

Chapter 13

DNS of non-premixed combustion in a compressible mixing layer

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Abstract The non-premixed reaction of fuel with air in a mixing layer is studied using DNS. The situation is a model for the mixing-controlled combustion in a Diesel engine. We show that the combustion region can be comparably passive with respect to relatively large scale aerodynamic instabilities. However the reaction decreases the small scale turbulent energy. A flamelet analysis shows differences between two and three dimensional situations. In a first analysis, performed for the two dimensional case, no correlation of the flame-normal compressive strain rate with a flamelet-like behavior is observed.

13.1 Introduction

A numerical code is being developed to perform DNS (Direct Numerical Simulation) and LES (Large-Eddy Simulation) studies of fully compressible flows. This code is extended to perform DNS studies of non-premixed combustion. The combustion of fuel with air is studied using a single step reaction scheme.

With this code it is possible to study fundamental aspects of Diesel combustion in engines. The simulations are intended to serve as a tool for understanding the complex phenomena and characteristic events that appear in such an environment. Results will be used to assess modeling issues when using more standard computational fluid dynamics codes for simulation of engines. The simulation code is based on compact high resolution schemes for direct numerical simulation and large eddy simulation.

Large-eddy simulation of in-cylinder flows with combustion is not trivial yet. On the other hand traditional RANS (Reynolds Averaged Navier-Stokes) modeling still has its drawbacks and more and more developments are in the direction of large-eddy simulation. The reason for this lies in the advance of computer capacity in combination with the much lower sensitivity of the final results to the LES turbulence model.