
PHYSICOCHEMICAL PECULIARITIES OF PARTIAL
OXIDATION OF METHANE IN THE SELF-IGNITION
REGIME

I. V. Bilera¹, V. A. Bogdanov¹, A. A. Borisov²,
Yu. A. Kolbanovskii¹, G. G. Politenkova²,
K. Ya. Troshin², and S. M. Frolov²

¹A. V. Topchiev Institute of Petrochemical Synthesis
Russian Academy of Sciences
Moscow, Russia

²N. N. Semenov Institute of Chemical Physics
Russian Academy of Sciences
Moscow, Russia

Partial methane oxidation in noncatalytic combustion regimes is fairly promising in developing gas-chemical technologies intended to synthesize hydrogen as a fuel for nonpolluting engines and power producing installations and also syn-gas as a primary product for synthesizing liquid motor fuels. The feasibility of implementing partial methane oxidation with oxygen and air in laminar and turbulent combustion regimes was recently explored by the authors. Unfortunately, the burning velocity in rich methane–oxygen mixtures suitable for industrial applications does not exceed 42 cm/s even under the most favorable conditions with excess oxygen ratio 0.35. Flow turbulization increases the burning velocity by a factor of 5 at most. Big-volume production of syn-gas would necessitate a significant increase in the rate of methane conversion. The solution of the problem associated with burning rate increase can efficiently be solved by conducting the partial methane oxidation in the autoignition regime. The questions to be answered before suggesting the new technology:

- (i) Are the rich mixtures capable of self-igniting and under what conditions?

- (ii) How much can the methane conversion rate be increased in this reaction mode?
- (iii) What are the yields of the desired products?

The data available in the literature are too scarce to properly answer the above questions; therefore, a study of autoignition of very rich methane–air mixtures in a constant volume reactor and rapid compression machine was undertaken. In addition, the kinetics of self-ignition process is modeled using the detailed reaction mechanism to see whether the reaction proceeds to full thermodynamic equilibrium and to assess the kinetic characteristics of methane conversion into hydrogen and carbon monoxide. Calculations were performed both for methane–air and methane–oxygen mixtures at elevated initial pressures and temperatures because high yields of the desired products can be attained when the initial mixtures are far beyond the standard flammability limits.