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Influence of biofuels on the internal flow in diesel injector nozzles

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ABSTRACT

In this paper, the behavior of the internal nozzle flow of a standard diesel fuel has been compared against a biodiesel fuel (soybean oil) at cavitating and non-cavitating conditions, using a homogeneous equilibrium model. The model takes into account the compressibility of both phases (liquid and vapour) and use a barotropic equation of state which relates pressure and density to calculate the growth of cavitation. Furthermore, turbulence effects have been introduced using a RNG k-ε model.

The comparison of both fuels in a real diesel injector nozzle has been performed in terms of mass flow, momentum flux, effective velocity at the outlet and cavitation appearance. The decrease of injection velocity and cavitation intensity for the biodiesel noticed by numerical simulation at different injection conditions, predict a worse air–fuel mixing process.

1. Introduction

It is well known that fossil fuel reserves will not provide energy eternally. That is why a lot of companies are interested in making engines more efficient to reduce the fuel consumption. Another solution that seems to be a great alternative is the use of vegetable oils, animal fats and algae as carburant that should provide enough power to run the actual thermal engines as they do with fossil fuels.

In addition, biofuels such as biodiesel, can be use as a method to reduce the emissions of engines [1]. Indeed, the environmental benefits can reduce emissions of carbon monoxide by 40%, carbon dioxide by 80% and eliminate sulfur particulates and HC emissions.

However, despite their beneficial effects for the environment, the repercussions on the internal flow and therefore on the injection process have not been studied yet. Up to now, biofuel studies have been focused only in the performance and emissions of the engine [2] treating the engine as a "black box", without studying in depth how biodiesel influences the injection process or what are the repercussions of its use on the air–fuel mixing process.

The present paper has been divided into 6 sections. First of all, a brief description of the cavitation phenomena and the code used will be performed in Section 2. The geometry simulated and the fuel properties used in the calculations will be explained in Sections 3 and 4 respectively. The results of the study will be presented in Section 5 and finally, the main conclusions will be drawn in Section 6.

2. Description of the CFD approach

Under the injection conditions in modern diesel engines (with pressures which can reach up 180 MPa) cavitation often occurs in fuel injection nozzles, whose length is about 1 mm and whose diameter ranges from about 0.1 to 0.2 mm.

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