DIPLOMARBEIT

Transient One-Dimensional Fluid Flow in High Pressure Applications for Diesel-Fuel

ausgeführt am Institut für Strömungsmechanik und Wärmeübertragung der Technischen Universität Wien

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durch

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Wien, am 27. Juli 2010
Acknowledgment

Initially I would like to thank Prof. Herbert Steinrück and Dr. Harald Schmidt for proposing and supervising this work. I also thank the whole Team from the ECS-MES department for their constant support, especially Christof, Alexander and Andreas. I would further like to thank my colleges from the institute of fluid dynamics for helping me with the numerical implementation. I deeply thank my family and friends, without their constant support my studies and this work would not have been possible. My special thanks go to Julia who permanently supports me. This work is for you!

This work was partially financed by Magna Powertrain and the technical University of Vienna.
Abstract

Future emission laws like EURO VI, JPNLT, US 10 and US T4 require to increase the efficiency of diesel engines. Shaping the rate of diesel fuel injected into a cylinder during one combustion cycle has a great influence on emission of CO, NOx and sooty particles. In order to determine an optimal rate shaping, knowledge of the thermodynamic behavior of diesel and of the pressure waves in the components of the injection system is needed.

Here we deduce a simulation model, that calculates transient one-dimensional flow of diesel fuel. The model consists of three components, which are all based on the equations of state for liquid diesel fuel. The flow in the pipes is considered one-dimensional and inviscid. Thus the Euler equations are solved numerically using Roe's method. In a volume the kinetic energy can be neglected and the changes of internal energy are calculated by a mass and energy balance considering the in and outflow masses and their enthalpy and the change of volume with time, as well. A throttle will be described by a pressure loss coefficient. Changes of temperature due to the Joule-Thomson effect are also taken into account. Equations of state for liquid diesel fuel have been derived from measured data for density and isobaric heat capacity. The equation of state is tested by comparing the predicted values for the speed of sound with measured data reported in the literature. To proof the ability of the simulation tool to resolve shock and rarefaction waves as well as contact discontinuities, the results for a shock tube test are shown. Further the change of density and temperature during compression and expansion in a piston pump is shown. Also the results for two volumes with different initial conditions, connected by a throttle in one test case and connected by a pipe in another test case, show different transient behavior. This work shall help simulating transient one-dimensional flow of liquid diesel fuel in modern diesel injection systems, having operating pressures of up to 2500 bar and operating temperatures from 260 K to 393 K.
Kurzdarstellung


Die Arbeit soll helfen instationäre eindimensionale Strömungsvorgänge von flüssigem Diesel in modernen Einspritzsystemen, mit Betriebsdrücken bis zu 2500 bar und Temperaturen zwischen −10° C und 120° C, zu simulieren.
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