

UNIVERSITI TEKNOLOGI MARA

**OPTIMIZATION AND
TRIBOLOGICAL PROPERTIES OF
SEMI METALLIC FRICTION
MATERIALS**

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Thesis submitted in fulfillment
of the requirements for the degree of
Doctor of Philosophy

Faculty of Mechanical Engineering

January 2017

ABSTRACT

The main goal of this work presented in this thesis was to study the tribological properties of newly formulated semi-metallic friction material under different manufacturing parameters, material constituents and friction test parameters. In the first category, the optimization of manufacturing parameters (molding pressure, molding temperature and molding time) for producing the friction materials using powder metallurgy technique were investigated. The optimum manufacturing parameters were determined using Taguchi method where coefficient of friction (COF) and thickness loss were selected as the quality target. These optimal parameters were 500 kN molding pressure, 150°C molding temperature, and 600 seconds molding time. The results revealed that high molding pressure and temperature do not compulsorily produce the best performance in tribological properties. It could be explained by degradation of the resin structure and the loss of binding properties. The investigation also found that adequate molding time was required for sufficient binding of the tested materials. It was also observed that molding pressure has the strongest effect on physical and tribological properties. High molding pressure may cause the binder to separate from the brake friction material, thus less binder to hold the powder particles in the matrix. In the second category, a study was performed to investigate the effect of phenolic resin, rubber, calcium carbonate and graphite on the tribological properties. The samples were prepared under optimum manufacturing parameters. Samples with 15 wt.% of phenolic resin, 3 wt.% of graphite, 2 wt.% of rubber, 15 wt.% of calcium carbonate, 20 wt.% of steel fiber, 10 wt.% of ceramic fiber, 5wt.% of iron powder, 10 wt.% of copper chip, 8 wt.% of iron oxide, 8 wt.% of friction dust, 3 wt.% of magnesium oxide and 1 wt.% of barium sulphate were the optimum friction material formulation combination which shown the best tribological properties. Through this study, phenolic resin has the greatest influenced on the tribological properties of brake friction materials. Finally, the effect of applied loads and braking times on the tribological characteristics on indigenously formulated brake friction materials were also investigated using Chase dynamometer. Friction and wear tests were carried out under six different loads (445, 890, 1335, 1780, 2225 and 2670 N) and braking times (4, 8, 12, 16, 20 and 24 minutes) while the rotating velocity of the disc was kept constant at 500 rpm during the tests. The brake friction materials were examined for microstructural changes on worn surface using Scanning Electron Microscope (SEM). Generally, it was observed that COF decreases while wear volume increases with increasing of applied loads and braking times. The optimized friction material was observed to be suitable for temperature up to 250°C, load up to 1335 N and continuous braking time less than 20 minutes. An increase in wear volume was corresponding to the microstructural changes and the decomposition of organic materials. The severity of wear mechanism increases with an increasing of applied load and braking time. Test results show that the optimum selection of the manufacturing parameters and materials formulation have the most impact on the tribological and performance characteristics.

ACKNOWLEDGMENTS

"All praises and thanks to ALLAH"

I would like to express my sincere gratitude to my supervisors, Professor Ir. Dr. Mohamad Noor Berhan and Associate Professor Dr. Talib Ria Jaafar for their valuable guidance, support and encouragement throughout this research work.

Great thanks for Universiti Teknologi MARA for providing me financial support for this research. Also, I would like to express my gratitude to the Faculty of Mechanical Engineering, Universiti Teknologi MARA.

I would also like to express my appreciation to the staff in the Advanced Research Centre (AMREC), SIRIM Bhd for their co-operation, technical assistance and valuable contribution to my work. The assistance from the staff of the Material Science Laboratory, FKM, UiTM is also acknowledged.

Finally, my deepest gratitude goes to my beloved husband, Ir. Hadzri bin Abdul Hamid, my children; Afrina Fatini, Muhammad Hafiz Irfan, Muhammad Hafizuddin and Aisyah Humaira for their patience and understanding all these years. This work is also dedicated to my family whose support has been endless during a long period of my studying and especially my parents who have tried their best providing me with the best education.

MAY ALLAH BLESS ALL OF US, AMIN...

THANK YOU.

Aznifa Mahyam Zaharudin
Penang, Malaysia.
2017

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