Catalytic Ozonation of PA in Water in the Presence of Cerium Dioxide (CeO₂)

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Abstract. Ozone is an excellent disinfectant and oxidant. Phthalate acid is a typical organic acid that with a good complex adsorption capacity. In this study, experiments were carried out to investigate the influence of adsorption to the catalytic ozonation. The removal of PA, the influence of tert-butanol and the ozonation mechanism during the catalytic zonation by Cerium Dioxide (CeO₂) were discussed. The results indicated that the catalytic ozonation by cerium oxide could increase the removal of PA, and after adding the tert-butanol, the removal of PA did not reduce. As the surface Ce (IV) of CeO₂ was a strong Lewis acid, it was easily to absorb PA and ozone to form the intermediates, the adsorption of organic matter increased the reactivity. CeO₂ in the process of catalytic ozonation played the role of adsorbent and catalyst.

Keywords: Catalytic ozonation, phthalate acid, iron hydroxide, cerium dioxide.

1 Introduction

Ozone had recently received more attention in water treatment because of its high oxidation and disinfection potential, and it had been used in many drinking water plants for the oxidation to improve taste and colour as well as to remove the organic compounds in water. Different ozone catalysts were used to improve the oxidation efficiency. Catalytic ozonation was found to be effective for the removal of several organic compounds from the drinking water. [1].

Generally, heterogeneous catalytic ozonation mainly played three roles: (1) After organic matter in water contact with the catalysts, it will be adsorbed on the catalyst surface, thus facilitating the further oxidation by ozone; (2) Catalysts can accelerate ozone decomposition to generate free radicals with high activity and oxidative ability (eg, hydroxyl radical, etc.). Then free radicals generated by catalytic ozonation react with organic matter to improve the removal efficiency of organic matter; (3)organic matter and ozone simultaneously adsorb on the catalyst surface, and then further reaction take place between the adsorbed organic matter and ozone.

Phthalate acid is a typical organic acid that with a good complex adsorption capacity, therefore, Therefore, PA was used in this study as the target to study the effect
of complex adsorption on the removal efficiency of different organic matter by catalytic ozonation, the study of ozone oxidation for in-depth study of the mechanism is important.

2 Experimental

2.1 Materials and Experimental System

Milli-Q ultrapure water (Millipore Milli-Q Gradient) was used in the study. Ozone was produced by DHX-SS-1G ozone generator (Harbin Jiujiu Electrochemical Engineering Co., Ltd.) with pure oxygen as gas source. Ozone dosage was adjusted by the oxygen flow rate and ozone generator control gear. As the catalysts used in the experiments were powdery, so the samples were filtrated through the glass fiber membrane (Whatman) to remove catalyst particles in the sample and the concentration of PA was not affected during the filtration of the sample and then added the filtered sample to the 10 ml colorimetric tube containing 0.5ml of 0.025mol / L Na$_2$SO$_3$ solution.

Fig. 1. Scheme of static test reactor

2.2 Analysis

The high performance liquid chromatography (Waters) was used to determine the concentration of PA, and the determination conditions were as follows: C18 column (Waters), 0.5% phosphoric acid -water(40:60) as mobile phase with the flow rate of 1mL/min, detection wavelength: 224nm, injection volume: 50μl. The ozone content in distilled water was determined by ultraviolet spectrophotometer (752) [2].

3 Results and Discussions

3.1 Effects of Catalytic Ozonation by Different Catalysts

It could be seen from Fig.2, the absorption capacity of PA on iron oxide hydroxides(FeOOH) was very little, but the absorption capacity of PA on cerium dioxide increased rapidly in 2min and increased slowly in 2min-30min after reaction.