Catalysis of Activated Carbon and Activated Carbon Fiber in High Voltage Pulse Discharge Water Treatment

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Abstract: Catalysis of granular activated carbon and activated carbon fiber were investigated in high voltage pulsed discharge wastewater treatment. The experimental result shows that the removal efficiency of methyl orange can be enhanced by 22% and 24% respectively in combined treatment of pulsed streamer discharge and granular activated carbon or activated carbon fiber. The degradation rate can be enhanced by 12.25% and 16.7% respectively with and without saturated granular activated carbon or activated carbon fiber in discharge. This indicates that the catalytic activity of activated carbon fiber is more advantageous. In addition, regeneration of granular activated carbon and activated carbon fiber can be achieved in this process.

Key words: pulsed discharge; water treatment; activated carbon; activated carbon fiber; catalysis
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Pulsed streamer discharge is a burgeoning Advanced oxidation processes, which is based on the generation of highly reactive species, and have displayed higher efficiency of degradation for organic compounds[1]. The combined treatment of pulsed streamer discharge with activated carbon enhanced the efficiency of degradation[2]. The combination of pulsed streamer discharge with activated carbon fiber (ACF) has not been reported so far.

The aim of this study is to investigate catalysis of granular activated carbon (GAC) and that of activated carbon fiber in pulsed streamer discharge.

1 Experiments

1.1 Experimental apparatus

Experimental apparatus are composed of high voltage power supply and gas-liquid series electrical discharge reactor[3]. Voltage and frequency ranges are 0 ~60 kV, 0 ~320 Hz respectively, storage capacitor is 67 PF and pulse rise time is less than 100 ns.

1.2 Experimental materials and analytical approach

The concentration of methyl orange solution and the volume of solution were 40 mg/L and 100 mL respectively. GAC manufactured from cocoanut shell with 1 ~2 mm in grain sizes. ACF manufactured from polyacrylonitrile felt.

The degradation rate of methyl orange can be written as $\eta = (C_0 - C_t)/C_0 \times 100\%$, where C_0 is the initial concentration of solution, C_t is the concentration of corresponding treatment time, η is the degradation rate.

2 Results and discussion

2.1 Synergistic effects of combined treatment

Figure 1 shows that 55.77% and 51.96% of the methyl orange was removed when 5 g/L GAC and 0.45 g/L PAN-ACF adsorbed for 15 min respectively without discharge. 72.61% of the methyl orange was removed by pulsed streamer discharge. The degradation rate increased to 94.46% and 96.55% respectively by combined treatment of pulsed streamer discharge with 5 g/L GAC or 0.45 g/L PAN-ACF. This result indicates that synergetic effects can be formed in the combined treatment.

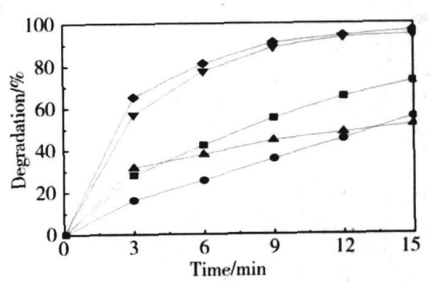

Fig. 1 Effects of GAC/ACF on degradation rate
■ Discharge ● GAC adsorption ▲ ACF adsorption
▼ Discharge/GAC ◆ Discharge/ACF

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2.2 Catalysis of GAC and PAN-ACF

The saturated GAC and PAN-ACF were added into the reactor. Figure 2 shows that the degradation rate was enhanced by 12.25% and 16.7% respectively. It indicates that GAC and PAN-ACF had catalysis in the combined treatment and the catalysis of ACF was prominent.

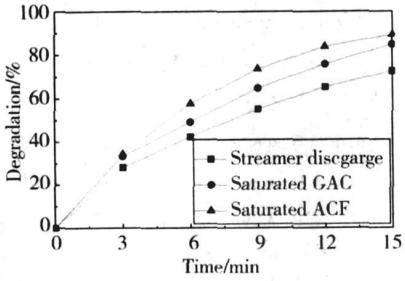

Fig. 2 Catalysis of GAC/ACF

2.3 Acceleration of H_2O_2 to hydroxide radicals

Figure 3 shows that 98.4% and 98.41% of methyl orange were removed respectively with adding H_2O_2 in combined treatment. This result indicates that H_2O_2 can accelerate the combined treatment process.

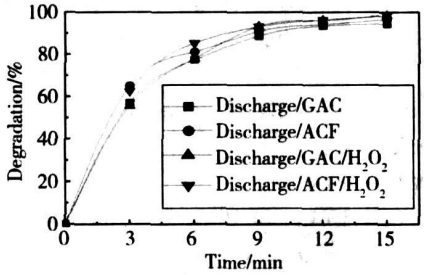

Fig. 3 Acceleration of H_2O_2 on degradation rate

2.4 H_2O_2 help to regeneration of GAC/PAN-ACF

Figure 4 shows that the degradation rate enhanced 5% and 3.11% respectively with adding H_2O_2 in pulsed streamer discharge with GAC saturated or PAN-ACF saturated. It can be observed that the adsorbed proportion of GAC and PAN-ACF decreased 1% respectively comparing with before H_2O_2 added. Therefore, it is helpful to the regeneration of GAC and PAN-ACF.

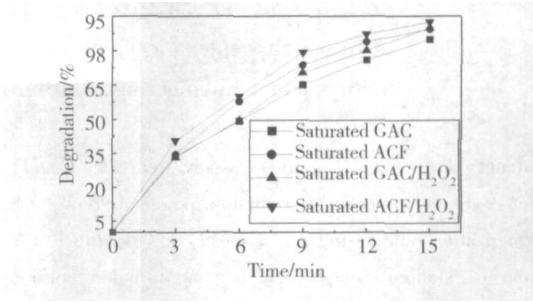

Fig. 4 H_2O_2 promoted the regeneration of GAC/ACF

3 Conclusions

Synergetic effects can be made in the combined treatment, GAC and PAN-ACF showed catalysis. The regeneration of GAC and ACF can be achieved simultaneously. The utilization ratio of O_3 and UV can be increased with addition of H_2O_2.

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活性炭和活性炭纤维在高压脉冲放电水处理中催化作用的对比研究

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摘　要：对脉冲流光放电与活性炭或活性炭纤维联合处理废水时活性炭和活性炭纤维的催化作用进行了研究。结果表明：脉冲流光放电与活性炭或活性炭纤维联合处理，降解率分别提高 22%和 24%，说明联合处理过程具有协同效应。与吸附饱和的活性炭或活性炭纤维联合处理，降解率分别提高 12.25%和 16.7%，说明活性炭和活性炭纤维在联合处理过程中起催化作用。联合处理过程中加入 H_2O_2，不但提高了 O_3 和 UV的利用率，而且还提高了活性炭和活性炭纤维的再生率。

关键词：脉冲放电；水处理；活性炭；活性炭纤维；催化作用

中图分类号：X701