CARBON TETRACHLORIDE DECOMPOSITION IN PULSED SPARK DISCHARGE

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Abstract. Decomposition of carbon tetrachloride diluted with argon was studied under pulsed spark discharge conditions with the use of a quartz-glass reactor of 10 mm i.d. with two electrodes. The reactor was powered with high voltage pulses (up to 18 kV) produced by a circuit supplied with a rotating spark gap. Chlorine was found to be the main product of CCl_4 decomposition, however, the presence of a solid deposit on the reactor wall was observed. The highest level of the overall CCl_4 conversions was about 0.8 with the conversion to Cl_2 exceeding 0.5.

1. INTRODUCTION

A number of processes have been developed until now, aimed at the abatement of organic chlorinated compounds emissions such as aliphatic and aromatic chlorinated hydrocarbons, e.g. tetrachloromethane, trichloroethylene, chloroform, vinyl chloride, chlorinated dioxins, furans and biphenyls. When however pollutants, appear in low concentrations diluted by large streams of inert gases, the simple and often used processes may not be energetically efficient. Therefore, more economic processes are searched for including those, witch make use of low temperature non-equilibrium (non-thermal) plasmas [1-10]. Those kinds of processes are characterized by high efficiencies at relatively low temperatures with a lower energy demand at the same time.

Recently, it has been shown that using spark discharges of very short (but strong) current pulses, their chemical efficiency may be much higher than that of normal corona discharges or dielectric barrier discharges [11,12]. This favorable effect is caused by high concentration of energized electrons generated in the spark channels. They are able to initiate gas reactions, even those with high activation energies. This state of high energy, however, occurs only in limited volumes of the plasma channels. The short time of the current pulses duration (some dozen nanoseconds) enables, when the current vanishes, the rapid quenching of the products when mixed with the cool gas surrounding the discharge channel. Due to the short duration of the current pulses and low pulse frequency, the overall energy demand may be kept at a moderate level.

2. EXPERIMENTAL

The experiments were carried out in a quartz-glass reactor (Fig. 1) of 10 mm i.d. with two electrodes. The high voltage electrode (3) was made of a brass or aluminium rod of 8 mm in diameter with an axial channel introducing gas reagent (1mm in diameter). The grounded electrode (5) was made of a tungsten rod (98% W + 2% ThO_2) 1mm in diameter located at the axis. The distance between the electrodes may be changed. Fig. 2 shows the schematic diagram of DC high voltage system used for the spark discharges generation. The reactor circuit was powered with high voltage pulses (up to 18 kV) produced by the rotating spark gap, with waveforms of voltage and current courses recorded with Tektronix TDS 3032B digital oscilloscope, using high voltage probes Tektronix P6015A (Fig. 3). The reactor was fed with gas mixtures of carbon tetrachloride with argon (99.99%), produced by evaporation of liquid CCl_4 (99.98%) and the mean residence time of the gases was about 29 s.