IGNITION OF MODEL BIOGAS MIXTURES IN AN ADIABATIC COMPRESSION REACTOR

I. V. Bilera

A. V. Topchiev Institute of Petrochemical Synthesis of the Russian Academy of Sciences, 29 Leninsky Prosp., Moscow 119991, Russian Federation

Abstract: The partial oxidation of two model biogas mixtures (vol./vol.) is investigated under adiabatic compression conditions: $CH_4/CO_2/N_2 = 60/40/0$ and $CH_4/CO_2/N_2 = 60/20/20$. Oxygen is used as oxidant, the oxidant-to-air equivalence ratio for both mixtures is $\alpha = 0.4$. Major (H_2, CO, and H_2O) and minor reaction products are determined, including ethylene and olefins C_3–C_5, acetylene and its homologues, dienes C_3–C_5, benzene, and toluene. The ranges of degrees of transformation of mixtures by the sum of all products are 0.8%–65% for mixture 1 and 1.7%–72% for mixture 2. It is found that at ignition in a narrow range of compression ratios there is a sharp increase in the degree of transformation of O_2 and CH_4. Three modes are found for CO_2 as a function of temperature: an increase in its content in the product mixture as compared to the initial mixture under conditions of partial oxidation without ignition, an increase in its content at ignition, and a decrease in its content at ignition.

Keywords: biogas; methane; CO_2; ignition; oxidation; adiabatic compression; synthesis gas; hydrogen

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Figure Captions

Figure 1 Pressure histories at adiabatic compression of mixtures No. 1 (*a*) and No. 2 (*b*)

Figure 2 The residual content of O_2 (*1*), CH_4 (*2*), CO_2 (*3*), and C_2H_6 (*6*) and yields of methane partial oxidation products as functions of maximum compression ratio $\varepsilon_{\max}$ for mixture No. 2: *4* — CO; *5* — H_2O (on balance); *7* — C_2H_4; *8* — C_2H_2; *9* — H_2; *10* — C_3H_8; *11* — C_3H_6; *12* — benzene; *13* — methylacetylene; *14* — allene; *15* — vinylacetylene; *16* — diacetylene; *17* — n-butane; *18* — but-1-ene; *19* — cyclopentadiene; *20* — isobutane; *21* — 1,3-butadiene; *22* — toluene; *23* — isobutene; *24* — n-pentane; *25* — pentene sum; *26* — sum of unidentified C_5–C_7 hydrocarbons; *27* — *trans*-but-2-ene; *28* — isopentane; *29* — but-1-yne; *30* — *cis*-but-2-ene; *31* — isoprene; *32* — but-2-yne; and *33* — n-hexane

Figure 3 The conversion degrees of O_2 (*1*) and CH_4 (*2*) and conversion degree by total product (*3*) as a function of maximum compression ratio $\varepsilon_{\max}$ for mixtures No. 1 (*a*) and No. 2 (*b*)

Figure 4 The conversion degrees of CO_2 as a function of maximum compression ratio $\varepsilon_{\max}$ for mixtures No. 1 (*1*) and No. 2 (*2*)

Figure 5 Selectivities of partial oxidation products of model biogas mixture No. 2: *3–33* the same as for Fig. 2; *34* — 2-methylbut-1-ene; *35* — 2-methylbut-2-ene; *36* — 3-methylbut-1-ene; *37* — *trans*-pent-2-ene; *38* — pent-1-ene; and *39* — *cis*-pent-2-ene

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Contributor

Bilera Igor V. (b. 1968) — Candidate of Science in chemistry, leading research scientist, A. V. Topchiev Institute of Petrochemical Synthesis of the Russian Academy of Sciences, 29 Leninsky Prosp., Moscow 119991, Russian Federation; bilera@ips.ac.ru