TEMPERATURE DEPENDENCY OF LAMINAR FLAME SPEED FOR STOICHIOMETRIC n-DECANE/AIR MIXTURE

M. G. Bryukov, S. M. Sergeev, V. A. Kudryashov, and N. V. Petrukhin

25th State Research Institute of Chemmotology of the Ministry of Defence of the Russian Federation, 10 Molodogvardeyskaya Str., Moscow 121467, Russian Federation

Abstract: The laminar flame speed in the stoichiometric n-decane/air mixture has been measured for the first time in temperature ranges 471–616 and 557–695 K at pressures of 101.3 and 202.7 kPa (1 and 2 atm), respectively. A detailed numerical simulation of the laminar flame speed dependency on temperature for stoichiometric n-decane/air mixture has been performed. The results of numerical simulation are in agreement with experimental data obtained in the present work within experimental errors.

Keywords: n-decane; air; laminar flame speed; ignition delay time; data processing algorithm

DOI: 10.30826/CE18110301

References

1. Dooley, S., S. H. Wona, M. Chaos, J. Heyne, Y. Ju, F. L. Dryer, K. Kumar, Ch.-J. Sung, H. Wang, M. A. Oehlschlaeger, R. J. Santoro, and T. A. Litzinger. 2010. A jet fuel surrogate formulated by real fuel properties. *Combust. Flame* 157:2333–2339.
2. Pfahl, U., K. Fieweger, and G. Adomeit. 1996. Self-ignition of diesel-relevant hydrocarbon–air mixtures under engine conditions. *26th Symposium (International) on Combustion*. The Combustion Institute. 781–789.
3. Zhao, Zh., J. Li, A. Kazakov, and F. L. Dryer. 2005. Burning velocities and high temperature skeletal kinetic model for n-decane. *Combust. Sci. Technol.* 177:89–106.
4. Kumar, K., and Ch.-J. Sung. 2007. Laminar flame speeds and extinction limits of preheated n-decane/O_2/N_2 and n-dodecane/O_2/N_2 mixtures. *Combust. Flame* 151:209–224.
5. Zhukov, V. A., V. A. Sechenov, and A. Yu. Starikovskii. 2008. Autoignition of n-decane at high pressure. *Combust. Flame* 153:130–136.
6. Shen, H.-P. S., J. Steinberg, J. Vanderover, and M. A. Oehlschlaeger. 2009. A shock tube study of the ignition of n-heptane, n-decane, n-dodecane, and n-tetradecane at elevated pressures. *Energ. Fuel.* 23:2482–2489.
7. Ji, Ch., E. Dames, Ya. L. Wang, H. Wang, N. Fokion, and F. N. Egolfopoulos. 2010. Propagation and extinction of premixed C_5–C_{12} n-alkane flames. *Combust. Flame* 157:277–287.
8. Singh, D., T. Nishiie, and Li Qiao. 2011. Experimental and kinetic modeling study of combustion of n-decane, jet-A, and S-8 in laminar premixed flames. *Combust. Sci. Technol.* 183:1002–1026.
9. Kim, H. H., S. H. Won, J. Santner, Zh. Chen, and Yi. Ju. 2013. Measurements of the critical initiation radius and unsteady propagation of n-decane/air premixed flames. *P. Combust. Inst.* 34:929–936.
10. Kee, R. J., F. M. Rupley, and J. Miller. 1989. CHEMKIN-II: A Fortran chemical kinetics package for the analysis of gas phase chemical kinetics. Sandia National Laboratories. Report No. SAND89-8009B.
11. Deminsky, M., V. Chorkov, G. Belov, I. Cheshigin, A. Knizhnik, E. Shulakova, M. Shulakov, I. Iskandarova, V. Alexandrov, A. Petrusev, I. Kirillov, M. Strelkova, S. Umanski, and B. Potapkin. 2003. Chemical Workbench — integrated environment for materials science. *Comp. Mater. Sci.* 28(2):169–178.
12. FLUENT 6.3 User's Guide. 2006. Ann Arbor, MI: Ansys, Inc.
13. CHEMKIN-PRO, Release 15101, Reaction Design. 2010. San Diego, CA.
14. Kintech Lab. 2015. Chemical Workbench 4.1. Available at: http://www.kintechlab.com/products/chemical-workbench/ (accessed June 21, 2018).
15. Lewis B., and G. von Elbe. 1938. *Combustion, flames, and explosions of gases*. Cambridge: University Press. 428 p.)
16. Bryukov, M. G., S. M. Sergeev, V. A. Kudryashov, and O. A. Prokopenko 2016. Normal'naya skorost' rasprostraneniya plameni v stekhiometricheskoy smesi naftila s vozdukhom [Laminar flame speed of stoichiometric naphthyl/air mixture]. *Goren. Vzryv (Mosk.) — Combustion and Explosion* 9(3):4–12.
17. Kopp, M. M., N. S. Donato, E. L. Petersen, W. K. Metcalfe, S. M. Burke, and H. J. Curran. 2014. Oxidation of ethylene–air mixtures at elevated pressures. Part 1: Experimental results. *J. Propul. Power* 30(3):790–798.
18. Naik, Ch. V., and A. M. Dean. 2006. Detailed kinetic modeling of ethane oxidation. *Combust. Flame* 145:16–37.

Received January 26, 2018

Contributors

Bryukov Mikhail G. (b. 1963) — Candidate of Science in physics and mathematics, senior research scientist, 25th State Research Institute of Chemmotology of the Ministry of Defence of the Russian Federation, 10 Molodogvardeyskaya Str., Moscow 121467, Russian Federation; MGBryukov@mail.ru

Sergeev Sergey M. (b. 1958) — Candidate of Science in technology, associate professor, head of laboratory, 25th State Research Institute of Chemmotology of the Ministry of Defence of the Russian Federation, 10 Molodogvardeyskaya Str., Moscow 121467, Russian Federation; ssm.58@mail.ru

Kudryashov Victor A. (b. 1968) — senior research scientist, 25th State Research Institute of Chemmotology of the Ministry of Defence of the Russian Federation, 10 Molodogvardeyskaya Str., Moscow 121467, Russian Federation; 25gosniihim@mail.ru

Petrukhin Nickolay V. (b. 1932) — Doctor of Science in technology, professor, leading research scientist, 25th State Research Institute of Chemmotology of the Ministry of Defence of the Russian Federation, 10 Molodogvardeyskaya Str., Moscow 121467, Russian Federation; 25gosniihim@mail.ru