MECHANICAL BEHAVIOUR OF CRYOGENICALLY TREATED EN – 19 ALLOY STEEL

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ABSTRACT

This paper describes about the cryogenic treatment application to EN – 19 gear material to improve its mechanical behaviour. Experimental studies were conducted to determine the effect of cryogenic treatment on tensile behaviour of EN19 case carburised alloy steel. The material was case carburised and then deep cryo treated at -191^{0}C. The following tests were conducted to understand the mechanical behaviour of the EN-19 steel, they are tensile testing, hardness (Rockwell hardness C scale) and impact strength. The results have showed an increase in tensile strength with a compensation of impact strength also there was a considerable increase in hardness in case carburised and cryo treated compared to case carburised and un-treated steel material.

Keywords : Cryogenic treatment, alloy steel, retained austenite, mechanical behaviour.

I. INTRODUCTION

In the recent decades the application of cryogenic treated steels in the field of tool and die steel is predominant [1] in improving the wear resistance. In these steels the carbon percentage is high enough to respond to the cryogenic treatment (Figure 1). But in EN19 steel the percentage of carbon is only around 0.40 and do not respond to the cryogenic treatment directly. Therefore the alloy is case – carburised and then cryo treated. Case – carburising mainly facilitates in increase in carbon percentage in the case depth alone, which could respond to the cryo treatment. This is because the presence of retained austenite in the case alone. This retained austenite is transformed to Martensite during cryo treatment[2].

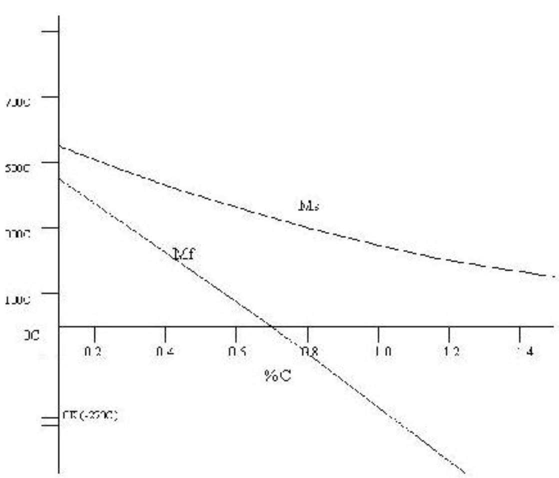

Figure 1[5]

II. LITERATURE SURVEY

A.Bensley et al. [2] studied the effect of cryogenic treatment of Case carburised 815M17 steel and reported that Deep cryogenic treatment greatly increased the tensile strength of the alloy, than the shallow and conventional heat treatments.

V.Manoj et al [3] conducted the effect of cryogenic treatment on rolling contact fatigue testing of EN353 steel. They found that steel with case carburised and deep cryo treated had higher life cycle than case carburised steel. Also the case carburised and deep cryo treated steel had lower impact strength than the untreated and case carburised steel.

P Sekar Babu et al. [4] studied the effect of cryogenic treatment of M1, EN19 and H13 Tool steels to improve the wear resistance. They reported that cryogenic treatment increased the wear resistance of these alloys. But they have not done case carburising for EN19 alloy steel.

III. EXPERIMENTAL DETAILS

Table 1 shows the nominal composition of the EN19 alloy used in this study.

C	Mn	Si	Cr	V	Mo	W	Fe
0.35	0.65	------	1.1	----	0.3	-----	Rem.

Table 1

The samples of size were prepared as per the IS standard 1608:1995 for tensile testing and tested in a universal testing machine. The tests were done on un-treated EN19, Case carburised EN19 and Case carburised and cryogenically treated EN19 specimens.

Five samples were tested and mean average of them were taken into account. Table 2 Shows the result of testing on various parameters.

The hardness test (Rockwell C scale) was conducted on a Rockwell hardness machine as per ASTM E-18 standard. The impact test (Izod) was conducted as per ASTM E23 standard. The results of hardness and impact are average of five trials. The samples were case carburised to a depth of 1mm and then cryo treated using liquid nitrogen at a temperature of -191^{o}C for a soaking period of 24hrs.

IV. RESULTS AND DISCUSSION

Stages of EN19 Steel	Tensile Strength (N/mm^2)	Percentage of Elongation	Hardness (case alone) HRC	Hardness (core alone) HRC	Impact Energy absorbed (Joules)
Un treated	1085.12	16%	------	34.5	14
Case Carburised	1171.24	0.8%	50.5	39	6
Case Carburised and Cryo treated	1330.59	1.0%	53.5	45.5	2

Table 2

From table 2 it is evident that there is an increase of tensile strength about 22.62% in cryo treatment and 7.94% increase in case carburised conditions respectively when compared to un-treated material. Further the hardness has also increased to 55% in cryo treated condition in the case region which was case hardened and has responded to cryo treatment. These results declare that the retained austenite in the case region has been converted to martensite.

The results of impact strength and percentage of elongation shows that the material has become more brittle due to deep cryogenic treatment. The material which was ductile in nature has transformed to brittle nature due to the formation of hard phase, martensite.

The microstructure of un-treated specimen reveals that there are no traces of retained austenite (figure 2). In case carburised condition there are traces of retained austenite in the case region for about 3-4% (figure 3). In cryo treated condition these retained austenite has been converted to finely distributed martensite in a ferrite matrix (figure 4).

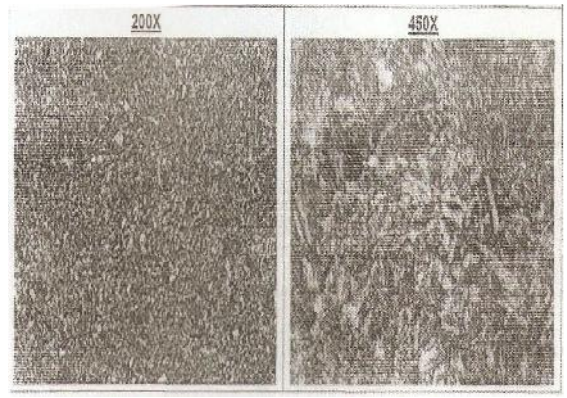

Figure 2

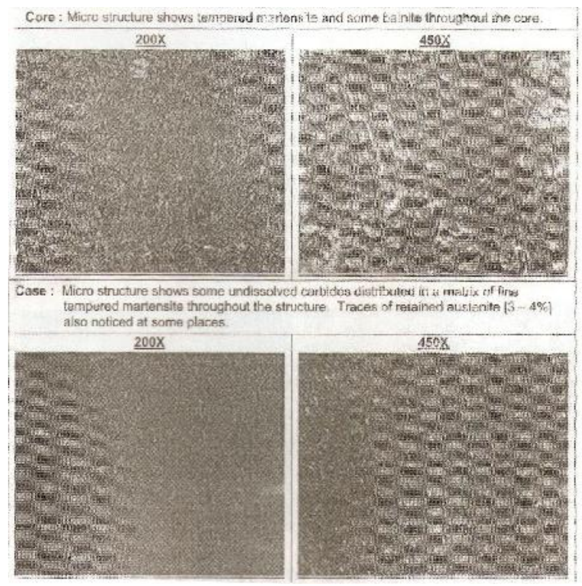

Figure 3

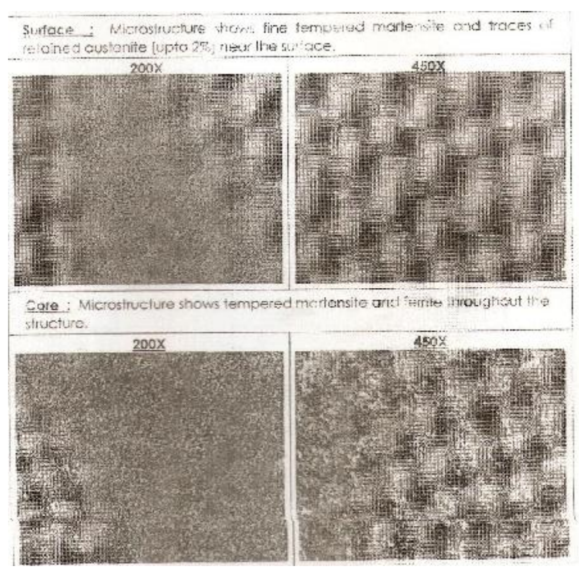

Figure4

V. CONCLUSION

It is evident that the results shows a good increase in tensile strength due to deep cryogenic treatment. But the material looses its ductility and becomes brittle which may not be suitable for handling impact loads.

Therefore depending upon the load applications it has to be determined whether cryogenic treatment is necessary for a particular steel.

VI. REFERENCES

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