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Effect of Case Hardening Treatment on the Structure and Properties of Automobile Gears

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***Abstract*:** *As my research concerned it is basically concentrate on "To study the effect of case hardening treatment on the structure and properties of automobile gears, which consist of carburizing process which is a case hardening process." 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, railway wheels. Comparative study of the following gears viz. grade of EN353, SAE8620 and 20MNCR5 are done in my research. The basic study in my research is Procedural study, Micro structure study, testing of hardness gradient of automobile gears.*

Keywords: *Hardness gradient, gears, defects, case depth, Defect, Microstructure,*

I. Introduction

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, martempering, 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, railway wheels. Comparative study of the following gears viz. grade of EN353, SAE8620 and 20MNCR5 are done in my research. The basic study in my research is Procedural study, Micro structure study, testing of hardness gradient of automobile gears.

II. Need Of Case Hardening Treatment

-In order to improve both the wear resistance and the fatigue strength of steel components under dynamic and thermal stresses.
-Makes the surface layer known as the case significantly harder than the residual material known as the core.
-Case hardness depth or the thickness of the hardened layer, is an important quality attribute of the case hardening process.

III. Purpose of Research Study

As there are various types of material are used for manufacturing of automobile gears viz.EN353, SAE8620, 20MNCR5. These material have different properties such as toughness, hardness, wear resistance, ductility etc. These properties are vary according to parameter of case hardening treatment on the temperature variation.

In order to improve the properties of these materials, we have to reduce the defect present in it at root level so that Gears will give the best performance while driving the vehicles.
There are various defects present in automobile gears and with this following parameter we can reduce them.

IV. Procedural Study

Heat treatment Procedure for EN353 Gear-

- CARBURISING:-
- Pack, salt or gas carburize at 910˚C, holding for sufficient time to develop the required case depth and carbon content.
- Slow cool from carburizing temperature and re-heat to 870˚C, hold until temperature is uniform throughout the section, quench as required in water, oil or air cool.

TEMPERING:

- Re-heat to 780˚C - 820˚C, hold until temperature is uniform throughout the section, and quench in oil.
- Temper immediately while still hand warm.
- Heat to 150˚C - 200˚C as required.
- Soak for 1 - 2 hours per 25mm of section, and cool in still air.

Heat treatment procedure for 20MnCr5 Gear:

- Carburizing process-Heating Gear up to 880^0 c
- Cycle Time – According to Case Depth required.
- Hardening Temp. -Drop Down to 850^0 c
- Oil Quenching
- Tempering-210^0C
- Hardness Testing
  -

Heat treatment procedure for SAE8620 Gear

- CARBURISING
- Pack, salt or gas carburize at 900˚C holding for sufficient time to develop the required case depth and carbon content.
- Slow cool from carburizing temperature and re-heat to 840˚C, hold until temperature is uniform throughout the section, quench as required in water, oil or air cool.

TEMPERING:

- Re-heat to 780˚C -820˚C, hold until temperature is uniform throughout the section, and quench in oil.
- Temper immediately while still hand warm.
- Heat to 150˚C -200˚C as required.
- Soak for1-2 hours per 25mm of section, and cool in still air.

V. Microstructure Study

Inclusion rating test

EN353 Gear

Inclusion type	Sulphide type (A)		Alumina type (B)		Silicate type (C)		Oxide type (D)	
	Thin	Heavy	Thin	Heavy	Thin	Heavy	Thin	Heavy
Rating	.5	.5	.5	0	.5	0	.5	.5

20MNCR5 Gear

Inclusion type	Sulphide type (A)		Alumina type (B)		Silicate type (C)		Oxide type (D)	
	Thin	Heavy	Thin	Heavy	Thin	Heavy	Thin	Heavy
Rating	.5	.5	.5	.5	.5	0	1	1

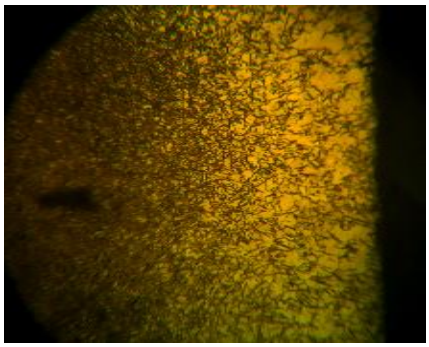
SAE8620Gear

Inclusion type	Sulphide type (A)		Alumina type (B)		Silicate type (C)		Oxide type (D)	
	Thin	Heavy	Thin	Heavy	Thin	Heavy	Thin	Heavy
Rating	.5	.5	.5	.5	0	0	.5	.5

- Inclusion ratings are within the desired limit of EN353, 20MNCR5, SAE8620 Grade

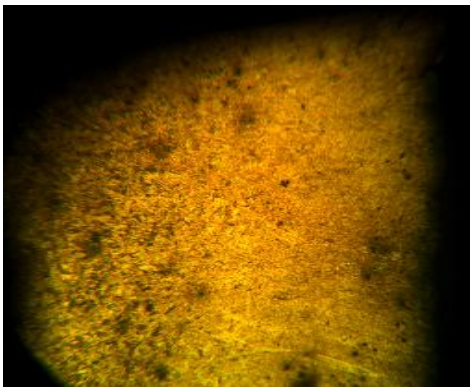
VI. Metallurgical Analysis of Gear

EN353 GEAR



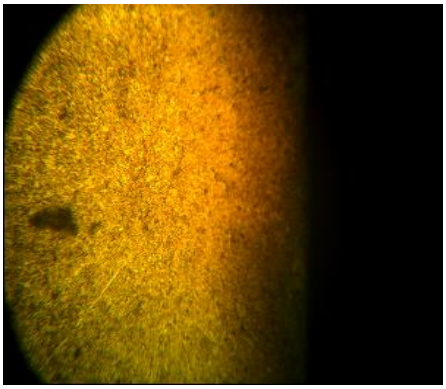
4 % Nital etched sample shows carburizing case depth Upto 0.6 mm at 500X magnification range.

20MNCR5 GEAR



4 % Nital etched sample shows carburizing case depth Upto 0.8 mm at 500X magnification range.

SAE8620 GEAR



4 % Nital etched sample shows carburizing case depth Upto 0.7 mm at 500X magnification range.

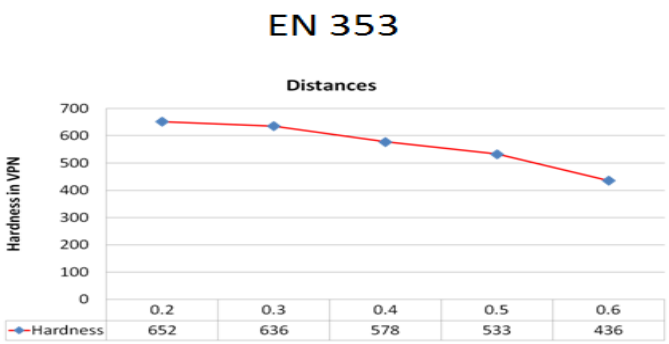
- Microscopic examination relieved the fact that there exists the amount of retained austenite along with the martensite.

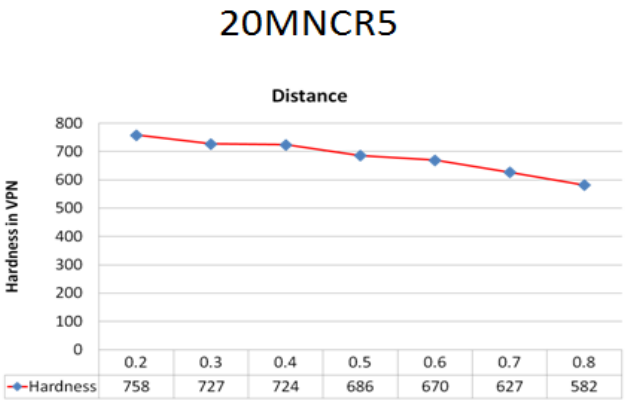
VII. Testing Of Hardness Gradient

Micro-Vickers hardness test:

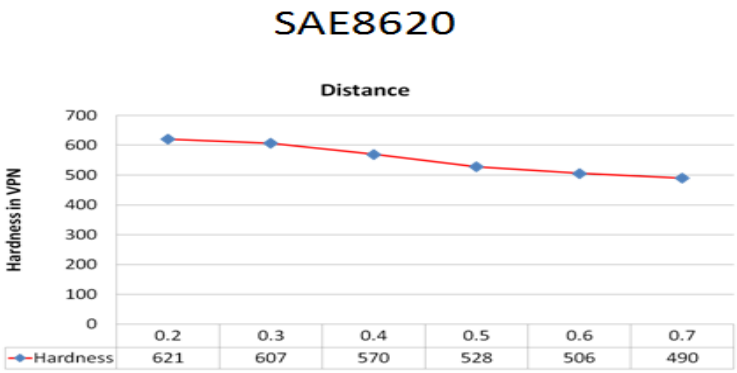
Sr No.	Sample ID	Distance	Hardness in VPN
1	EN353 GEAR	0.2	652
		0.3	636
		0.4	578
		0.5	533
		0.6	436

- Hardness gradient values shows in EN353 Grade sudden drop at the case depth 0.6mm.This is due to less amount of chromium.





Sr No.	Sample ID	Distance	Hardness in VPN
1	20MNCR5 Gear	0.2	758
		0.3	727
		0.4	724
		0.5	686
		0.6	670
		0.7	627
		0.8	582



Sr No.	Sample ID	Distance	Hardness in VPN
1	SAE8620 Gear	0.2	621
		0.3	607
		0.4	570
		0.5	528
		0.6	506
		0.7	490

VIII. Conclusion

- Inclusion ratings are within the desired limit of EN353, 20MNCR5, SAE8620 Grade.
- Microscopic examination relieved the fact that there exists the amount of retained austenite along with the martensite.
- Retained austenite in EN353 is more thanSAE8620, 20MNCR5 due to higher hardening temperature.
- Hardness gradient values shows in EN353 Grade sudden drop at the case depth0.6mm. This may be due to less amount of chromium.

Referance

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