Optimized Nanolubricant for Friction Reduction

M.I.H.C. Abdullah[1], M.F.B. Abdollah[1*], H. Amiruddin[1], N.R. Mat Nuri[1]

[1]Center of Advanced Research on Energy, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Melaka, Malaysia

[*]Corresponding author for mohdfadzli@utem.edu.my

1. Introduction

In Malaysia, capability of nanoparticles as lubricating oil additive to improve the performance of diesel engine oil has not yet been studied extensively. Therefore, this paper presents the experimental results for conventional diesel engine oil enriched with optimized nanoparticles

2. Experimental procedure

Based on design of experiment (DOE) through Taguchi method of L_9 orthogonal array (Table 1), nanolubricant samples were prepared using various fractions of hexagonal boron nitride (HBN) and alumina (Al_2O_3) nanoparticles. The samples were stabilized only with addition of an appropriate amount of surfactant.

The tribological testing of nanolubricants was performed using four-ball tester according to ASTM D4172.

The results were analyzed using analysis of signal-to-noise (SN) ratio and analysis of variance (ANOVA) for determining optimal values for low coefficient of friction (COF) and quantitatively measured the significance of all main factors.

Table 1 L_9 orthogonal arrays design by Taguchi method

Sample	Factors		
	Alumina (vol%)	HBN (vol%)	Surfactant (vol%)
1	0	0	0
2	0	0.05	0.1
3	0	0.5	0.3
4	0.05	0	0.1
5	0.05	0.05	0.3
6	0.05	0.5	0
7	0.5	0	0.3
8	0.5	0.05	0
9	0.5	0.5	0.1

3. Results and discussion

A greater SN ratio value corresponds to a better performance (low COF). From Fig. 1, the COF is decreases with decreasing Al_2O_3 content and increasing HBN content. On the other hand, surfactant does not have a significant effect on COF. The increases in COF can be caused by Al_2O_3 nanoparticles making tiny grooves on the surface. Meanwhile, increasing HBN can make a protective film to some extent by coating the rough friction surfaces to achieve low COF [1].

However, from ANOVA, Al_2O_3 and surfactant have bigger contribution or greater influence on the mean of means compared to mean of SN ratio. It means that the optimum value of HBN was taken from the response of mean of SN ratio, while the optimum value of Al_2O_3 and surfactant was taken from response of mean of means. By using the optimized values of 0.5 vol% HBN and 0.3 vol% surfactant, COF decreased by 12%~33% compared to conventional diesel engine oil as shown in Fig. 2.

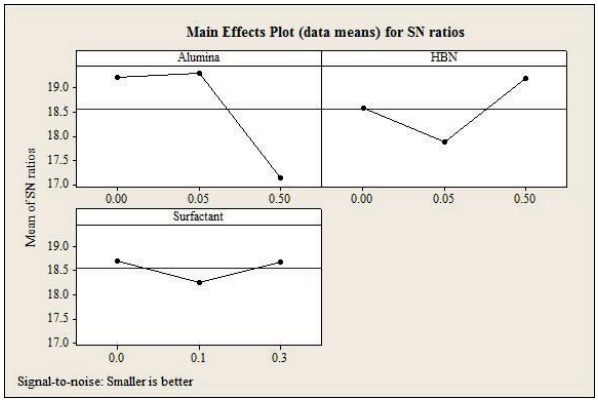

Fig.1 Effect of main factors on COF

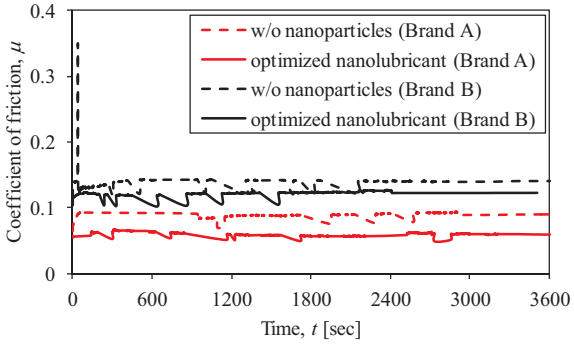

Fig.2 COF with and without nanoparticles additives

4. Conclusion

From the statistical analysis using SN ratio and ANOVA, the COF is decreases with increasing HBN content in conventional diesel engine oil. The optimized values of 0.5 vol% HBN and 0.3 vol% surfactant decreased COF by 12%~33% compared to conventional diesel engine oil.

5. References

[1] Lee, K., Hwang, Y., Cheong, S., Choi, Y., Kwon, L., Lee, J. ans Kim, S.H., "Understanding the role of nanoparticles in nano-oil lubrication," Tribol Lett. 35, 2009, 127-131.