PRODUCTION OF SYNGAS BY SELF-IGNITING AND/OR BURNING OF VERY RICH METHANE MIXTURES

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Mass production of syngas for hydrogen energetic and synthesizing liquid motor fuels in non-catalytic combustion regimes is believed to be a promising development line in contemporary gas-chemical industry. For many objective reasons the modern combustion science paid not very much to studies of physical chemistry of oxidative processes in very rich methane-air and –oxygen mixtures burning in various regimes.

This work studies experimentally and theoretically combustion of super-rich methane-air and –oxygen mixtures. Thermodynamic and kinetic calculations of methane oxidation in flame and self-ignition regimes are performed. The initial conditions are shown to significantly affect the equilibration time in the combustion products. The effect of the initial conditions (pressure and temperature) on expanding the rich concentration flammability limits is ascertained. Experimental yields of the desired products in both mixture burning and self-ignition in a constant volume reactor are found to be very close to their thermodynamic counterparts. Burning velocities of mixtures with different oxidizer excess values are measured. Their values even in mixtures burning under favorable conditions do not exceed 40 cm/s. Mixture turbulization permits the burning rate to be increased by no more than a factor of 5. Self-ignition regime can increase the methane conversion rate many-fold (by a factor of few orders, just by increasing the temperature).

Soot formation is one of the most serious problems to be solved in developing the non-catalytic method of syngas production. Experiments show that water vapor additives reduce the soot yield and under most favorable conditions lead to suppression of its formation. Additives of syngas, hydrogen, and carbon monoxide exert similar effect on the soot yield and intensify the combustion process. The results of studies were used to develop and manufacture a flow reactor (at TIPS RAS) for methane conversion into syngas by direct burning.

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