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ABSTRACTS

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PREFLAME SELF-IGNITION AND SHOCK FORMATION IN AN INTERNAL COMBUSTION ENGINE

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A mathematical model is developed for predicting knocking onset in an internal combustion engine. The model is based on distinguishing two essential stages of the process, namely, the 'slow' stage of turbulent flame propagation in a cylindrical combustion chamber of variable volume, and the 'fast' stage of preflame self-ignition of an unburnt mixture and shock formation in it.

The 'slow' stage is governed by the set of one-dimensional conservation equations coupled with the k-epsilon model of turbulence, the equation of one-step Arrhenius type chemical reaction, and a standard procedure of equilibrium state calculation. For terminating the 'slow' stage of the process the Livengood-Wu integral approach was used in evaluating ignition delay in the unburnt mixture. The 'fast' stage is governed by the conservation equations without regard for transport processes. The 'sewing' of the stages is achieved through settling the proper initial conditions for the 'fast' stage.

Used in calculations were the numerical values of governing parameters typical for the experimental one-cylinder engine UIT-65 fed with the stoichiometric n-heptane-air mixture. Four situations were analysed numerically which differed by boundary conditions at cylinder walls. The calculations indicated a possibility of strong shock and detonation wave formation in an end gas following to the Zeldovich coupling mechanism. The predicted knock frequency band correlates with experimental observations.