Characterisation of electric discharge in laminar flow with optical diagnostics

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HIGHLIGHTS

• An electric discharge generated between pin-to-pin electrodes with 3mm gap and fed by a commercial Audi pencil coil is characterized by means of optical diagnostics in quiescent air flow and in laminar flow with varying velocities.
• Velocity of the flow surrounding the spark is measured by high resolution PIV and put forward strong interactions between the flow and the spark. In particular, intense gas recirculations are observed along the electrodes.
• Spark deformation in a controlled flow is analyzed by means of high rate and short gated imaging.
• Gas temperature is measured by Spontaneous Raman Scattering. The results show that the gas surrounding the spark is rapidly heated by a convective process induced by the rapid expansion of the shock wave generated during the breakdown phase of the electric discharge. A conductive heating of the gas occurs at later timings.
• Voltage and current evolutions with time are monitored and the energy deposited to the electrodes is evaluated. The elongation of the spark due to its interaction with the laminar flow shows that the energy available at the electrode increase with the flow velocity while the spark duration decreases.

ABSTRACT

The present work focuses on the interaction between an electric discharge generated by a commercial pencil coil and surrounding air flow in terms of aerodynamics and heat release using advanced optical diagnostics. This investigation is firstly performed with pin-to-pin electrodes in air at rest under atmospheric pressure condition. The velocity of the gas surrounding the spark is measured by Particle Image Velocimetry. The temperature field is measured by Spontaneous Raman Scattering. The time evolution of the current and voltage at the electrodes are monitored for an evaluation of the maximum deposited energy. In a second step, the topology of the discharge is investigated in a laminar air flow with varying velocities. High-speed intensified imaging technique is used for visualizing the spark interactions with the flow and its changes in growth, shape, and duration. The impacts of the electric discharge on the gas flow are investigated by means of phase-locked PIV under several laminar flow conditions. The whole results build a database which intends to bring a better understanding of plasma-aerodynamics interactions but also to provide data for the validation of ignition models.