THE EFFECTS OF SPRAY ATOMIZATION BY USING BLENDED ALUMINA OXIDE ,TITANIUM OXIDE, AND CERIUM OXIDE NANO PARTICLES WITH DIESEL FUEL IN DIRECT INJECTION ENGINE

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I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang Al-Sultan Abdullah or any other institutions.

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ABSTRAK

Pelbagai kajian telah dijalankan dalam dekad yang lalu untuk mencari bahan api alternatif yang dapat mengurangkan masalah alam sekitar yang disebabkan oleh bahan api diesel. Satu kajian terdahulu telah menunjukkan bahawa bahan api diesel berpenambahbaikan nano adalah alternatif yang boleh digunakan. Walau bagaimanapun, kajian mengenai sifat fizikal dan ciri semburan bahan api diesel berpenambahbaikan nano masih terhad. Tujuan kajian ini adalah untuk mengkaji parameter semburan makroskopik seperti panjang penetraan semburan dan sudut kon diesel nano yang berbeza seperti DFAL (bahan api diesel alumina), DFTI (bahan api diesel Titanium), dan DFCE (bahan api diesel cerium) pada kepekatan 25, 50, dan 75 bahagian per juta (ppm). Sifat semburan ini dikaji menggunakan kamera berkelajuan tinggi dalam keadaan statik berterusan dengan kaedah bayangan. Eksperimen dijalankan pada suhu bilik dengan menggunakan tekanan suntikan 50, 80, dan 100 MPa. Gambar bahan api ujian diolah dengan program penyuntingan gambar da-Vinci dan ImageJ. Getaran ultrasonik digunakan sebagai pendekatan penstabilan eksperimen ini. Selain itu, absorbans puncak nanocecair, hubungan antara kepekatan dan absorbans, tempoh sonikasi optimum, dan data sedimentasi yang bergantung pada masa digunakan untuk mengkaji kestabilan bahan api. Absorbans bagi ketiga-tiga dos tersebut menurun berbanding dengan absorbans asal tetapi masih berkekalan lebih daripada 80% dalam masa 200 jam. Apabila kepekatan diperbaiki pada 25 ppm sambil mengubah tekanan, didapati bahawa dispersi yang lebih baik berlaku disebabkan oleh peningkatan kuasa pemacu, dengan itu, penembusan hujung semburan yang lebih baik (STP), dan sudut kon semburan (SCA), sebagai contoh, DFTI jarak awal meningkat sebanyak 30% pada 27.25 mm dalam 0.1 ms dan masa pecahan 0.3 ms lebih cepat daripada diesel tulen D100 pada 80 MPa. Ia diikuti oleh DFAL dan DFCE pada masa pecahan 0.4 ms pada jarak 26.51 mm dan 44.3 mm dari 0.1 ms. Dalam hal peningkatan kepekatan, dapat diringkaskan bahawa peningkatan nanopartikel membantu prestasi proses atomisasi; bagaimanapun, mencapai kepekatan yang lebih tinggi, seperti 100 ppm, bukan pendekatan yang sesuai kerana ia memberi kesan kepada sifat fizikal bahan api, yang mencerminkan pada nanopartikel cerium DFCE, yang mencapai nilai yang tidak baik berbanding dengan kepekatan nano 50 ppm di semua tekanan suntikan 50, 80, dan 100 MPa yang mencukupi untuk membolehkan bahan api atomisasi. Kesimpulannya, peningkatan tekanan meningkatkan interaksi bahan api nano dengan persekitaran sekitar, menyebabkan penembusan yang lebih tinggi berbanding dengan diesel tulen kerana dispersi semburan yang lebih baik. Berkenaan dengan sudut kon, bahan api nano sama dengan diesel tulen tetapi mempunyai penembusan yang lebih baik. Selain itu, penemuan menunjukkan bahawa peningkatan tekanan suntikan menghasilkan penembusan yang lebih besar. Pada masa yang sama, masa pecahan semburan menjadi lebih rendah dengan bahan api berpenambahbaikan nano. Campuran bahan api ini berkelajuan lebih baik dan teratomisasi lebih cepat daripada diesel tulen, yang mengambil masa yang terlalu lama untuk sampai ke tepi dinding. Akibatnya, bahan api tidak teratomisasi dengan baik, menyebabkan diesel memasuki dengan terlalu perlahan dan sudutnya meningkat secara drastik. Apabila menggunakan kaedah suntikan terbelah, peningkatan tekanan secara signifikan mempengaruhi aspek makroskopik semburan. Tekanan yang lebih tinggi padabahan api yang disuntik secara umum meningkatkan interaksi bahan api nano dengan persekitaran sekitar, menghasilkan penembusan yang lebih besar berbanding dengan diesel tulen kerana dispersi semburan yang lebih baik

ABSTRACT

Various studies have been undertaken over the previous decades to locate an alternative fuel that can reduce the environmental issues caused by diesel fuel. A previous study has indicated nano-enhanced diesel fuels as viable diesel fuel alternatives. However, research on nano-enhanced diesel fuel's physical properties and spray characteristics is sparse. The goal of this study was to look at the macroscopic spray parameters like spray penetration length and cone angle of different nano diesel fuels like DFAL (alumina diesel fuel), DFTI (Titanium diesel fuel), and DFCE (cerium diesel fuel) at concentrations of 25, 50, and 75 parts per million (ppm). The spray properties were explored using a high-speed camera in continuous static situations by shadowgraph methods. Experiments were carried out at room temperature using 50, 80, and 100 MPa injection pressures. The images of the test fuels are handled with the picture editing programs da-Vinci and ImageJ.Ultrasonic vibration served as the experiment's stabilizing approach. Furthermore, the peak absorbance of the nanofluid, the connection between concentration and absorbance, the optimal sonication period, and time-dependent sedimentation data were used to study fuel stability. All three doses' absorbances declined when compared to their original absorbances but remained more than 80% stable over 200 hours. Fixing the concentration at 25 ppm while varying the pressure shows that a better dispersion occurs due to the increase of the power of the injector, therefore, better spray tip penetration (STP), and spray cone angle (SCA), for example, DFTI initial distance increased by 30% at 27.25 mm in 0.1 ms and breakup time of 0.3 ms faster than the neat diesel D100 at 80 MPa. They were followed by DFAL and DFCE at break up time of 0.4 ms at a distance of 26.51 mm and 44.3 mm from 0.1 ms. In terms of increasing concentration, it can be summarized that increasing nanoparticles aids the perdormance of the atomization process; however, reaching higher concentrations, such as 100 ppm, is not a suitable approach because it affects the physical properties of the fuel, which reflect on cerium nanoparticle DFCE, which achieves poor values compared to where using 50 ppm nano concentration at all injection pressures of 50,80, and 100 MPa are sufficient to allow the fuel to atomize. To summarize, increasing pressure increased the interaction of the nano fuel with the surrounding environment, resulting in more penetration than pure diesel due to improved spray dispersion.Regarding cone angle, the nano fuel is identical to the neat but has superior penetration.Furthermore, Findings indicate that increasing injection pressure leads to greater penetration. While lowering breakup time, which was greater with the nano-enhanced fuel. The fuel blend was better and atomized faster than the neat diesel, which took too long to reach the edge of the wall. As a result, the fuel did not atomize equally, leading the diesel to enter too slowly and the angle to rise drastically. When using the split injection method, raising the pressure substantially influenced the macroscopic aspects of the spray. Higher pressure of the injected fuel in general increased the interaction of the nano fuel with the surrounding environment, resulting in greater penetration compared to neat diesel due to improved spray dispersion.

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