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Application of a Novel Approach for Calculating the Premixed Combustion in Engines

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Modern gasoline engines are mostly applying fuel direct injection and due to downsizing concepts also turbo charging is quite common. These two technologies increase the level of complexity of such engines compared to former simple port fuel injection systems. On one hand the GDI concept promotes the probability of mixture inhomogeneities, which can lead to a significant increase of particle emissions. On the other hand, the higher specific output can cause problems with untypical combustion events like knocking.

In this context engine developers are applying, amongst other tools, CFD methods to optimize geometrical and operation parameters of their systems. For this kind of calculations it is highly necessary to be able to rely on the most accurate description of the combustion, auto-ignition and emission formation process. This paper focuses on describing a new method for modeling the turbulent combustion in engines, including knocking and the calculation of pollutants.

The ‘flame tracking model’ (FTM) [1] is a numerical algorithm to simulate the kinetics of the premixed flame represented by a surface. The method is based on a well-balanced combination between Lagrangian and Eulerian approach. From the Lagrangian formulation, it takes an advantage of obtaining the detailed evolution of surface movement based on flame speed and local flow velocity. From the Eulerian approach, heuristic numerical stability is achieved and it is possible to compute a smooth surface normal vector field from Lagrangian particles, which is very important in order to include the effect of turbulent combustion.
The model utilizes well known correlations for the turbulent flame speed, which connect the fuel property of the laminar flame speed with local turbulence intensities.

In this paper the model will be shortly described from the theoretical point of view. The focus will be on showing results on academic validation examples and on some operating points of a state-of-the-art gasoline combustion engine.

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