Regimes of near-stoichiometric hydrogen/air combustion under reciprocating engine conditions

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The study represents the numerical analysis of near-stoichiometric hydrogen/air flame development in the 2D cylindrical chamber under the moving piston simulating conditions of the four-stroke spark-ignition engine. It is demonstrated that three regimes of combustion could be distinguished based on the indicator diagrams and the analysis of flame development: detonation, fast and slow combustion regimes. In the process of fast combustion regime an intensive development of gas-dynamic instability of the flame front under the interaction of flame with compression waves inside the enclosed chamber takes place. This regime is similar to knock according to its output parameters, however, the auto-ignition of combustible mixture ahead of the flame front does not occur. The similarity could be explained by the high intensity of pressure waves generated by the flame and their amplification by the mechanism of thermoacoustic instability. Besides, quantitative estimations demonstrate the best level of combustion completeness for the fast combustion regime. The obtained results should be useful when elaborating new energy technologies based on hydrogen combustion.
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