OH KINETICS IN PHOTO-TRIGGERED DISCHARGES USED FOR VOCs CONVERSION

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Abstract. The kinetic of the hydroxyl radical is studied in $N_2/O_2/H_2O$ mixtures with small amounts of acetone or iso-propoyl alcohol (0.5 %) added. The radical density is measured in absolute value in the afterglow of a photo-triggered discharge, which generates an homogeneous transient non-equilibrium plasma, using to a time resolved absorption measurement method.

1. INTRODUCTION

Abatement of Volatile Organic Compounds (VOCs) using non-thermal plasmas is attracting many interests [1-4]. For various VOCs, the OH radical is known to be one of the most important reactive species involved in the removal of the pollutant molecule. This radical is efficiently produced during the discharge by dissociative electron collisions on H_2O or reaction of the water molecule with the first excited state of the oxygen atom. Thereafter OH reacts with the VOC. For dry mixtures, O is usually assumed to be the most important specie for the conversion of the pollutant. However the hydroxyl radical, which is much more reactive with numerous VOCs than the oxygen atom at a temperature close to the ambient one, can be produced through numerous kinetic processes. In particular, it was recently demonstrated by works on homogeneous discharges [5] that the recombination of O- and H-atoms, through three body collisions involving background molecules, is an efficient OH production process in high pressure and low temperature non-thermal plasmas. Therefore the relative importance of O and OH for the removal of VOCs by pulsed discharges deserves to be studied in more details. Numerous works have been devoted to the use of dielectric barrier or corona discharges for the de-VOC process [1-4]. However such discharges are characterized by highly non-homogeneous transient plasmas for which diagnostics of primary radicals and self-consistent modeling are very difficult. In order to avoid problems in connection with density and temperature gradients, we use an homogeneous pre-ionized (photo-triggered) discharge [6]. Isopropyl alcohol (IPA) is chosen as a test molecule. Acetone is the main by-product of IPA conversion [7, 8], so that the role of OH on acetone abatement is also under investigation.

2. EXPERIMENTAL SET-UP

The experimental set-up is given in figure 1. The photo-triggered discharge reactor used for this work was described previously [5]. Two electrodes, 50 cm long with a spacing d=1 cm and a flat profile over 1 cm width, are directly connected to an energy storage unit of capacitance C=17.44 nF charged up to a voltage V_0 in a few hundred nanoseconds. Once V_0 is reached on the electrodes, the gas breakdown is achieved through photo-ionization of the gas mixture by UV-photons which are produced by an auxiliary corona discharge located at the bottom of the main discharge.

A gas compressor is used to produce a gas flow through the discharge gap. The discharge frequency, 1.25 Hz, is chosen such that the whole reactor volume, 500 cm^3, is renewed between two discharges. The volume of the experimental device, 9 l, which corresponds to the total volume of the gas mixture studied, is much higher than the discharge one (50 cm^3) owing to the use of a tank in the loop. The total pressure is 460 mbar for an oxygen percentage ranging from 1 % up to 20 %, and for a VOC