

# Decomposition of N<sub>2</sub>O. Dynamics of Explosion and Flame Propagation.

Mike Kuznetsov<sup>1\*</sup>, Simon Jallais<sup>2</sup>

<sup>1</sup> Institute for Nuclear and Energy Technologies, Karlsruhe Institute of Technology, Karlsruhe, Germany

<sup>2</sup> Air Liquide CRCO, Jouy en Josas, France

## Abstract

Nitrous oxide N<sub>2</sub>O can exothermically decompose due to forced ignition (local energy deposition using electric sparks or exploding wires) or self-ignition (auto-ignition due to high temperature). It is of great scientific and practical interest the evaluation of initial pressure and temperature at which N<sub>2</sub>O decomposition flame can propagate. The minimum pressure at which nitrous oxide completely burnt out was experimentally found to be above 5 bars [1]. The laminar flame speed  $S_L$  at 20°C and different of pressures was found to be as low as 1 to 2 cm/s [2-4]. As a consequence of such low flame speed, the flame dynamics is strongly influenced by buoyancy and extinction near the wall. Nevertheless, the N<sub>2</sub>O flame can accelerate due to turbulence and also in presence of different impurities promoting the flame propagation velocity. Main thermo-kinetic combustion properties of nitrous oxide (N<sub>2</sub>O) were calculated for safety purposes using Cantera code with GRI30 mechanism in order to evaluate the Peclet number and so called quenching distances. As an example, Figure 1 (left) shows higher laminar flame velocity at elevated temperatures. Effect of pressure has a maximum for flame velocity at 10 bar (Figure 1, right). We also calculated explosion limits and detonation properties of N<sub>2</sub>O decomposition at different pressures. The calculations have been done as a primary step before the experimental program to evaluate main characteristics of N<sub>2</sub>O decomposition at initial pressures up to 50 bar.

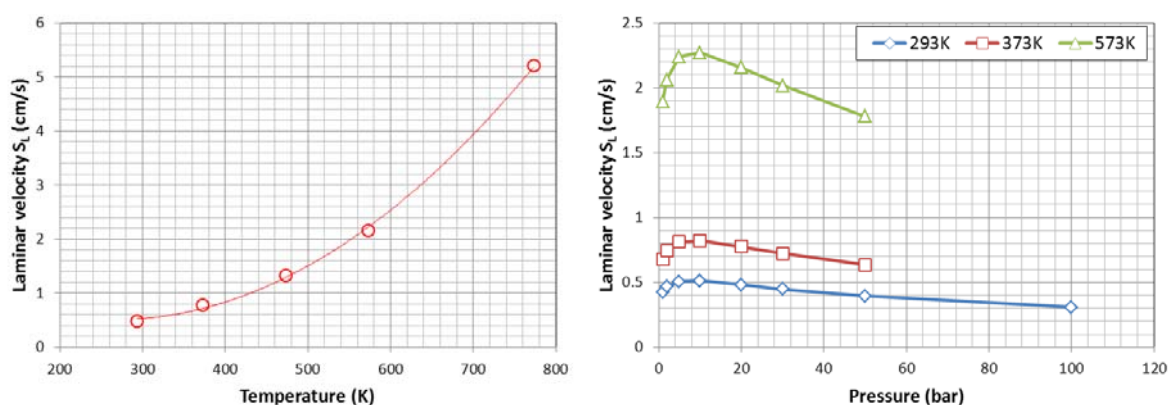


Figure 1: Effect of temperature (left) and pressure (right) on laminar flame velocity for N<sub>2</sub>O decomposition flame (GRI 3.0 Mech).

## References

- (1) Borisov, A.A., Troshin, K.Ya., Biryulin, Yu.S. Critical conditions for nitrous oxide ignition. *Combustion, Explosion, and Shock Waves*, **2009**, 3, 610-614
- (2) Rhodes, G.W., Investigations of Decomposition Characteristics of gaseous and liquid Nitrous. Air Force Weapons Laboratory, Kirtland Air Force Base, New Mexico July 1974
- (3) Borisov, A.A., Troshin, K.Ya., Biryulin, Yu.S. Flame propagation in gaseous nitrous oxide. *Combustion, Explosion, and Shock Waves*, **2009**, 3, 813-817
- (4) Volkov, E.N., Konnov, A.A., Gula, M., Holtappels, K., Burluka, A.A. Chemistry of NO<sub>x</sub> decomposition at flame temperatures. *Proc. of the 4th European Combustion Meeting*. - Austria, Vienna: Combustion Institute, 2009