

TRICHLOROMETHANE CONVERSION IN PLASMA-CATALYTIC SYSTEM

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Abstract. The conversion of trichloromethane in mixtures with air at normal pressure was investigated in the gliding discharge (GD) reactor operated in both homogeneous and plasma-catalytic arrangements. The catalysts produced by MnO₂ deposition on porous structures from zirconia's ceramics were located in the GD reactor below the electrode ends. Cl₂ and HCl were found the main products of the CHCl₃ conversion, with a little addition of CCl₄. The MnO₂ catalyst revealed some activity in the trichloromethane processing resulting in slightly increased overall CHCl₃ conversion with smaller production of CCl₄ than that in the homogeneous system. The effect of temperature on CHCl₃ conversion was found significant.

1. INTRODUCTION

Nowadays, the abatement of volatile pollutant emissions has become one of the main environment saving tasks. The derivatives of aliphatic and aromatic hydrocarbons containing bromine and chlorine, and sometimes also fluorine belong to the most harmful pollutants. The necessary destruction of hazardous volatile pollutants is attained in different ways, the high temperature and catalytic processes being the most often used. As the chlorinated organic compounds are often characterized by a stable structure (e.g. chlorinated dioxines), especially high temperatures are needed for their destruction. This task becomes more troublesome when pollutants are diluted in large volumes of neutral gases, e.g. in air. The low pollutant concentrations make the thermal and catalytic processes of poor economy as a considerable part of energy must be consumed for the bulk of the gas stream heating. There is opening, however, of a new area of processes for diluted pollutant destruction being effective at low temperature range, owing to the action of low temperature non-equilibrium (non-thermal) plasmas. That kind of processes has drawn a great deal of attention in the last decade.

The gliding discharge (GD), known also as "GlidArc", has been found to be effective for the chemical processes where non-equilibrium plasmas are used for the initiation of chemical reactions at atmospheric pressure. Since the time (1988), when the first GD reactor was demonstrated^[1,2], several types of GD systems have been developed. Up till now, a number of experiments were performed with different GD reactors applied for destroying the chemically stable pollutants occurring in industrial waste gases, e.g. volatile organic substances, nitrogen oxides, hydrogen sulphide^[3-11]. The GD techniques were also used for other processes, assistant to the environment protection, e.g. decomposition of chlorofluorocarbons and of a number of other chlorine organic compounds^[12-18]. In order to improve the efficiency of those processes, new plasma-catalytic systems were developed where catalysts are capable to accelerate the required reactions. Studying plasma-catalytic processes, it was found that the yields of reactions proceeding in plasma-catalytic systems are strongly influenced by the distance between the active discharge zone and the catalyst's surface. If the catalyst is not located nearby the discharge channel, only a small fraction of active species (radicals, ion-radicals) generated by the plasma action can reach its surface and take part in the catalytic reactions.

Recently, the efficiency of gliding discharge techniques was tested in several studies on the chlorinated hydrocarbon decomposition including trichloromethane. High conversion (97%) was obtained using gliding discharge of frequency 15 – 20 kHz in the mixture of 1% CHCl₃ with air. The product selectivity of Cl₂ was observed over the range of 33 – 50.5% and the selectivity of CCl₄ (the portion of chloroform converted to CCl₄) was 5.3 – 11.8%. On the basis of those experiments, it was concluded that gliding-discharge plasma may be very effective in trichloromethane processing, especially in the presence of oxygen^[14-17].

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