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# Comparison of Adsorption Characteristics of Acetone Vapor and Toluene Vapor on Silica- Alumina Fixed-Bed Reactor

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## 1. Introduction

The volatile organic compounds (VOCs) are the critical toxic substances, and these substances may cause harmful effects on human health and could even cause cancer if people are exposed for a long time [Lillo-Rodenas et al., 2002; Tancrede et al., 1987]. Adsorption method is regarded as effective technologybecause it is possible to separate adsorbate selectively according to pore structure of adsorbent. VOCs generated in plants and factories are composed of polar and nonpolar organic compounds mixed with each other. So adsorption characteristics between polar and nonpolar organic compounds were thought to be different. This study was compared of adsorption characteristics according to polarity of adsorbate. Breakthrough experiments were carried out according to inlet concentration and linear velocity of adsorbate; acetone and toluene, using silica-alumina fixed bed reactor.

## 2. Experimental

Silica-alumina in the particle size of 8~12 mesh was used as adsorbent. Pore volume was 0.44 $cm^3/g$, average pore diameter was 27Å, BET specific surface area was 641 $m^2/g$. Toluene and acetone of 99.9% grade were used as adsorbate without purification. Adsorption experiments were conducted by using the apparatus shown in Fig. 1. Adsorption experiments were conducted at room temperature (20℃), and the fixed bed prepared by Pyrex tube of 16 mm inside diameter was used. The upside of the reactor was connected to the injection port of gas chromatography (GC, Donam DS-6200) and the concentration was analyzed at interval of 10 minutes.

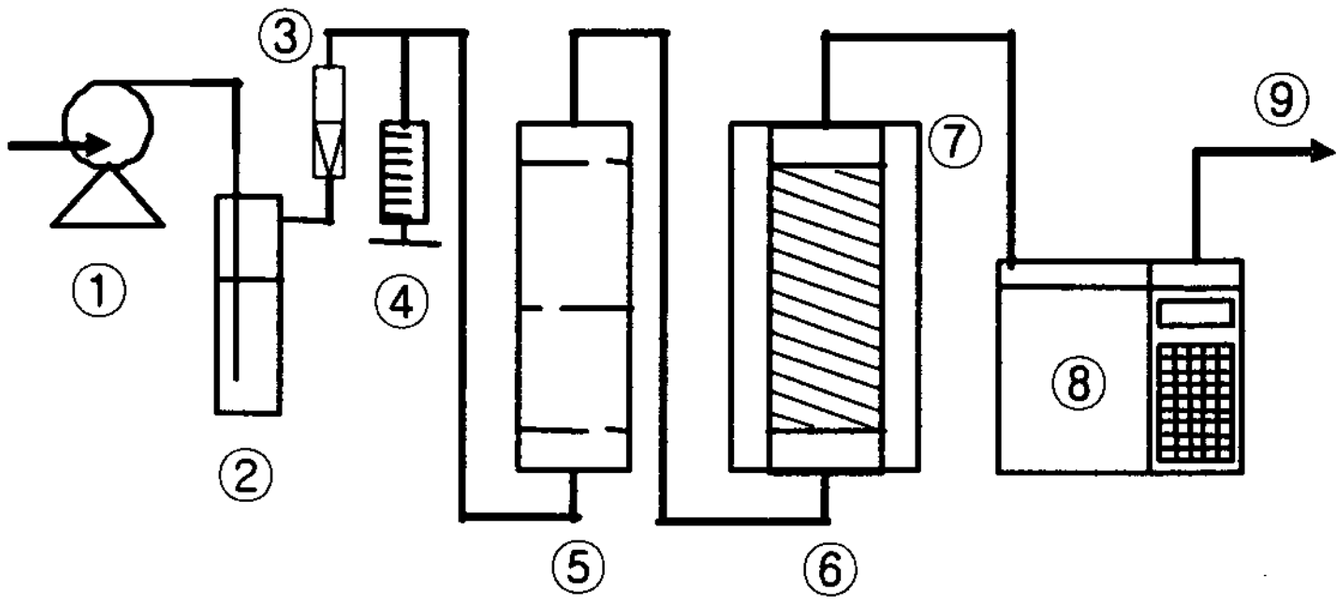


Fig. 1. Schematic diagram of experimental apparatus (① air pump, ② drying bottle, ③ flow meter, ④ syringe pump, ⑤ mixing chamber, ⑥ adsorption bed, ⑦ jacket, ⑧ GC, ⑨ vent).

## 3. Results and discussion

To investigate breakthrough characteristics according to inlet concentration of acetone and toluene vapors, adsorption experiment was carried out at 20℃ in the condition; linear velocity 0.42 m/s, inlet concentration of acetone vapor 60~120 ppmv, inlet concentration of toluene vapor 10~30 ppmv. The breakthrough curves of acetone vapor according to inlet concentration were compared in Fig. 2.

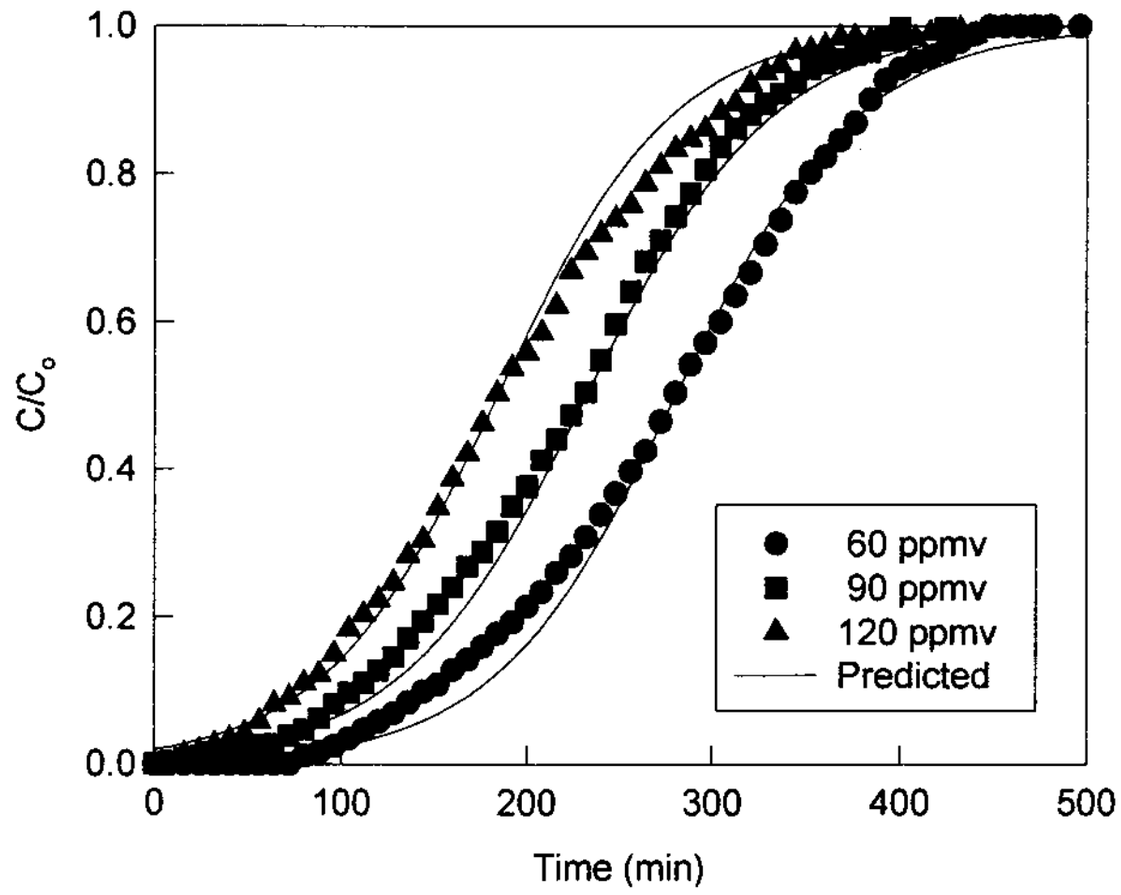


Fig. 2. Effect of inlet concentration of acetone vapor on breakthrough curve (linear velocity : 0.42 m/s, silica-alumina : 3.74 g).

And the breakthrough curves of toluene vapor according to inlet concentration were compared in Fig. 3. The higher inlet concentration of adsorbate was, the faster breakthrough was and the slope of breakthrough curve was gradually increased. Also, the variation range of breakthrough curve of toluene vapor was not larger than that of acetone vapor. Therefore, as inlet concentrations of acetone vapor and toluene vapor were

increased, the breakthrough time was decreased, but the equilibrium adsorption capacities of acetone vapor and toluene vapor were increased. At the same concentration, 30 ppmv, the equilibrium adsorption capacity of acetone vapor was 4.4 times than that of toluene vapor. It was thought that these results were due to polarity difference between adsorbates, acetone and toluene, and silica-alumina.

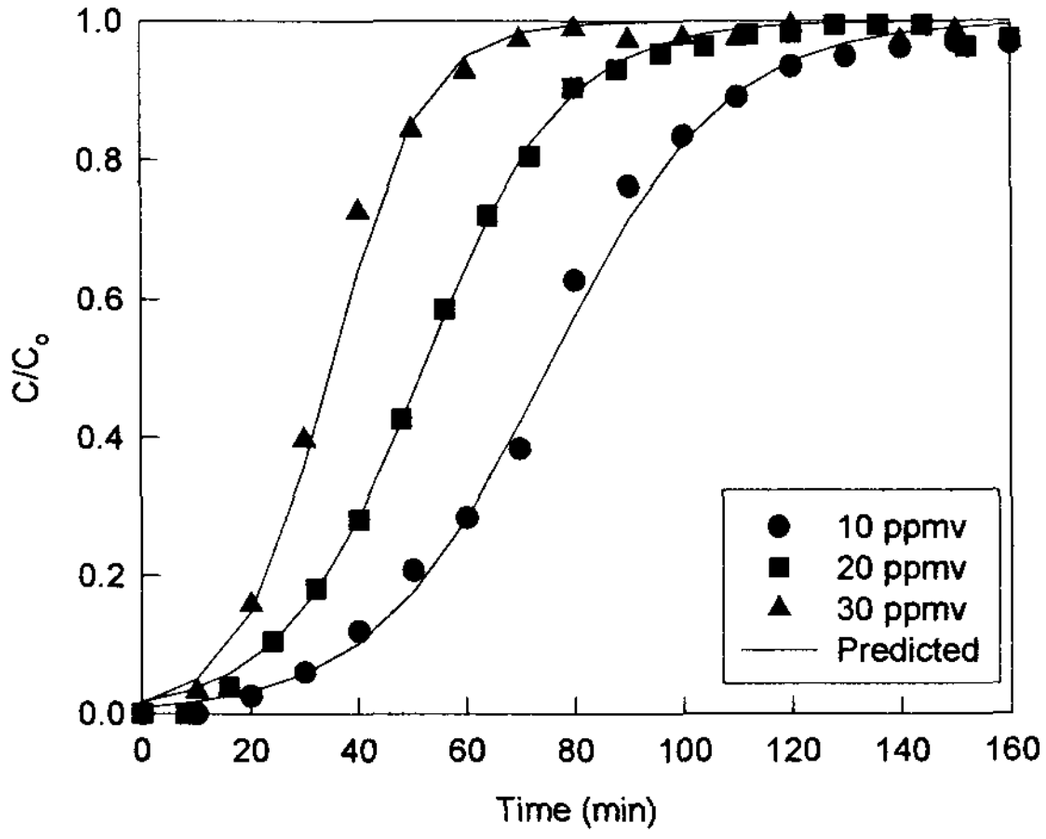


Fig. 3. Effect of inlet concentration of toluene vapor on breakthrough curve (linear velocity : 0.42 m/s, silica-alumina : 3.74 g).

To investigate breakthrough characteristics according to linear velocity of adsorbate, adsorption experiment was carried out at 20℃in the condition; linear velocity 0.33~0.49 m/s, inlet concentration of acetone vapor 60 ppmv, inlet concentration of toluene vapor 20 ppmv. The breakthrough curves of acetone vapor according to linear velocity were compared in Fig. 4.

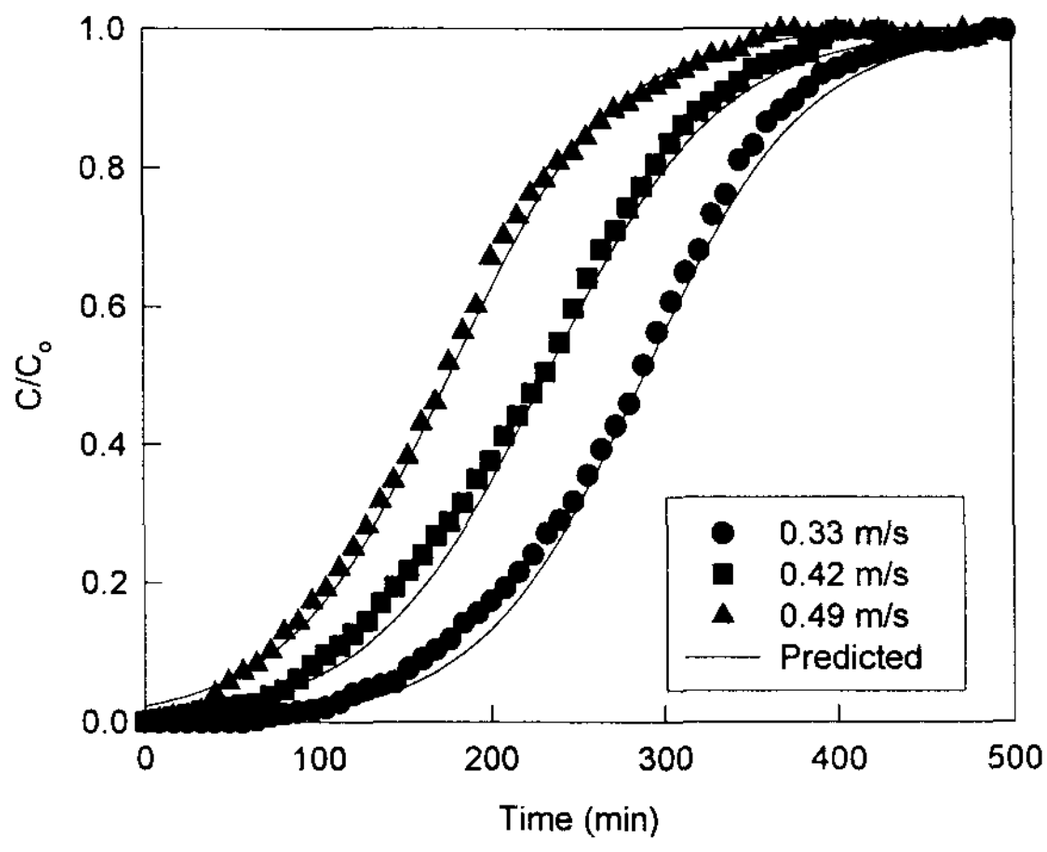


Fig. 4. Effect of linear velocity of acetone vapor on breakthrough curve (Inlet acetone concentration : 60 ppmv, silica-alumina : 3.74 g).

And the breakthrough curves of toluene vapor according to linear velocity were compared in Fig. 5. As increasing linear velocity from 0.33 m/s to 0.49 m/s, the breakthrough times of acetone vapor and toluene vapor were reduced from 168 min to 72 min, and from 35 min to 15 min, respectively, but adsorption capacities did not show the difference as 43~46 mg/g and 5.6~6.6 mg/g, respectively. The breakthrough time was also decreased according to the increase of linear velocity.

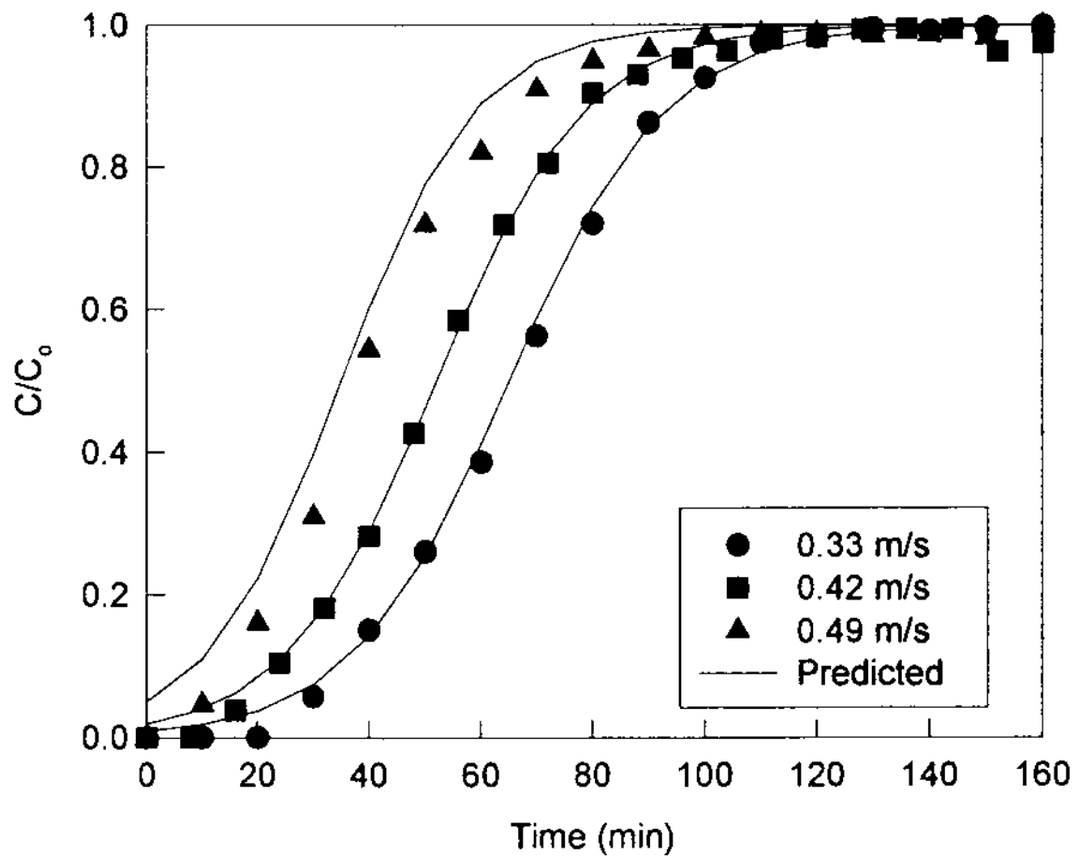


Fig. 5. Effect of linear velocity of toluene vapor on breakthrough curve (Inlet toluene concentration : 20 ppmv, silica-alumina : 3.74 g).

## 4. Conclusions

The breakthrough time was decreased as increasing inlet concentration and linear velocity of acetone and toluene vapors. Adsorption capacity was increased according to the increment of inlet concentration, while it kept at constant value regardless of the increment of linear velocity. The equilibrium adsorption capacity of acetone vapor was 4.4 times as much as the equilibrium adsorption capacity of toluene vapor.

## References

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