

CFD Analysis of Arc Stretching and Plasma Temperature for a Spark Plug

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The ignition phase in spark ignition (SI) engines is crucial for reliable combustion, especially with lean mixtures and carbon-free fuels like hydrogen and ammonia. The flow field around the igniter and the in-cylinder turbulence can have an important effect on ignition.

Detailed Computational Fluid Dynamics (CFD) simulations can help to in-depth investigate the interaction between the flow field and a spark discharge. The CONVERGE v3.0 CFD software package was used as the computational framework for the simulations in order to compare Imposed Stretch Spark Ignition Model (ISSIM) [1] and Lagrangian-Eulerian Spark Ignition (LESI) model [2]. ISSIM model uses a simplified electrical diagram of the inductive system for a spark plug to calculate the energy deposited into the surrounding gas. LESI model improves the spark ignition energy deposition process with respect to standard methods, combining the accuracy of the Eulerian formulation for energy deposition with the flexibility of the Lagrangian formulation for arc tracking.

This study conducts a combined experimental and numerical investigation of the flow field surrounding a conventional J-type spark gap and its influence on the evolution of spark discharge [3]. Two distinct flow field velocities are investigated and compared to the static configuration under ambient conditions in an air flow channel, with the goal of determining the influence of the flow velocity on the spark stretching [4]. Focusing on plasma temperature evaluations for the quiescent case (Fig.1 - left), the model was found to provide good results, with proper evolution during the entire spark discharge process. Spark stretching was also found to be predicted with acceptable accuracy (Fig.1 - right), demonstrating correct modeling of spark-fluid interactions in the chosen conditions.

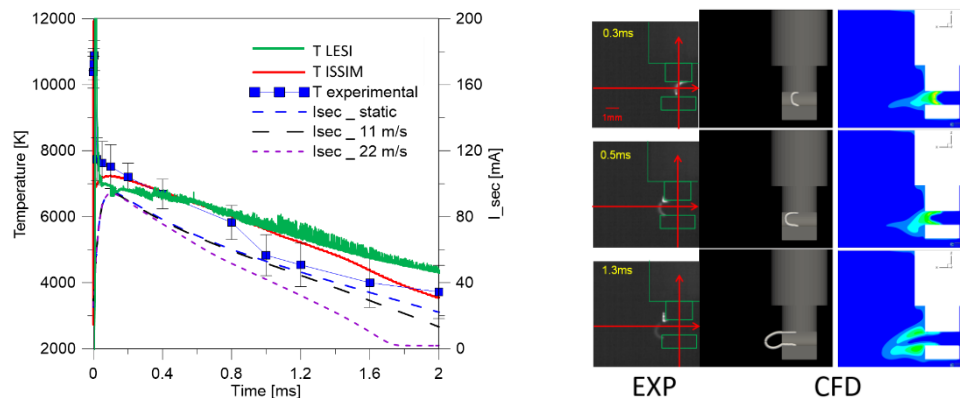


Figure 1: Plasma temperature evaluation in quiescent conditions (left); Arc stretching comparison (right).

References

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