

COLD FLOW AND STABILITY PROPERTIES ANALYSIS OF B40 BIODIESEL WITH ETHANOL AND TURPENTINE OIL BLENDS

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ABSTRACT

Cold flow and stability properties analysis of B40 biodiesel with ethanol and turpentine oil blends was conducted. The research was intended to analyze the effect of low content ethanol and turpentine oil addition to cold flow properties and oxidation stability properties of B40, determine the optimum composition of B40-ethanol-turpentine oil ternary blends with the best cold flow and stability properties, and study the interaction between ethanol and turpentine oil as a B40 biodiesel blends cold-flow improver (CFI). The research was started with the characterization of the pure samples and the preparation of B40 fuel. Experiment design optimization using response surface methodology (RSM) was conducted next and the summarized experimental ternary blend formulations runs were prepared. The 13 formulation blends were then verified its content and tested its cloud point, cold filter plugging point, filter blocking tendency, precipitation, and oxidation stability. The responses obtained from all parameter testing were analyzed using ANOVA and the optimization of the ternary blend was conducted. The optimized blend was then tested by differential scanning calorimetry (DSC), compared to the pure and binary blends, and the mechanism of improving cold flow properties was analyzed.

The CFI formulation was achieved at a 0.59 % v/v ethanol concentration and a 10 % v/v turpentine oil concentration, according to the results. Because the experimental values were found to be in good agreement with the projected values (accuracy 91 %), the results demonstrated that it was possible to predict the five response parameters using models developed by RSM. Even though the B40 ideal ternary blend showed an increase in oxidation stability as expected since oxidation stability opposed cold flow properties, the result was still satisfied the requirements from the Indonesian government. The combination of ethanol and turpentine inhibited excessive wax crystallization at low temperatures in a synergistic manner, making it an attractive choice for addition to a B40 biodiesel blend.

Keyword: B40 fuel, cold flow improver, ethanol, response surface methodology, turpentine oil

ANALISIS SIFAT ALIR DINGIN DAN STABILITAS BIODIESEL B40 DENGAN CAMPURAN ETANOL DAN MINYAK TERPENTIN

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INTISARI

Analisis sifat alir dingin dan stabilitas biodiesel B40 dengan campuran etanol dan minyak terpentin telah dilakukan. Penelitian ini bertujuan untuk menganalisis pengaruh penambahan etanol dan minyak terpentin kadar rendah terhadap sifat aliran dingin dan sifat stabilitas oksidasi B40, menentukan komposisi optimum campuran terner minyak B40-etanol-terpentin dengan sifat aliran dingin dan stabilitas terbaik, dan mempelajari interaksi antara etanol dan minyak terpentin sebagai biodiesel B40 yang memadukan *cold-flow improver* (CFI). Penelitian diawali dengan karakterisasi sampel murni dan persiapan bahan bakar B40. Optimasi desain eksperimen menggunakan *response surface methodology* (RSM) dilakukan selanjutnya dan ringkasan formulasi campuran terner eksperimental disiapkan. Sejumlah 13 campuran formulasi tersebut kemudian diverifikasi kandungannya dan diuji titik kabut, titik penyumbatan filter dingin, kecenderungan pemblokiran filter, presipitasi, dan stabilitas oksidasi. Respon yang diperoleh dari seluruh pengujian parameter dianalisis menggunakan ANOVA dan dilakukan optimasi campuran terner. Campuran dengan komposisi optimum kemudian diuji dengan *differential scanning calorimetry* (DSC), dibandingkan dengan campuran murni dan biner, dan mekanisme peningkatan sifat aliran dingin dianalisis.

Menurut hasil riset, formulasi CFI dicapai pada konsentrasi etanol 0,59 % v/v dan konsentrasi minyak terpentin 10 % v/v. Nilai eksperimen ditemukan sesuai dengan nilai yang diproyeksikan dengan akurasi 91% berhasil menunjukkan bahwa lima parameter respons dapat diprediksi menggunakan model yang dikembangkan oleh RSM. Meskipun campuran terner ideal B40 menunjukkan peningkatan stabilitas oksidasi seperti yang diprediksikan karena sifat stabilitas oksidasi berlawanan dengan sifat aliran dingin, hasilnya masih memenuhi persyaratan pemerintah Indonesia. Kombinasi etanol dan terpentin menghambat kristalisasi *wax* berlebihan pada suhu rendah secara sinergis, menjadikannya kandidat yang menjanjikan untuk ditambahkan pada campuran biodiesel B40.

Kata kunci: bahan bakar B40, *cold flow improver*, etanol, minyak terpentin, respon permukaan metodologi.