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Sonophotochemical Degradation of Phenol with Solid Catalysts

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1. Introduction

Phenol is a very important pollutant in wastewater treatment because it is a toxic even in low concentration and widely used in chemical industry [1]. Many researches have been studied to removal phenol in a long time. One of method is advanced oxidation process (AOPs) which is chemical treatment to oxidize organic and inoraganic material using reagent such as OH radical, hydrogen peroxide.

Application of ultrasound (US) in removal of phenol is one of AOPs. When ultrasound is irradiated in aqueous phase cavitation bubbles are produced. The collapse of the cavitation bubble produces localized high pressure and temperature. Under these condition, gas molacules in cavitation bubbles pyrosis and generates energetic free radical species such as OH radical which combine and produce other oxidants such as hydrogen peroxide. Below reaction schemes show simply the formation OH radical and hydrogen peroxide when ultrasound is irradiated in water [2,3].

$$H_2O \rightarrow))) \; OH\cdot + H\cdot \quad (1)$$

$$OH\cdot + H\cdot \rightarrow H_2O \quad (2)$$

$$2\,OH\cdot \rightarrow H_2O \quad (3)$$

$$2\,OH\cdot \rightarrow H_2O_2 \quad (4)$$

Many previous reports have clearly shown that application of ultrasound is available to removal of phenol. Recently combination of sonochemistry and other AOPs such as Fenton oxidation process have investigated to solve enhance removal efficiency of phenol. [1,3-6]. Combination of sonochemistry and photocatalytic process is one of these method.

The aim of study is to comparison of the removal rate and mineralization of phenol according to solid catalyst to find catalyst suitable for sonophotochemical degradation of phenol.

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2. Materials and method

The experimental set-up is depicted schematically in Fig. 1. The glass reactor which volume is 200mL and Five UV-C lamps are in the bath type Ultrasound sonicator made pentagon shape (Mirae Ultrasonic Tech.). UV-C lamp (10.5 W, 18.5 cm) is a commercial halogen lamp. The phenol (99%, Samjun chemical co.) solution which volume is 150mL and initial phenol concentration is 100mg/L is input the reactor. Sonicator was operated at constant frequency, 20kHz and power density, 1.85W/mL and temperature was maintained 20±1℃.

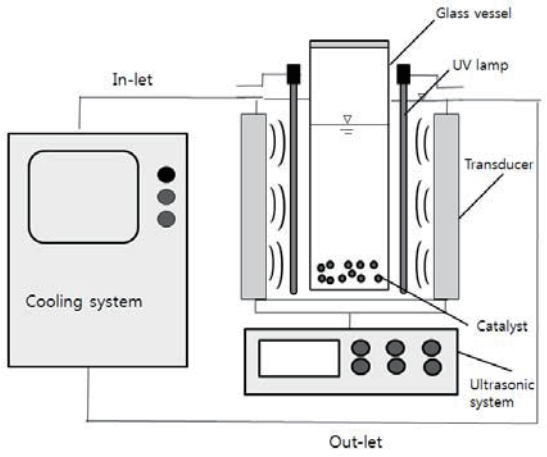

Fig. 1 Schematic of experimental set-up.

When sonophotochemical experiment with catalysts, CuO are used as catalyst which concentration is fixed 0.1g/L. Samples are filtrated by Syringe filter (0.45 μm, Whatman).

The phenol concentration was analyzed by direct photometric method using UV-spectrophotometer (DR 2800- HACH) and Solution which include 98% potassium ferrocyanide, 98% 4-aminoantipyrine, 28-30% aminium hydroxide 99% KH_2PO_4 (Samjun chemical co). and 99% K_2HPO_4 (Kanto chemical co.). Total organic carbon is analyzed with Siever 900 TOC analyzer.

3. Result and discussion

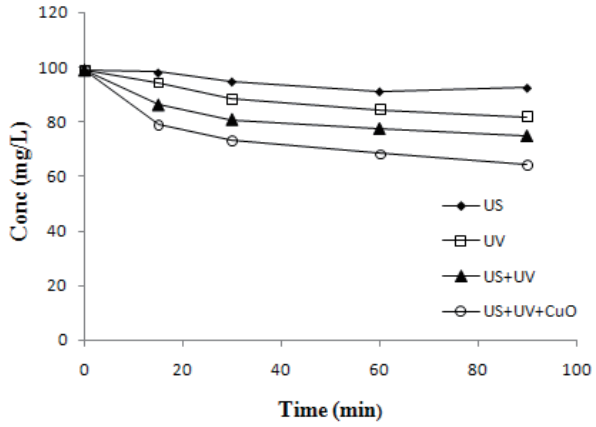

Fig. 2 The comparison of phenol reduction in aqueous phase by US only, by UV only, by US + UV, by US +UV+ CuO (0.1g/L

Fig. 2. shows the comparison of removal rate with method. After 90min of reaction, the amount of removals in combination of sonochemistry and photochemistry process is similar to sum of the amounts using ultrasound and ultraviolet irradiation separately. These results were different from previous reports, because ultrasound power density was much lower than UV intensity [7].

When ultrasound and ultraviolet were irradiated together, the presence of CuO increased the degradation rate. Because CuO acted as catalyst, formation rate of OH radical and H_2O_2 is accelerated.

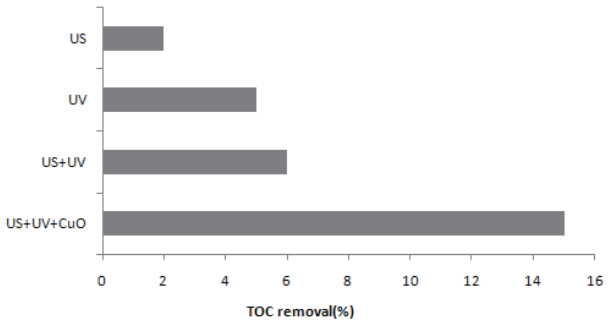

Fig. 3 The comparison of TOC degradation by US only, by UV only, by US + UV, by US +UV+ CuO (0.1g/L) after 90min of reaction

TOC degradation after 90min of reaction is shown in Fig 3. There isn`t Synergy effect in using ultrasound and ultraviolet without CuO. These results are similar to degradation of phenol concentration.

When ultrasound and ultraviolet were irradiated in presence of Cuo, TOC was significantly degraded.

Acknowledgment

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References

1. R. Chand, N. H. Ince, P. R.Gogate and D.H. Bremner: Separation and Purification Technol. **67** (2009) 103
2. K. S.Suslick, D.A. Hammerton, R. E. Cline and J.Am: Chem. Soc. **108** (1986) 5641
3. R. Kidak and N.H. Ince: Ultrason Sonochem **13** (2006) 195
4. E. Naffrechoux, S.Chanouz, C. Petrier and J. Suptil: Ultrason Sonochem **7** (2000) 255
5. Y.C.Chen and P. Smirniotis: Ind. Eng. Chem. Res. **41** (2002) 5958
6. D. Drijvers, H. V. Langenhove and M. Beckers: Wat. Res. **33** (1999) 1187
7. C. Wu, X. Liu, D. Wei, J.Fan and L.wang: Wat. Res. **35** (2001) 3927