# THE EFFECT OF HYDROGEN PEROXIDE ON NITRIC OXIDE FORMATION AT COMBUSTION OF THE VAPOR/AIR/METHANE MIXTURES

G. A. Poskrebyshev, I. A. Korobeinikova, and V. N. Popov

V. L. Talrose Institute of Energy Problems of Chemical Physics, Russian Academy of Sciences, 38-2 Leninsky Prosp., Moscow 119334, Russian Federation

**Abstract:** The effect of the hydrogen peroxide ($H_2O_2$) on the formation of nitric oxide (NO) at combustion of $H_2O$/air/$CH_4$ mixture is studied. It is demonstrated that the addition of hydrogen peroxide to the stoichiometric mixture of $H_2O$/air/$CH_4$ increases the yield of NO. The observed increase is mainly due to the overstoichiometric amount of oxygen introduced to the mixture by addition of the hydrogen peroxide as well as to the small (7 K), but noticeable increase in the value of maximum temperature reached during the combustion of methane ($T_{\max}$). The observed increase in the value of $T_{\max}$ is due to the higher heat release of the reaction $3H_2O_2 + CH_4 = 5H_2O + CO$ ($\Delta_r H^0_{298.15}(1) = -836.3$ kJ/mol $CH_4$) than that for the reaction $1.5O_2 + CH_4 = 2H_2O + CO$ ($\Delta_r H^0_{298.15}(2) = -519$ kJ/mol $CH_4$).

**Keywords:** $CH_4$; $H_2O_2$; combustion; NO

**DOI:** 10.30826/CE19120209

## References

1. Golovitchev, V. I., Pilia M. L., Bruno C. 1996. Autoignition of methane mixtures: The effect of hydrogen peroxide. *J. Propul. Power* 12(4):699–707.
2. Chen, G. B., Y. H. Li, T. S. Cheng, H. W. Hsu, and Y. C. Chao. 2011. Effects of hydrogen peroxide on combustion enhancement of premixed methane/air flames. *Int. J. Hydrogen Energ.* 36:15414e26.
3. Poskrebyshev, G. A., A. N. Yermakov, I. A. Korobeinikova, and V. N. Popov. 2017. Vliyanie para na dinamiku obrazovaniya NO pri szhiganii $CH_4$ v reaktorakh ideal'nogo smesheniya i ideal'nogo vytesneniya [Effect of steam on the dynamics of NO formation during $CH_4$ combustion in the perfectly stirred and plug flow reactors]. *Goren. Vzryv (Mosk.) — Combustion and Explosion* 10(3):10–14.
4. Yermakov, A. N., I. A. Korobeinikova, G. B. Pronchev, and A. A. Ivanov. 2015. Ob aktivatsii sgoraniya metana v GTU s "vlazhnym" szhatiem [The activation of mathane combustion in gas turbines with a wet compression]. *Proceedings of the Russian Academy of Sciences Power Engineering J.* 6:34–44.
5. Martinez, A. I., L. F. Corredor, and W. Tamara. 1997. Reduction of combustion emissions using hydrogen peroxide in a pilot scale combustion chamber. *1997 Air and Waste Management Association's 90th Annual Meeting and Exhibition Proceedings*. Toronto, Canada. Paper 97eTP30B.01.
6. Born C., and N. Peters. 1998. Reduction of soot emission at a DI diesel engine by additional injection of hydrogen peroxide during combustion. SAE Paper 982676.
7. Flowers, D., S. Aceves, C. K. Westbrook, J. R. Smith, and R. Dibble. 2001. Detailed chemical kinetic simulation of natural gas HCCI combustion: Gas composition effects and investigation of control strategies. *J. Eng. Gas Turb. Power* 123(2):433–439.
8. Smith, G. P., D. M. Golden, M. Frenklach, N. W. Moriarty, B. Eiteneer, M. Goldenberg, C. T. Bowman, R. K. Hanson, S. Song, W. C. Gardiner, Jr., V. V. Lissianski, and Z. Qin. 1999. GRI-Mech 3.0. Available at: http://combustion.berkeley.edu/gri-mech/version30/text30.html (accessed May 27, 2019).
9. Wang, F., J. Mi, and P. Li. 2013. Combustion regimes of a jet diffusion flame in hot co-flow. *Energ. Fuel.* 27:3488–3498.

*Received January 18, 2019*

## Contributors

**Poskrebyshev Gregory A.** (b. 1965) — Candidate of Science in chemistry, leading research scientist, V. L. Talrose Institute of Energy Problems of Chemical Physics, Russian Academy of Sciences, 38-2 Leninsky Prosp., Moscow 119334, Russian Federation; gposkr@chph.ras.ru

**Korobeinikova Irina A.** (b. 1962) — Candidate of Science in chemistry, senior research scientist, V. L. Talrose Institute of Energy Problems of Chemical Physics, Russian Academy of Sciences, 38-2 Leninsky Prosp., Moscow 119334, Russian Federation; koriren@rambler.ru

**Popov Vladislav N.** (b. 1930) — senior research scientist, V. L. Talrose Institute of Energy Problems of Chemical Physics, Russian Academy of Sciences, 38-2 Leninsky Prosp., Moscow 119334, Russian Federation; vnpop@rambler.ru