11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20 - 25, 2014, Barcelona, Spain

ANALYISIS OF PARTICLE SEPARATION WITH RESPECT TO PRE-IGNITON IN AN SI-ENGINE

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Key Words: *Pre-Ignition, Multi-Component Fuel, Autoignition, Wall Film Formation, Particles, Lagrange*

Abstract

For downsized SI-engines at high loads and particularly at low engine speeds spontaneous self-ignitions randomly occur already before the regular spark timing leading to severe engine damage. This kind of irregular combustion phenomenon avoids fully exploiting the downsizing potential. Therefore, it was subject of extensive numerical and experimental investigations at the Institute for Powertrains and Automotive Technology at the Vienna University of Technology.

For the experimental investigations, a fuel with a high amount of components with low volatility and high boiling temperature was used to provoke wall film formation and droplet separation. An optical access was installed on the test engine for high-speed imaging [1]. A five component model fuel was introduced in STAR-CD to reproduce a realistic evaporation and wall film behaviour in the CFD-simulations [2], see Figure 1.

Figure 1: CFD-simulation result of the injection and wall film formation

Transient trajectories of separated droplets were compared to the path of recorded local light emissions. Especially stripped droplets from wetted areas on the piston crown close to the liner showed a good correlation with the video observations.

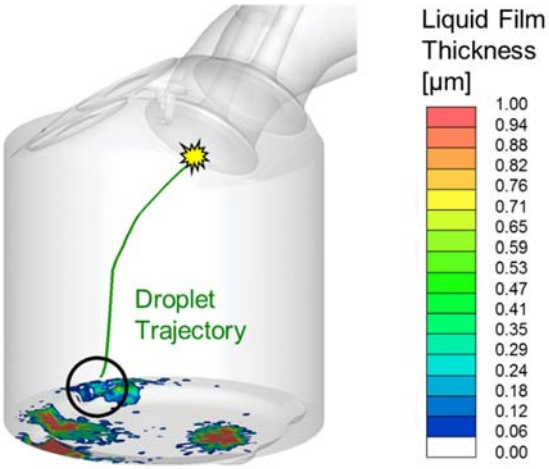

Figure 2: Trajectory of a separated droplet until pre-ignition timing (yellow sign)

Additionally, the detachment of soot particles from the combustion chamber walls caused by the high-frequency pressure oscillations during a pre-igniting cycle was modelled in CFD with respect to the video observations. Particles that remained in the combustion chamber after gas exchange heated up during the following regular combustion cycle and therefore became critical for follow-up pre-ignition events in the next cycle.

In this way, droplets and particles could be confirmed as possible initiation mechanisms for pre-ignitions.

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