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Photo Catalytic Reaction of Titanium Dioxide by Sol-Gel Method

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Abstract

Toluene, volatile organic compounds (VOCs) are pollutants and their emissions have indirectly influence climate change photocatalytic oxidation one method which can degrade the toluene by using titanium dioxide as a catalyst by sol-gel technique. The reactant mol ratio for titanium dioxide sol-gel formation was 1:40. The dependency of the toluene removal efficiency on relative humidity, UV light intensity, and photocalalyst loading were studied in the photocatalytic reactor. The results show factors play an important role in the oxidation of toluene.

Keywords: Photocatalytic reactor, UV light, VOCs, Toluene, Titanium Dioxide, Sol-Gel.

Introduction

VOCs, toluene are the most pollutants producing fog and clouds and also toxic in a central nervous system depressant and an irritant of the eyes. The most extensively used technology to remove to toluene from waste air is activated carbon adsorption process [1-3]. Total weighted average over a typical eight-hour worked, of toluene in limited at 150ppm, the efficient and economical degradation of determination under varying condition such as adsorption temperature, humidity & activated carbon [4-6] of emission air has increased attention.

To accomplish our goal is to prepare titanium dioxide by sol-gel method and study the photocatalytic activity of toluene degradation in waste air [7]. Photocatalytic oxidation was performed in plug-flow reactor at varying of relative humidity. The experiments were allowed for identification of efficient operating condition to enhance the oxidation of toluene in the waste air.

Instrumentation and measurements

The system used in experiment consists of 1- Air compressor, 2- water container, 3- toluene tank, 4- rotameter, 5- photoreactor (waste air synthesis system, UV lamp, and gas flow meter, 35cm long glass column and 2.5cm interior diameter) [8]fig.1.

A part of air flow was bubbled in liquid toluene tank to generate toluene contaminated air. The toluene concentration in the air was controlled by the ratio of the toluene contaminated air flow to total compressed air flow. The experiments were conducted at toluene concentration in waste air of 100-200 ppm. The contaminant air was monitored at flow rate of 3.5 per min. After initiation of illumination, 10 min equilibration time proved adequate to attain stable condition within the reactor and the photocalalytic reaction to achieve steady state. After 180 minutes to toluene degradation was performed. The relative humidity was controlled at 20-90%. In order to determinate the concentration of toluene in waste air, sampling 1 (inlet) and sampling 2 (outlet) of photoreactor using charcoal activated carbon adsorbent tube. The removal efficiency of the photocatalytic system was calculated by equation:

$$\text{Toluene removal eff. (\%)} = \frac{C_\circ - C}{C_\circ} \times 100$$

Where the $C_\circ$ = inlet concentration (ppm) and C is outlet concentration.

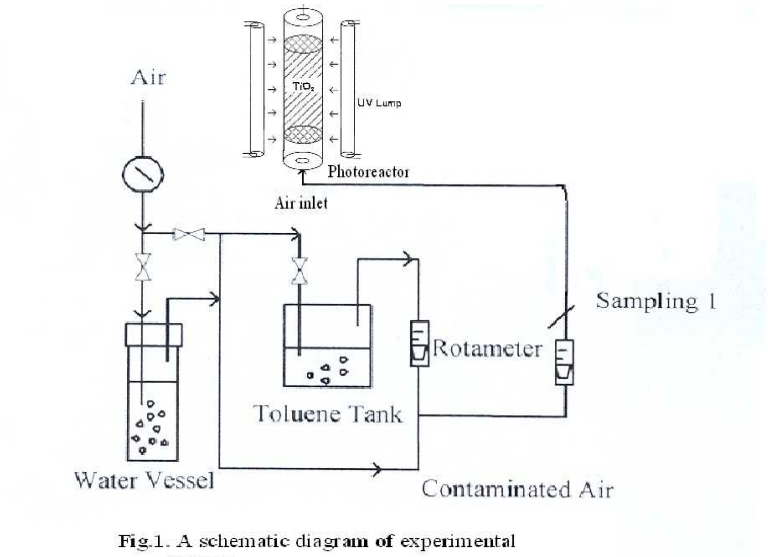

Fig.1. A schematic diagram of experimental System.

Results

The phase transformation of titanium dioxide from amorphous to crystalline anatase was completely occurred at 300°C and increasing to 600°C. This shows that the crystallinity of the particle and completely transformed into anatase phase [9]. Fig.2, illustrates the saturation time, time at $C/C_\circ$=0.95, at various toluene concentration. This shows at specific adsorption temperature, the breakthrough time and the total adsorption time were decreased with increasing inlet concentration. The breakthrough curves were steeper at higher concentration due in part to the effect of concentration on the transfer rate of toluene.The experiments carried out with different relative humidity in the gas from 10 to 90%, this shows that toluene

removal efficiency as a function of relative humidity at 150 ppm toluene concentration in waste air.

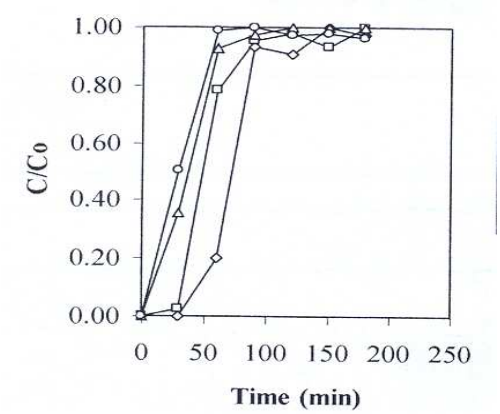

Fig.2. The through break curve of toluene

Therefore, the high quantity of water vapor inhibited the photo catalytic degradation of toluene in the waste air [10-12].

Conclusion

The composite titanium dioxide catalyst was successfully prepared by sol-gel method to remove toluene in waste air. The continuous plug flow reactor was packed by photo catalyst material and positioned the UV light outside to conduct the experiments toluene removal from waste air in the reactor using the prepared titanium dioxide were performed to compare the influence of illumination, photo catalyst packed loading and relative humidity.

The breakthrough curve was steeper at higher concentration due in part to the effects of concentration on the transfer rate of toluene from the fluid phase to the solid adsorbent. The toluene removal efficiency decreased significantly when increasing relative humidity beyond 40%. Adsorptions and oxidation of toluene on the photocatalyst was found to be significantly affected by all parameters. In the experiment showed a high catalytic reactivity with a maximum toluene removal efficiency of about 50% for the toluene feed concentration of 100-200 ppm.

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