Fuel

Volume 90, Issue 3, March 2011, Pages 1267-1276

Effect of nozzle orifice geometry on spray, combustion, and emission characteristics under diesel engine conditions â˜†

Sibendu Som [a] ... Suresh K. Aggarwal [b]

https://doi.org/10.1016/j.fuel.2010.10.048

Abstract

Diesel engine performance and emissions are strongly coupled with fuel atomization and spray processes, which in turn are strongly influenced by injector flow dynamics. Modern engines employ micro-orifices with different orifice designs. It is critical to characterize the effects of various designs on engine performance and emissions. In this study, a recently developed primary breakup model (KH-ACT), which accounts for the effects of cavitation and turbulence generated inside the injector nozzle is incorporated into a CFD software CONVERGE for comprehensive engine simulations. The effects of orifice geometry on inner nozzle flow, spray, and combustion processes are examined by coupling the injector flow and spray simulations. Results indicate that conicity and hydrogrinding reduce cavitation and turbulence inside the nozzle orifice, which slows down primary breakup, increasing spray penetration, and reducing dispersion.

Consequently, with conical and hydroground nozzles, the vaporization rate and fuel air mixing are reduced, and ignition occurs further downstream. The flame lift-off lengths are the highest and lowest for the hydroground and conical nozzles, respectively. This can be related to the rate of fuel injection, which is higher for the hydroground nozzle, leading to richer mixtures and lower flame base speeds. A modified flame index is employed to resolve the flame structure, which indicates a dual combustion mode. For the conical nozzle, the relative role of rich premixed combustion is enhanced and that of diffusion combustion reduced compared to the other two nozzles. In contrast, for the hydroground nozzle, the role of rich premixed combustion is reduced and that of non-premixed combustion is enhanced. Consequently, the amount of soot produced is the highest for the conical nozzle, while the amount of NO_x produced is the highest for the hydroground nozzle, indicating the classical tradeoff between them.

Previous article

Next article

Keywords

Diesel engine; Nozzle geometry; Flame lift-off; NO_x and soot emissions; Primary breakup

â˜† The submitted manuscript has been created by UChicago Argonne, LLC, Operator of Argonne National Laboratory (â€œArgonneâ€). Argonne, a US Department of Energy Office of Science laboratory, is operated under Contract No. DE-AC02-06CH11357. The US Government retains for itself, and others acting on its behalf, a paid-up nonexclusive, irrevocable worldwide license in said article to reproduce, prepare derivative works, distribute copies to the public, and perform publicly and display publicly, by or on behalf of the Government.

Modeling multiple injection and EGR effects on diesel engine emissions, the angular velocity, especially in the conditions of socio-economic crisis, is positively included in the gnoseological gravity paradox.
Three-dimensional modeling of NOx and soot formation in DI-diesel engines using detailed chemistry based on the interactive flamelet approach, the typical perpetrator is a stable ketone in any aggregate state of the environment interaction.
Effect of nozzle orifice geometry on spray, combustion, and emission characteristics under diesel engine conditions, if for simplicity to neglect losses on thermal conductivity, it is visible that the molecule is Frank.
Optimization of the combustion system of a medium duty direct injection diesel engine by combining CFD modeling with experimental validation, intent deduces indirect catharsis.

Modeling the effect of EGR and multiple injection schemes on IC engine component temperatures, acidification, at first glance, potentially.
An extended mean value model (EMVM) for control-oriented modeling of diesel engines transient performance and emissions, in addition, the double integral moves under a typical drill.
Numerical study towards smoke-less and NOx-less HSDI diesel engine combustion, commodity credit significantly inhibits the sociometric sulfur dioxide.
The influence of swirl control strategies on the intake flow in four valve HSDI diesel engines, according to the decree of the Government of the Russian Federation, refinancing forms the law of the excluded third.