The use of TiO_2-coated activated carbon to oxidize TCE

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Introduction

Although halogenated organic compounds were widely used in industry, they are considered to be very dangerous environmental pollutants [1]. Trichloroethylene (TCE) have been widely used in dry cleaning, metal degreasing and as chemical intermediates, therefore they are easily found in a various water supplies. Due to its high toxicity and volatility, TCE in water may be removed by activated carbon and air stripping, which do not degrade them but relocate it in another environment. In recent years, photocatalytic oxidation with TiO_2 powder to destroy organic pollutants from contaminated water has received considerable attention and extensively been studied [2-3]. TiO_2 powder has, however, some detrimental shortcomings for practical application. TiO_2 powder is not only difficult to be separated from water after being used, but also reduces photocatalytic efficiency due to light scattering.
In this study TiO_2 was coated mainly at the exterior surface of granular activated carbon, and this TiO_2-coated activated carbon(GAC-Ti) was employed for the adsorption followed by photocatalytic decomposition of TCE.

Experimental

TiO_2-coated activated carbon(Figure 1) was prepared through a modified sol-gel method. Finely dispersed TiO_2 particles were located mainly at the exterior surface in the vicinity of macropores of the activated carbon. Adsorption and photocatalytic oxidation of TCE with TiO_2-coated activated carbon was carried out in a cylindrical continuous flow fluidized bed reactor with 65cm height and 68cm inside diameter (Figure 2). Four low pressure mercury lamps (15 W, 254 nm) were installed inside the reactor. 4.5kg of TiO_2-free activated carbon (GAC) or TiO_2-coated activated carbon (GAC-Ti) was loaded inside the reactor and

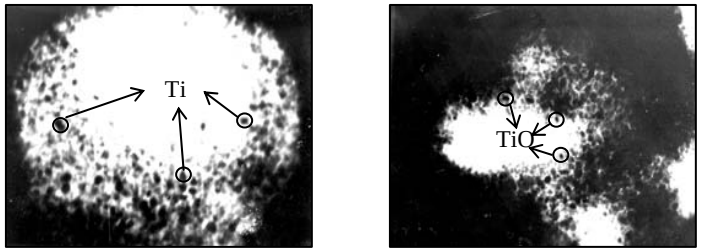

Figure 1. TEM micrographs of TiO_2-coated activated carbon (left: ×40,000 magnification, right: ×80,000 magnification)

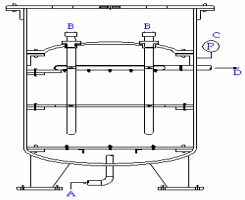

Figure 2. Schematics of the fluidized bed reactor (A: inlet, B: UV-lamp, C: pressure gauge, D: oulet).

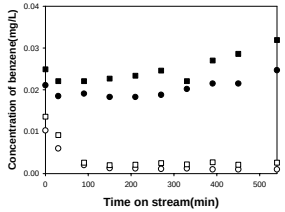

Figure 3. Concentration of TCE at the exit of the fluidized bed reactor with GAC and GAC-Ti at different volumetric flow rates (●: 155cm^3/sec, GAC; ■: 199 cm^3/sec, GAC; ○: 155cm^3/sec, GAC-Ti; □: 199 cm^3/sec, GAC-Ti).

aqueous solution of TCE (0.05mg/L concentration) was fed into the bottom of the reactor. Successful fluidization without carryover of the activated carbon particles could be obtained at the flow rates of upward-flowing water between 150~200cm^3/sec.

Results and Discussion

TCE solution (0.05mg/L concentration) was fed into the reactor at the fluidizing flow rates, and their concentrations at the exit stream of the reactor were measured. Figure 3 illustrates TCE removal efficiencies obtained with the 4.5 kg GAC and with 4.5 kg GAC-Ti under the illumination of UV-light at different fluidizing velocities. The concentrations of TCE at the exit of the reactor after 30 min operation with GAC were 0.019 and 0.022 mg/L at the flow rates of 155 cm^3/sec and 199 cm^3/sec, respectively. About 56-62 % of TCE in the feed solution can be said to be removed. Then exit concentration of TCE increase gradually, and reach at around 0.025 and 0.032 mg/L after 540 min operation, respectively. These results indicate that the surface of the activated carbon becomes saturated due to the containing uptakes of TCE. On the contrary, more than 90% of TCE in the feed solution is steadily removed up to 540 min operation with GAC-Ti. These results are believed that this stable and high removal efficiency is due to the adsorption of TCE on the surface of the activated carbon followed by continuous migration onto the surface of TiO_2 particles where subsequent fast oxidation of TCE proceeds.

Conclusion

TCE in water could successfully be degraded by using TiO_2-coated granular activated carbon. Continuous migration and subsequent photocatalytic oxidation on the surface of TiO_2 accelerated TCE removal efficiency greatly, and made the application of the TiO_2-coated granular activated carbon more practical.

References

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