Measurements of rate constants for $O_2(b^1\Sigma)$ quenching by CH_4, NO, N_2O at temperatures of 300−800 K

G.I. Tolstov[1], M.V. Zagidullin[1,2], N.A. Khvatov[2], A.M. Mebel[1,3], V.N. Azyazov[1,3]

[1]*Samara National Research University (Samara, 443086, Russia)*
[2]*Lebedev Physical Institute (Samara, 443011, Russia)*
[3]*Florida International University (SW 8th St, Miami, 33199, USA)*
Email: outloot@yandex.ru

Electronically excited oxygen has an important place in the kinetic schemes of the processes taking place in the atmosphere, in the active medium of an oxygen-iodine laser, and in plasma-assisted combustion. Over the past decades, a large amount of data on the rate constants of quenching $O_2(b)$ on a large number of collision partners (http://iupac.pole-ether.fr/) has been accumulated. However, they mostly refer to the results of measurements at room temperature. The temperature dependences of the rate constants for the relaxation of $O_2(b)$ are very meager.

In this paper, rate constants for the quenching of $O_2(b^1\Sigma_g^+)$ by collisions with N_2O, NO and CH_4 have been determined in the temperature range from 297 to 800 K, by the laser-induced fluorescence method. $O_2(b^1\Sigma_g^+)$ was excited by pulses from a tunable dye laser, and the deactivation kinetics were followed via observing the temporal behavior of the $b^1\Sigma_g^+ \rightarrow X^3\Sigma_g^-$ fluorescence. From the analysis of experimental results, the following temperature dependencies of the quenching rate constants by these gases were obtained, and could be represented by the expressions:

$k_{CH4}=(3.54\pm0.4)\times10^{-18}\times T^{1.5}\times exp\left(\frac{-220\pm24}{T}\right)$, $k_{N2O}=(2.63\pm0.14)\times10^{-18}\times T^{1.5}\times exp\left(\frac{590\pm26}{T}\right)$, and $k_{NO}=exp(-56.8\pm0.05)\times T^{3.8}\times exp\left(\frac{1250\pm28}{T}\right)$ cm^3 $molecule^{-1}$ s^{-1}. All of the rate constants measured at room temperature were found to be in good agreement with previously reported values.

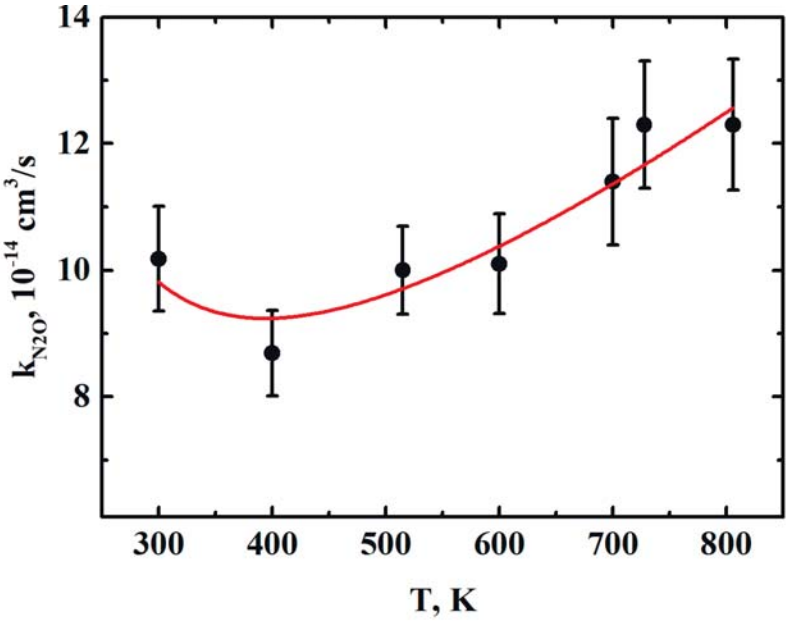

Figure 1. Temperature dependence of quenching rates of O_2 by N_2O.