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Effect of Induction Hardening on Microstructure and Hardness of Helical Gear

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Abstract— Vehicles with engine characteristics that can produce large torque can provide acceleration to the vehicle. Gear is one of the components of a vehicle engine in the transmission system that functions to transmit power from the driveshaft to the shaft that will be driven. One of the good heat treatment types for gears is surface hardening. For hardening gears, many IKM have limited ability. One of the hardening tools that can be used by IKM is an induction heating device. IKM still does not provide good hardening parameter data for tilt gears, in which cases some important parameters to be examined are the number of turns and the output flow. From the results of the hardening of the inclined gear surface used induction heating machine with a static method that has been successfully carried out by varying the parameters of the heating time, the number of coil windings and the output current. The temperature during the surface hardening process affects the phase change from ferrite-pearlite to martensite. While the heating time and frequency will affect the formation of the thickness of the hard layer on the surface of the gear specimen. To obtain the best testing parameters, namely Induction hardening on specimens of 4 gears using 3 coils obtained a measured frequency of 29 kHz, maximum output current position of 1200 A with heating time for 32 seconds, the cooling medium is quenchant oil and the maximum hardness value of 1561 HV is obtained.

Index Terms— Automatic Motorcycle, Chamshaft, Material Characterization, Surface Hardening.

1 INTRODUCTION

A car is a transportation tool that is needed right now to make it easy to do daily activities for those who are mostly outside and always move around to different places. This results in the need for vehicles with engine characteristics that are ca-pable of producing large torque to be able to provide acceler-ation to the vehicle.

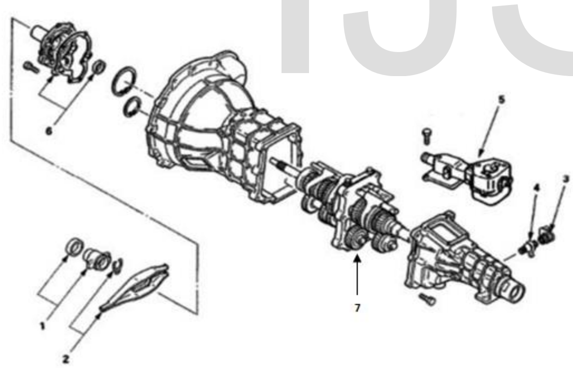

Fig 1. Transmission system components

Figure 1 shows the Transmission system components. Gear is one of the engine components in the transmission system that serves to carry the power from the driveshaft to the shaft that will be driven. The power is transferred through the contact rolling process between two surfaces of gears. As a result, of the transfer of power in the form of a very large torque will have enough emergence of pressure on the contact surface between the two gear surfaces of the gear.

This study aims to perform surface hardening techniques using an induction heating device with a static method on helical gears of P20 equivalent material. Determine the effect of induction hardening treatment with variations in the number of turns of 2 and 3 coil and 850A and 1200A put out currents on helical gear specimens. Analyzing the distribu-tion and thickness of the hardening of the gears after induc-tion hardening. Analyzing changes in the microstructure of the helical gear specimens before and after treatment.

2 RESEARCH METHODOLOGY

The test specimen in this study is an helical gear as shown in Figure 2.

Fig 2. Helical gear

In this study, the material used was ASTM 681 equivalent to AISI P20. In this study, using four helical gears made with a milling machine. Hardness and micro-structure tests were carried out on the specimens before induction hardening. The hardening process on the gears is hardening with induction surface hardening to harden only the surface of the teeth. The fixed variable is quenchant (cooling) using oil. the independent variable uses the output current are 850A and 1200A and coil 2 and 3 windings. The next step is characterization of hardening specimen using hardness and microstructure testing.

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3 Results

3.1 . Material Composition

Table 1
Material Composition of Helical Gear

Elements	C	Si	Cr	Mo	Mn	Ni	Fe
Contents (%)	0.42	0.29	1.95	0.21	1.32	0.94	94.5

In Table 1 the result obtained of C content of 0.42%, with Si content of 0.29%, Mn of 1.32%, Cr of 1.95% and Mo of 0.21%. Thus, it can be concluded that the gear material is low alloy steel which can be defined as ASTM 681 type P20. The equipment used to test the chemical composition in this study is the ARL Optic Emission Spectrometer, the type of machine is the TXC03 spectrotest. The chemical composition test was carried out at the Industrial Laboratory UPTD Tegal Regency - Central Java..

3.2 Hardness

Table 2
Hardness test result on gear specimen

No	Depth (mm)	Hardness (HV)			
		Gear 1	Gear 2	Gear 3	Gear 4
1	2	609	685	888	1472
2	4	582	691	857	1365
3	6	631	794	794	1264
4	8	621	760	728	1245
5	10	456	722	825	1338
6	12	457	624	670	1561
7	14	575	628	696	1202

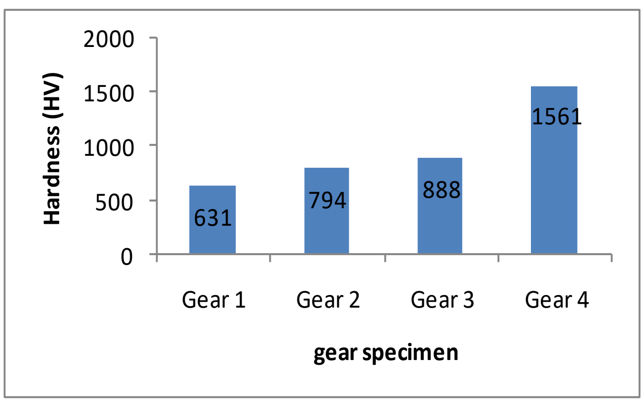

Fig 5. Comparison of the hardness test on gear specimen

Base on Figure 5, induction hardening process can produce hardness of up to 1561 HV shown by gear specimen 4. While the lowest hardness is 631.3 HV shown by gear specimen 1.

3.3 Microstructure

This test is carried out to see the microstructure formed in the gears specimens that have been heated using the surface treatment induction hardening process. The image captured by an optical microscope shows that the martensite phase has formed on the surface of the specimen through the martenisite strengthening process.

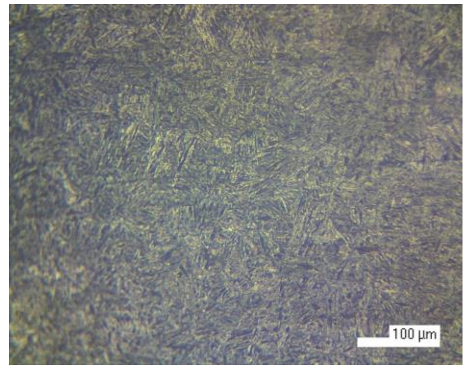

Fig 6. Micro photographs on gear specimens with a 200x magnification of 2 mm distance

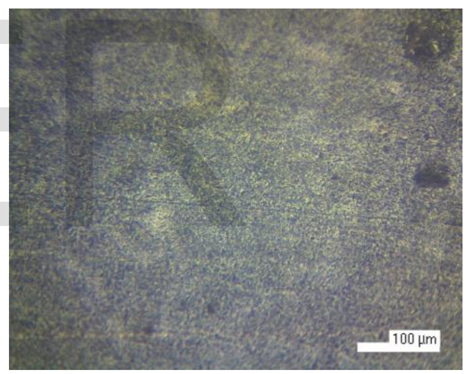

Fig 7. Micro photographs on gear specimens with a 200x magnification of 10 mm distance

4. Conclusion

From the analysis of microstructure and hardness on the inclined gear surface hardening results using induction heaters, it can be concluded that induction heaters are strongly influenced by factors of heating time, frequency and temperature. The temperature during the surface treatment process affects the phase change from ferrite-pearlite to martensite. While the heating time and frequency will affect the formation of the thickness of the hard layer on the surface of the gear specimen. The hardness value generated by the induction hardening process is very high on the surface and tends to decrease in the hardness value on the inside of the specimen.

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To obtain the best testing parameters, namely Induction hardening on specimens of 4 gears using 3 coils obtained a measured frequency of 29 kHz, maximum output current position 1200 A. heating time for 32 seconds, the cooling medium is quench oil and a maximum hardness value of 1561 HV is obtained.

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