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SHORT COMMUNICATION

PHOTOCATALYSIS–MEMBRANE SEPARATION COUPLING REACTOR: REMOVAL OF ORGANIC POLLUTANTS FROM WATER

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Abstract: This work reports the photodegradation process of methylene blue in a membrane photoreactor by using TiO_2 as the photocatalyst and phosphate microfiltration membrane as separation barrier recovery and recycle the photocalysts particles. The rejection rate of the TiO_2 photocatalyst particles reaches 99.9% and the degradation rate of methylene blue is 75% in 1 hour of filtration.

Keywords: *filtration, methylene blue, microfiltration, photocatalysis membrane, photodegradation*

INTRODUCTION

Organic pollutants are present in the water environment usually as a result of their occurrence in industrial effluents. The treatment of such wastewater is based on various mechanical, biological, physical and chemical processes [1].
The increasing volume of wastewater containing non biodegradable pollutants discharged into the environment demands the development of new powerful, clean and safe decontamination technologies.
The photocatalytic degradation has received a great attention as an alternative method in the removal of environmental pollutants in aqueous as well as gaseous media [2]. Anatase-type titania have been proven as environmental friendly catalysts because of its capability to decompose the different organic and inorganic pollutants [3].
However, the step of separation of the catalyst is necessary, which increase the overall costs of the process, although TiO_2 shows high photocatalytic activity, the problem of separation of its particles emerges in the practical applications [4].
A ceramic microfiltration membrane can meet this requirement and has been used for this purpose owing to its excellent material properties. In fact the membrane separation process, because of its selective separation, has already been shown to be competitive with the other separation process in energy cost, material recovery and reduction of the environmental impact. Thus coupling of photocatalysis and membrane separation should result in a useful process for water treatment.
This study reports the photodegradation process of methylene blue in a membrane photoreactor by using TiO_2 as the photocatalyst and microfiltration membrane as separation barrier recovery and recycle the photocalysts particles.

EXPERIMENTAL

Membrane preparation

After collection the phosphates, stones and other heavy particles were removed from the samples, which when crushed, ground and sieved through a 50 µm sieve to remove the larger non-clay fractions for obtaining fine fraction of clay. The sample shaping was performed by extrusion of the mixture of phosphates and organic additives (starch, Amijel and PEG 1500) and heated to 1200 °C.
The zirconia layer (microfiltration layer) was deposited on the inner surface of the phosphate support by slip casting. After drying at room temperature the ZrO_2 membrane was sintered at 1100 °C for 2 h, after bonding at 300 °C for 1 h; the zirconium layer presents a pore diameter of 0.23 µm and an average thickness of the layer above 10 µm.

Experimental set up

Figure 1 presents the schematic diagram of the photocatalysis-membrane coupling reactor and experimental unit.

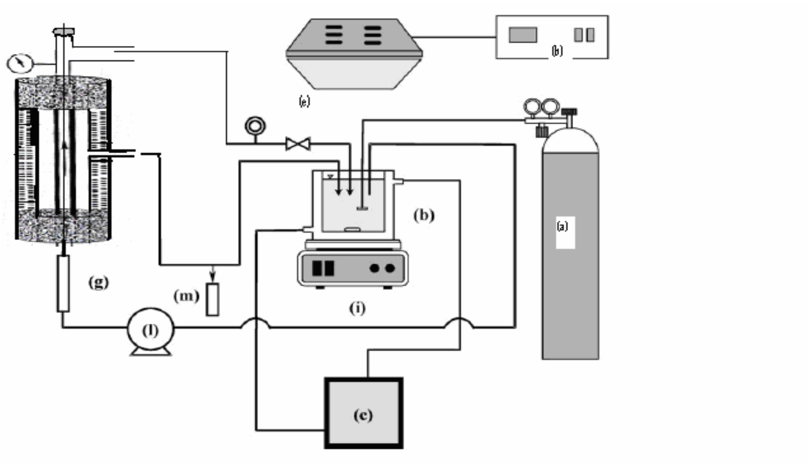

Figure 1. *Experimental set up:*
(a) oxygen cylinder, (b) cylindric reactor with cooling jacket; (c) thermostatic bath;(d) power supply;(e) medium pressure Hg lamp with conic reflector; (f) manometer; (g) rotameter, (h) cell containing the membrane; (i) magnetic stirrer; (l) pump; (m) graduate cylinder for permeate sampling

RESULTS AND DISCUSSION

The rejection rate of the ceramic membrane for the TiO_2 photocatalyst is shown in Figure 2.
In the initial period of the microfiltration, the rejection rate for TiO_2 particles was more than 98%. After 40 min, the rejection rate completely TiO_2 particles was more than 99.5%. Meanwhile, no TiO_2 particles could be detected in the permeation liquid. This showed that TiO_2 photocatalyst was separated completely.
In order to measure the photocatalyst degradation rate in the coupling reactor, the photocatalytic oxidation of methylene blue was conducted in the coupling reactor. The result is shown in Figure 3. The degradation reaches 75% in 1 hours of filtration.

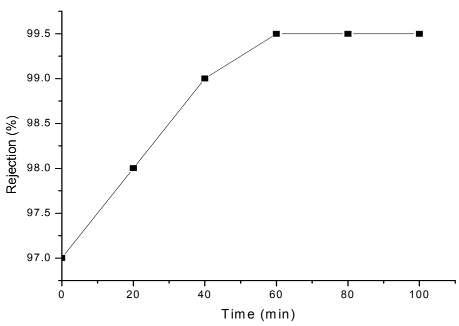

Figure 2. *The rejection rate of TiO_2 versus the time*

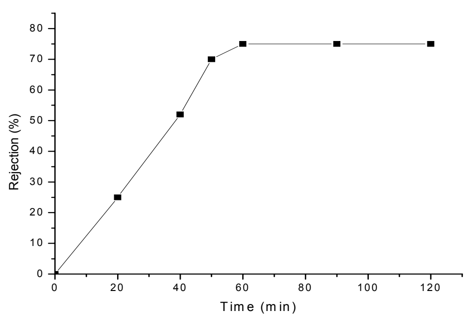

Figure 3. *The rejection rate of methylene blue solution*
(reaction condition: methylene blue 25 ppm, TiO_2 1 g/L, 30 W lamp)

CONCLUSION

The photocatalysis membrane separation coupling reactor system was studied. The rejection rate of TiO_2 particles, the microfiltration flux and the photocatalytic degradation rate of Methylene blue was investigated in the reactor under optimized operating conditions. This coupling reactor can meet the needs of both the separation of the particles and the photocatalytic reaction, and it is suitable for continuous and pilot scale operations.

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