# AUTO-IGNITION OF HYDROGEN-OXYGEN-STEAM MIXTURES AT ELEVATED PRESSURES UP TO 74 BAR

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The auto-ignition temperatures of premixed stoichiometric hydrogen-oxygen mixtures diluted with steam were experimentally measured and numerically calculated at the initial pressures from 1 to 74 bar. A series of experiments have been performed in cylindrical geometry for two different scales (23 and 50 mm of inner diameter) and for two different materials: martensitic and austenitic steel. Steam concentration was changed in the range from 0 to 75 mol.%. The experimental procedure for measurements of the auto-ignition temperature consisted of precise pressure and temperature records during the linear pressure and temperature increase with a velocity of 0.1 $^{o}$C/s until the self-ignition was identified by a sudden pressure increase associated with an abrupt temperature rise. Initial pressure and temperature of the test gas before heating were kept significantly lower than the expecting self-ignition conditions.
The experimental results continue the well known three explosion limit curve obtained for stoichiometric hydrogen-oxygen mixture up to initial pressure of 1 bar. It was shown that the initial pressure above 1 bar reduces the auto-ignition temperature. For instance, the auto-ignition temperature of 778 K at 2 bar of initial pressure reduces to the temperature of 687 K at pressure of 74 bar. Dilution of the stoichiometric hydrogen-oxygen mixture with up to 75% of steam increases an auto-ignition temperature only in 15-20K depending on the initial pressure. All the tested mixtures at high pressures more than 1 bar are nearby so called third explosion limit where reaction heat release competes with heat losses at the wall surface. Thus, the system becomes sensitive to the size of reaction volume. It was found in current experiments that in two times larger tube the self-ignition temperature decreases in 12-20K compared to the smaller one. Numerical simulation of the auto-ignition for the same mixtures was also performed using several H-O chemical reaction mechanisms: Lutz, Li, Mueller and Maas-Warnatz. Two different numerical codes INSFLA and Cantera have been used for the simulations. As we found in numerical simulations, an induction time of 30-40 s can be used as a threshold for the self-ignition limit. Reduction of the initial temperature corresponding to the induction time of 30-40 s by only 5 degrees completely alters the reactor behavior. The mixture temperature does not change within several hours of residence time. It was shown good agreement of calculated and experimental data on the auto-ignition temperature. Current work was made in order to study explosion limits of stoichiometric hydrogen-oxygen mixtures diluted with steam in order to validate computer codes for safety applications of Boiling Water Reactors at pressures up to 70 bar.