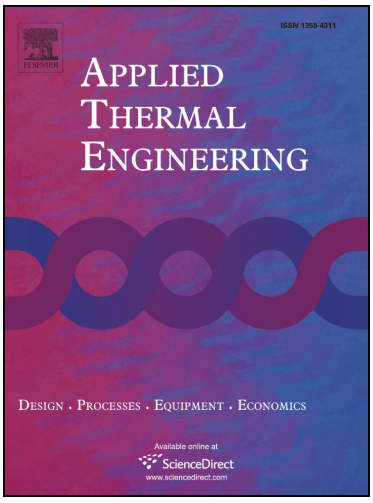

Research Paper

Predictions of droplet heating and evaporation: an application to biodiesel, diesel, gasoline and blended fuels

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Predictions of droplet heating and evaporation: an application to biodiesel, diesel, gasoline and blended fuels

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Abstract

This work is focused on the analyses of automotive fuel droplets' heating and evaporation with application to biodiesel, diesel, gasoline, and blended diesel-biodiesel fuels. The analyses are made considering conditions representative of real internal combustion engines. The evolutions of droplet radii and temperatures for gasoline, diesel, and a broad range of biodiesel fuels and their selective diesel fuel blends have been predicted using the Discrete Component model (DCM). These mixtures are combined with up to 116 components of 98 hydrocarbons and 4-18 methyl esters. The results are compared with the predictions of the case when blended biodiesel/diesel fuel are represented by pure fossil and biodiesel fuels. In contrast to previous studies, it is shown that droplet evaporation time and surface temperature predicted for 100% biodiesel are not always close to those predicted for pure diesel fuel, but they are entirely dependent on the biodiesel fuel composition. Also, the previously introduced multi-dimensional quasi-discrete model and its application to the aforementioned fuels are discussed. The application of the latter model contributes to improving the CPU efficiency with up to 96% in computational time compared to the original approach (the DCM), with a minimal loss in the accuracy of the model predictions.

Keywords

Biodiesel, Diesel, Fuel blends, Gasoline, Droplet, Heating and evaporation

1. Introduction

There have been many studies to simulate fuel droplets heating and evaporation (e.g. [1–5]); their findings have shown that modelling approaches based on the analysis of individual components, i.e. the discrete component model (DCM), produce the highest accuracy in comparison to previous approaches [6–8].

Based on recent research findings, the drawbacks in modelling fuel droplets heating and evaporation processes (computationally expensive models, ignoring temperature gradient and transient species diffusion) have been addressed using the multi-dimensional quasi-discrete model (MDQDM). In the MDQDM, a large number of components are replaced with a small number of representative components (described as 'quasi-components') [9–12]. The previous use of this model, however, has been limited to quasi-components of individual fuels, without fully considering the quasi-components of fuel blends. Also, it has been tested with a limited range of biodiesel fuel types and their mixtures with diesel fuel, rather than the broad range of globally used biodiesel fuels (22 types).

This paper summarises some comparisons between the results, referring to fuel droplet evaporation times and time evolution of droplet surface temperatures and radii, predicted by the recently developed versions of the DCM and MDQDM. The latter two models take into