TUGAS AKHIR

PENGUJIAN SIFAT TRIBOLOGI PADA PELUMAS BERBASIS AIR DENGAN ZAT ADITIF *MULTI-WALLED CARBON NANOTUBES* (MWCNTs) DAN *IONIC LIQUID*

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ABSTRACT

The rapid development of modern technology requires mechanical systems that are efficient, reliable, and durable; however, friction and wear remain significant factors that decrease performance and increase maintenance costs. Mineral oil-based lubricants have long been widely applied due to their favorable lubrication properties, but their poor biodegradability generates negative environmental impacts, creating the need for more sustainable alternatives. One promising option is the Water Based Lubricant (WBL), although its effectiveness in reducing friction and wear remains relatively limited. To improve its performance, the addition of ionic liquid (IL), Carboxymethyl Cellulose (CMC), and Multi-Walled Carbon Nanotubes (MWCNTs) has been proposed, since these additives exhibit excellent thermal and chemical stability and are capable of forming a protective tribofilm on metal surfaces, thereby lowering the coefficient of friction and slowing down the wear rate. The objective of this study is to investigate the effect of IL, CMC, and MWCNTs addition into WBL on tribological behavior, focusing on the coefficient of friction and wear rate, and to compare the results with WBL without additives. The experimental method involved mixing deionized water with 0.35 wt% IL, CMC, and MWCNTs, followed by testing using a pin-on-disc tribometer in accordance with ASTM G99 standards under a constant load of 25 N with rotational speeds of 557 and 2886 rpm. The results show that the addition of IL, CMC, and MWCNTs effectively improves lubrication performance. At a rotational speed of 557 rpm, the coefficient of friction decreased by 69.8% and the wear rate was reduced by 37.5%. Meanwhile, at 2886 rpm, the coefficient of friction decreased by 59.4% and the wear rate decreased by 38.4%. In addition, surface morphology observations revealed that the wear track produced by MWCMIL was smaller compared to WBL, indicating enhanced tribological performance of the water-based lubricant.

Keywords: Water Based Lubricant, Ionic Liquid, CMC, MWCNTs, Friction Coefficient, Wear Rate, Tribology, Pin-on-Disc.

ABSTRAK

Perkembangan teknologi modern menuntut adanya sistem mekanis yang efisien, andal, dan memiliki umur pakai panjang, namun gesekan serta keausan masih menjadi faktor utama dapat menurunkan kinerja dan meningkatkan biaya pemeliharaan. Selama ini, pelumas berbasis minyak mineral banyak digunakan karena memiliki sifat pelumasan baik, tetapi sifatnya sulit terurai secara alami menimbulkan dampak negatif terhadap lingkungan sehingga diperlukan alternatif pelumas lebih ramah lingkungan. Salah satu opsi menjanjikan adalah Water Based Lubricant (WBL), meskipun kinerjanya dalam mengurangi gesekan dan keausan masih terbatas. Untuk meningkatkan efektivitasnya, penambahan aditif berupa **i**onic liquid (IL), Carboxymethyl Cellulose (CMC), dan Multi-Walled Carbon Nanotubes (MWCNTs) dapat digunakan, karena memiliki kestabilan termal dan kimia tinggi serta kemampuan membentuk lapisan pelindung (*tribofilm*) pada permukaan logam sehingga mampu menurunkan koefisien gesek sekaligus memperlambat laju keausan. Penelitian ini bertujuan untuk menganalisis pengaruh penambahan IL, CMC , dan MWCNTs pada WBL terhadap sifat tribologi, khususnya koefisien gesek dan laju keausan, serta membandingkannya dengan WBL tanpa aditif. Metode penelitian dilakukan dengan mencampurkan air deionisasi dengan 0,35 wt% IL, CMC dan MWCNTs, kemudian diuji menggunakan tribometer tipe *pin on disc* sesuai standar ASTM G99 dengan beban konstan 25 N dan variasi kecepatan putar 557 rpm serta 2886 rpm. Hasil penelitian menunjukkan bahwa penambahan IL,CMC,dan MWCNTs efektif dalam meningkatkan kemampuan pelumasan. Pada kecepatan putar 557 rpm, Nilai koefisien gesek mengalami penurunan sebesar 69,8% dan laju keausan berkurang sebesar 37,5%. Sementara itu, pada kecepatan 2886 rpm, koefisien gesek menurun sebesar 59,4% dan laju keausan turun sebesar 38,4%. Selain itu, hasil observasi permukaan keausan menunjukkan bahwa jejak keausan pada pelumas MWCMIL lebih kecil dibandingkan WBL.

Kata kunci: *Water Based Lubricant, Ionic Liquid, CMC*, *MWCNTs*, Koefisien Gesek, Laju Keausan, *Tribologi, Pin on Disc*