

REAL-TIME WATER-IN-DIESEL EMULSION FUEL PRODUCTION SYSTEM
FOR DIESEL ELECTRIC GENERATOR

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To my father, my mother, my wife and my relatives

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ABSTRACT

This research focused on the design and development of a novel emulsion fuel making device that can eliminate emulsion fuel main weaknesses; stability issues and high dependency of surfactant. The device is called Real-Time Water-in-Diesel Emulsion Fuel Production System (RTES) and utilized for the diesel electric generator application. The concept of RTES device consists of fuel and water which being stored in different units. These two immiscible liquids are transferred and instantaneously being emulsified by a mixing system before the produced emulsion fuel is injected into the combustion chamber. The research started with engine performance and emission test using water-in-diesel emulsion as fuel under various water percentages (5, 10, 15 and 20 %). The water content that gives optimum impact of engine performance and emission was selected to be used in RTES. Next, emulsion fuel stability test was conducted where different mixing equipments and conditions were tested to mix water and diesel without the existence of surfactant. The findings are used as reference to generate the conceptual design in the design process of the RTES. RTES device was then developed and tested onto the 0.406 litre, single-cylinder, four-stroke, air-cooled diesel engine. The engine testing result showed that emulsion fuel without surfactant made by RTES does gives significant improvement to the engine with the 3.59 % increase in brake thermal efficiency (BTE) and 3.89% reduction in brake specific fuel consumption as compared to diesel fuel. In addition, Nitrogen Oxides (NO_x) and Particulate Matter (PM) contents in the exhaust emission reduced significantly compared to neat diesel fuel with the average reduction of 31.66% and 16.33% respectively. Overall, RTES device proved that emulsion fuel can be used in the engine without the existence of surfactant while maintaining its benefits which are greener exhaust emission and fuel saving.

ABSTRAK

Kajian ini tertumpu kepada mereka-bentuk dan membangunkan alat baru bagi menghasilkan bahan api emulsi yang dapat menyelesaikan masalah utama bahan api tersebut iaitu; isu kestabilan dan pergantungan yang tinggi kepada bahan penguat emulsi. Alat ini dinamakan 'Real-Time Water-in-Diesel Emulsion Fuel Production System' (RTES) dan ianya digunakan untuk penjana elektrik enjin disel. Konsep RTES adalah terdiri daripada bahan api dan air yang disimpan di dalam unit yang berbeza. Kedua-dua cecair yang secara fizikalnya tidak boleh bercampur, akan dipindahkan dan serta-merta diemulsikan oleh sistem pencampuran di dalam RTES sebelum disuntik ke dalam kebuk pembakaran enjin. Kajian ini dimulakan dengan menjalankan ujian prestasi enjin dan pelepasan ekzos dengan menggunakan bahan api emulsi yang mengandungi peratusan isipadu air berbeza (5, 10, 15 dan 20%). Peratusan isipadu air yang dapat memberikan kesan optimum terhadap prestasi enjin dan pelepasan ekzos dipilih untuk digunakan pada RTES. Seterusnya, ujian kestabilan bahan api emulsi tanpa menggunakan bahan penguat emulsi dijalankan dengan menggunakan alat dan keadaan pencampuran yang berbeza. Hasil daripada ujian tersebut digunakan sebagai rujukan untuk penghasilan konsep reka-bentuk RTES. Alat RTES dibangunkan dan kemudiannya diuji pada 0.406 liter, satu silinder, empat lejang, penyejukan udara disel enjin. Hasil ujian menunjukkan bahawa bahan api emulsi yang dihasilkan oleh RTES tanpa menggunakan bahan penguat emulsi memberikan perubahan yang ketara kepada enjin dengan peningkatan kecekapan haba (BTE) sebanyak 3.59% dan penjimatan bahan api sebanyak 3.89% berbanding bahan api disel. Nitrogen Oksida (NO_x) dan jirim zarah (PM) dalam emisi ekzos berkurangan secara purata masing-masing sebanyak 31.66% dan 16.33%. Secara keseluruhan, alat RTES berjaya membuktikan bahawa bahan api emulsi boleh digunakan di dalam enjin tanpa bahan penguat emulsi di samping dapat mengekalkan manfaatnya iaitu pengurangan pelepasan ekzos dan penjimatan bahan api.