Butterworths, London, 1976, p. 53, 161-253 and 286- 354.

3. INCO, Engineering Properties and Applications of Ni-Hard CastIrons, International Nickel Co., Inc., New York, 1978, p. 2-15.

4. Patwardhan, A.K., Singh, S.S., and Jain, N.C.; Tool and Alloy Steels, October 1987, p. 369-377.

5. Barton, R.; Special Cast Irons, Report No. 576, BCIRA Journal Nov.1960, Vol. 8, No.

6. Ohide, T., and Ohira, G.; British Foundry, Vol. 76, Part 1,January 1983, p. 9.

7. INCO.; Ni-Resist Austenitic Cast Irons – Properties and Applications, International Nickel Co., Inc., 1965, p. 1-21.

8. Stefanescu, D.M., Mitea, D., and Cracium, S.; AFS International Cast Metal Journal, June 1976, Vol. 1. No. 2, p. 19-26.

9. Battelle, B.L., Minkoff, I. And Mollard, F.; Editors, The Metallurgy of Cast Irons, Proc. of 2nd International Symposium,Geneva, Switzerland, May 1974, p. 29-31.

10. Henon, G.; Properties and Uses of Irons Alloyed with Nickel,Copper and Chromium, Foundry Trade Journal, March 1966, p.507-519.

11. Bansal A.K., M.E. Dissertation, 1999 Malviya Regional Engineering College, Jaipur, University of Rajasthan.

12. Srinivasan, T., M.E. Dissertation, University of Roorkee,Roorkee. 1975.13. Sharma, C.P., M.E. Dissertation, University of Roorkee,Roorkee. 1976.

14. Sudan, A.S., M.E. Dissertation, University of Roorkee, Roorkee.1976.

15. Singh, S.S.; Ph.D. Thesis, University of Roorkee, Roorkee.1981.

16. Internet address http://www.us.com.br

17. T.S. Skoblo, N.I. Sandler, V.K. Parfenyuk and B.S. Gilman, “Influence of Nb additions on properties of Cast Iron”, Russian casting production, 6 (1967), 306-307.

18. K.A. Valsov, Vetsnik Akad. Nauk SSSR, 1 (1960).

19. E. Pivovarsky, Hochwert Gussesien, Berlin, 1961.

20.Chaleur et industry, 3 (1935).

21. M.A. Tylkin, ”Strength and wear resistance of components for metallurgical equipments”, Moscow Metallurgizdat, (1965).

22 Li Shao-nan, “Effect of Nb on the Mechanical Properties of Grey Cast Iron”, FOUNDRY TECHNOLOGY, 4 (1999)

23.W.L. Guesser, "Private Report to CBMM on Dissolution of Standard Ferroniobium in Cast Iron", Industria de Fundição Tupy, Joinville, Brazil (1986).

24.S.A. Argyropoulos, “Dissolution characteristics of ferroalloys in liquid steel”, Proc. 41stElectric furnace conference, Detroit, 41 (1983), 81-93.