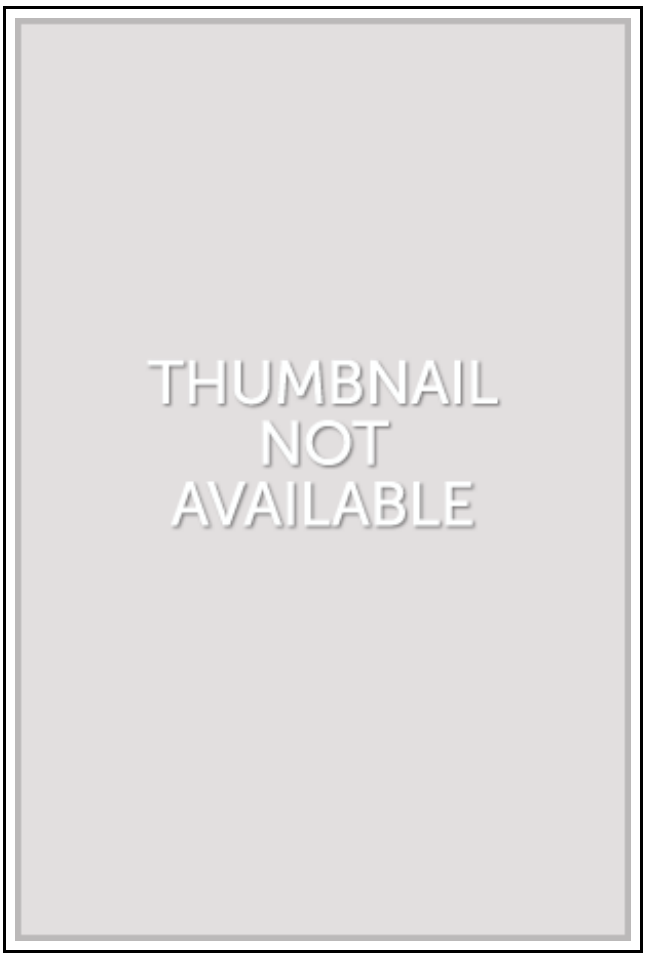
Numerical Analysis of Mixture Formation and Combustion in a Hydrogen Direct-Injection Internal Combustion Engine



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NUMERICAL ANALYSIS OF MIXTURE FORMATION AND COMBUSTION IN A HYDROGEN DIRECT-INJECTION INTERNAL COMBUSTION ENGINE

Cuvillier Verlag Feb 2008, 2008. Taschenbuch. Book Condition: Neu. 211x144x17 mm. Neuware - The present work investigates the mixture formation and combustion process of a direct-injection (DI) hydrogen internal combustion engine by means of three-dimensional numerical simulation. The study specifies details on the validity of turbulence models, combustion models as well as aspects on the definition of hydrogen-air burning velocities with respect to hydrogen IC engine applications. Results of homogeneous, stratified and multi-injection engine operation covering premixed, partially premixed and non-premixed combustion of hydrogen are presented. Results of the numerical simulations are validated using data of experimental analysis from parallel works, employing a one-cylinder research engine and a research engine with optical access. As a fundamental contribution to combustion modelling of hydrogen IC engines, a new correlation for laminar burning velocities of hydrogen-air mixtures at engine-relevant conditions is derived from measurements of premixed outwards propagating flames conducted in a single-cylinder compression machine. Numerical results of the direct-injection mixture formation give a detailed understanding of the interrelation between injection timing and the degree of mixture homogenisation. A favourable agreement between the computed fuel concentration and results of Planar Laser Induced Fluorescence (PLIF) measurements is reported for various injection timings. Different two-equation turbulence models, a Shear Stress Transport (SST) model and a k- model based on Renormalisation Group (RNG) theory as well as a Reynolds Stress Model (RSM) are discussed. The impact of the models on the level of turbulent kinetic energy proves to be of major importance. State-of-the-art turbulent combustion models on the basis of turbulent flame speed closure (TFC) and on the basis of a flame surface density approach, the Extended Coherent Flame Model (ECFM), are examined. The models are adapted to hydrogen internal combustion engines and are interfaced to the established three-dimensional flow field solver ANSYS CFX within the...

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