Catalytic Ozonation of 2, 4-Dichlorophenol by Activated Carbon

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Abstract: Ozonation treatment of 2, 4-dichlorophenol (2, 4-DCP) with granular activated carbon (GAC) in a fluid bed reactor was investigated, and enhanced 2, 4-DCP decomposition was obtained when GAC amount increased. Higher efficiency of catalytic ozonation could be achieved in acid pH, but the influence of the strength of acid and basic pH could be neglected. The results of repeated use showed that GAC could be efficiently regenerated in situ in the reactor and maintain its high activity.

Key words: Catalytic ozonation; 2, 4-dichlorophenol; GAC adsorption; GAC regeneration
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Chlorophenols could be found in many industrial wastewaters which are hard to be treated by biological system. Although adsorption of GAC is effective, however, GAC could get saturated easily and need to be regenerated or even replaced. Lin et al.[1-2] reported that GAC acts not only as the adsorbent but also as a catalyst in promoting ozone oxidation. In current work, 2, 4-DCP were selected as a model contaminant to assess the catalytic performance of GAC in the ozonation of 2, 4-DCP.

1 Experiments

The pyrex reactor was Φ3 cm × 50 cm, and 250 ml 2, 4-DCP solution was used for each run. The Actual O_3 concentration from ozone generator (CF-G-3-10G, Apolo Corp., Jinan, China) was controlled by airflow rate, which was 9.8 mg/L at 5 L/min inlet airflow rate. GAC (Shanxi Xinhua Co., China) was coal-based PJ8×20 with a BET surface area of 830 m^2/g and a total pore volume of 0.3498 cm^3/g. 2, 4-DCP concentration in water was determined by UV762 spectrophotometer as described by Zhang et al.[3]. The pH value of the solution was measured by PHSJ-3F pH meter.

2 Result and discussion

2.1 Effect of variables

The effect of the GAC amount on the removal of 100 mg/L 2, 4-DCP shown in Fig. 1 is quite significant. For a short ozonation time of 2 min, the 2, 4-DCP removal was drastically elevated from 19.5% without GAC to 98.6% with 12 g of GAC, due to the combined adsorption and catalysis of GAC.

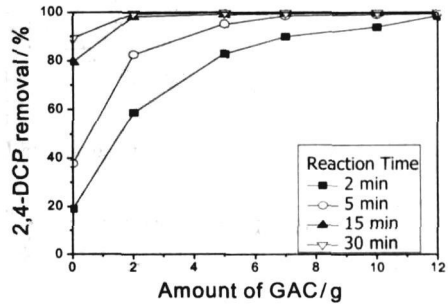

Fig. 1 Effect of GAC amount on 2, 4-DCP removal

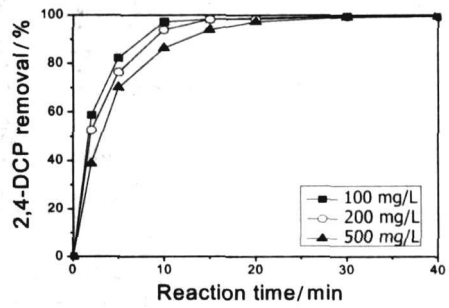

Fig. 2 Catalytic ozonation of different initial 2, 4-DCP concentration (2g GAC)

As shown in Fig. 2, with the increase of initial 2, 4-DCP concentration, the 2, 4-DCP removal decrease slightly. At 10 min, 2, 4-DCP removal was 86% for an initial 2, 4-DCP concentration of 500 mg/L, but about 97% for that of 100 mg/L. However, the total removed

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2, 4-DCP increased significantly when the initial concentration increased. This implies a higher ozone utilization efficiency.

The results in Fig. 3 showed that the 2, 4-DCP removal were much higher at pH<7. The different acidic pH had little influence on the 2, 4-DCP removal, and so did the different basic pH. This may be caused by the following reasons: At pH<7, the dissociation of 2, 4-DCP molecules could be neglected, that they were adsorbed by GAC and reacted rapidly with ozone on the surface of carbon. 2, 4-DCP was hydrolyzed into phenolate ions at pH>7, which are hardly adsorbed by GAC, leading to a lower 2, 4-DCP removal.

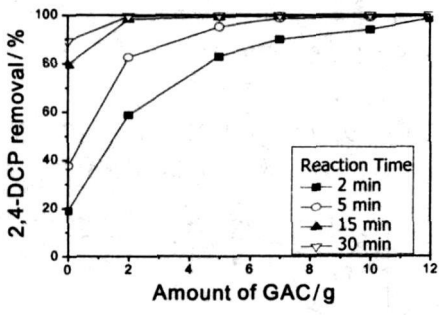

Fig. 3 Effect of pH on the 2, 4-DCP removal (2 g GAC)

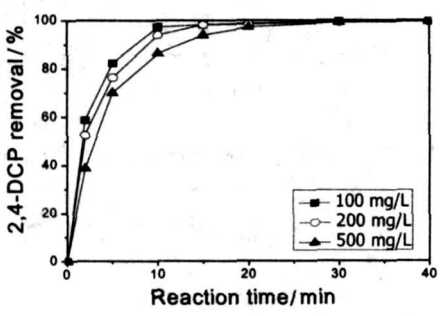

Fig. 4 Repeated use of 2 g GAC

2.2 Catalytic activity of GAC in 2, 4-DCP ozonation

Lin, et al.[1,2] reported that GAC could be regenerated in situ in the ozonation of industrial wastewaters. To ascertain the regeneration efficiency of GAC by ozonation, experiments were conducted to use the same GAC continuously up to four cycles. The results in Fig. 4 showed that there was little difference in the catalysis of GAC, it still result in nearly complete removal of 2, 4-DCP even for up to four repeated uses. These indicate that GAC can be well regenerated in situ in the ozonation of 2, 4-DCP.

3 Conclusions

GAC can increase significantly the 2, 4-DCP removal, especially in the initial ozonation stage. The increase of initial concentration caused the 2, 4-DCP removal decreased slightly, but the total removed 2, 4-DCP increased significantly. Higher efficiency could be achieved at acid pH, and the strength of acid or basic pH hardly influenced 2, 4-DCP removal. The repeated use showed that GAC could be well regenerated in situ in the ozonation of 2, 4-DCP and the catalytic ability of GAC was almost not reduced.

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活性炭对 2, 4—二氯苯酚的催化臭氧化降解

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摘 要: 研究了粒状活性炭 (GAC) 对 2, 4—二氯苯酚 (2, 4-DCP) 臭氧化降解的催化性能。由于活性炭的吸附和催化作用, 提高了 2, 4-DCP的分解。在酸性条件下具有较高的催化臭氧化效率, 而酸性和碱性的强弱对 2, 4-DCP的分解几乎没有影响。活性炭的重复使用实验表明活性炭在臭氧化处理过程中可以得到原位再生, 多次使用后其催化活性几乎没有降低。

关键词: 催化臭氧化; 2, 4—二氯苯酚; GAC吸附; GAC再生

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