Effect of alcohol on performance of microemulsion fuels

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Abstract
Our current work attempts to examine the usability of alcohol-diesel-water microemulsion fuels in a diesel engine. The microemulsion regions were mapped out in a ternary phase diagram, and the fuel was characterized as per ASTM D975, and further examined for its performance in a diesel engine. The formulated microemulsions satisfied the ASTM standards, and had properties close to those of neat diesel. The calorific values for the microemulsion fuels showed a maximum reduction of 8.31% as compared to that of neat diesel. The brake thermal efficiency, however, increased by 15.38% for the same, with 5.04% lower brake specific fuel consumption, and with reduced emissions.

Introduction
Microemulsions are thermodynamically stable and optically isotropic colloidal dispersions of oil, water, and surfactant, with dispersed droplets size less than a quarter of the wavelength of visible light. Water-in-oil microemulsions are used as a fuel replacement, as they improve the fuel atomization and efficiency, as well as reduce the combustion temperature and NOx, PM, CO, and smoke emissions. The water droplets present in the microemulsions rapidly evaporate at high temperatures in combustion chamber, causing secondary atomization or microexplosions, as shown in Figure 1, resulting in an improved mixing and efficiency as well. The current work focuses on diesel-based microemulsion fuels, without the need of any additional surfactant, thereby making the entire process facile and economical.

Materials and Methods
The microemulsion region was determined using an experimental bisection method. The formation of microemulsions was confirmed using a red-laser beam. The properties of microemulsions were determined as per ASTM D975, and then the fuel was run in CI to check the performance and emission characteristics.

Conclusions
The alcohol-based microemulsion fuels could be used as an alternative diesel replacement, as the microemulsion with 30% diesel replacement, at load a of 2.4 kW and speed of 1500 rpm, showed promising reduction in fuel consumption, and emissions of CO, unburnt HC, and CO2, along with an increase in the thermal efficiency.

Industrial Significance
The current work showed that microemulsions can be used as a diesel replacement, as the fuel has a higher efficiency and lower emissions. The use of bio-alcohols will further make the process more economical and environment friendly.

Technology Readiness Level
Engine studies were successful. Endurance test needs to be done before its commercialization.

Results
The microemulsion fuels satisfying ASTM standards were tested in a diesel engine to evaluate the performance and emissions parameters. The percentage change in property ‘ε’ was calculated as 
\[ \frac{(E_{\text{diesel}} - E_{\text{microemulsion}})}{E_{\text{diesel}}} \times 100. \]

The BSFC of sample 5 was 5.05% lower at 2.4 kW load, while the BTE was 15.38% higher (2% increase in the overall efficiency of engine) than those for neat diesel (sample 1). The CO, HC, and CO2 emissions reduced for sample 5 by 53.48%, 54.18%, and 12.44%, respectively, when compared to the neat diesel.

References

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