DETERMINATION OF SELF-IGNITION DELAY OF METHANE–AIR MIXTURES WITH ADDITION OF C_2–C_5 ALKANES

K. Ya. Troshin[1,2], A. V. Nikitin[1,3], A. A. Borisov[1,2], and V. S. Arutyunov[1,3]

[1]N. N. Semenov Institute of Chemical Physics, Russian Academy of Sciences, 4 Kosygin Str., Moscow 119991, Russian Federation

[2]National Research Nuclear University MEPhI, 31 Kashirskoe Sh., Moscow 115409, Russian Federation

[3]Institute of Problems of Chemical Physics, Russian Academy of Sciences, 1 Acad. Semenov Av., Chernogolovka, Moscow Region 142432, Russian Federation

Abstract: The effect of the addition of C_2–C_5 alkanes on self-ignition delay of methane–air mixtures under constant volume conditions was experimentally studied. Investigations were performed with stoichiometric mixtures at atmospheric pressure and initial temperature up to 1000 K. It was shown that even low admixture of pentane at a level of 0.5 %(vol.) reduces self-ignition delay several times. Kinetic modeling satisfactory describes experimental results and shows that small additives of heavier alkanes reduce ignition delays of methane due to faster formation of active radicals.

Keywords: natural gas; associated petroleum gas; methane; alkanes; combustion; ignition time

Acknowledgments

The work was supported by the Program No. 24 of the Presidium of the Russian Academy of Sciences.

References

1. Levinsky, H. B., S. Gersen, M. H. Rothink, and G. H. J. van Dijk. 2009. Progress towards a method for ranking gases for knock resistance using ignition delay times. *European Combustion Meeting Proceedings*.
2. Gersen, S., M. H. Rothink, G. H. J. van Dijk, and H. B. Levinsky. 2011. A new experimentally tested method to classify gaseous fuels for knock resistance based on the chemical and physical properties of the gases. *Gas Union Research Conference (International)*.
3. Borisov, A. A., V. G. Knorre, E. L. Kudryashova, G. I. Skachkov, and K. Ya. Troshin. 1998. On temperature measurements in the induction period of ignition of homogeneous gas mixtures in a static admittance apparatus. *Chem. Phys. Rep.* 17(7):1323–1331.
4. Troshin, K. Ya., A. V. Nikitin, A. A. Borisov, and V. S. Arutyunov. 2015. Eksperimental'noe issledovanie vosplameneniya binarnykh smesey metana s dobavkami alkanov C_3–C_5 v vozdukhe [Experimental investigation of self-ignition of binary methane mixtures with C_3–C_5 alkane additives in air]. *Goren. Vzryv (Mosk.) — Combustion and Explosion* 8(1):42–49.

5. Natural Gas II. Available at: http://c3.nuigalway.ie/naturalgas2.html (accessed February 28, 2016).
6. Bourque, G., D. Healy, H. J. Curran, C. Zinner, D. Kalitan, J. de Vries, C. Aul, and E. Petersen. 2008. Ignition and flame speed kinetics of two natural gas blends with high levels of heavier hydrocarbons. *Proc. ASME Turbo Expo.* 3:1051–1066.
7. CWB 4.0. Available at: http://www.kintechlab.com/products/chemical-workbench/ (accessed February 28, 2016).

Received December 18, 2015

Contributors

Troshin Kirill Ya. (b. 1949) — Doctor of Science in physics and mathematics, chief scientist, N. N. Semenov Institute of Chemical Physics, Russian Academy of Sciences, 4 Kosygin Str., Moscow 119991, Russian Federation; National Research Nuclear University MEPhI, 31 Kashirskoe Sh., Moscow 115409, Russian Federation; troshin@chph.ras.ru

Nikitin Aleksey V. (b. 1988) — research scientist, N. N. Semenov Institute of Chemical Physics, Russian Academy of Sciences, 4 Kosygin Str., Moscow 119991, Russian Federation; engineer, Institute of Problems of Chemical Physics, Russian Academy of Sciences, 1 Acad. Semenov Av., Chernogolovka, Moscow Region 142432, Russian Federation; ni_kit_in@rambler.ru

Borisov Anatoliy A. (b. 1932) — Doctor of Science in physics and mathematics, professor, chief scientist, N. N. Semenov Institute of Chemical Physics, Russian Academy of Sciences, 4 Kosygin Str., Moscow 119991, Russian Federation; National Research Nuclear University MEPhI, 31 Kashirskoe Sh., Moscow 115409, Russian Federation; borisov@chph.ras.ru

Arutyunov Vladimir S. (b. 1946) — Doctor of Science in chemistry, professor, head of laboratory, N. N. Semenov Institute of Chemical Physics, Russian Academy of Sciences, 4 Kosygin Str., Moscow 119991, Russian Federation; Institute of Problems of Chemical Physics, Russian Academy of Sciences, 1 Acad. Semenov Av., Chernogolovka, Moscow Region 142432, Russian Federation; arutyunov@chph.ras.ru