

Supplementary Materials

Kinetic, Isothermal, and Thermodynamic Analyses of Adsorption of Humic Acid on Quaternized Porous Cellulose Beads

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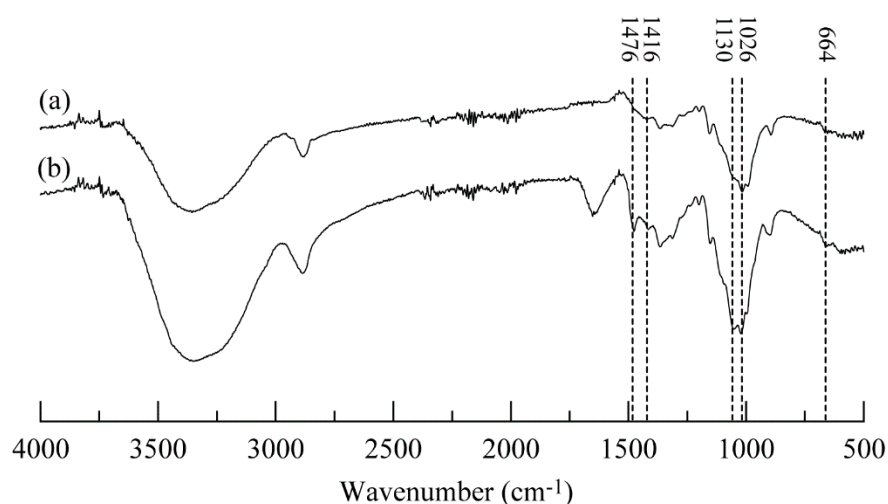


Figure S1. The FT-IR spectra of (a) the untreated cellulose beads and (b) the quaternized cellulose beads with 0.524 mmol/g.

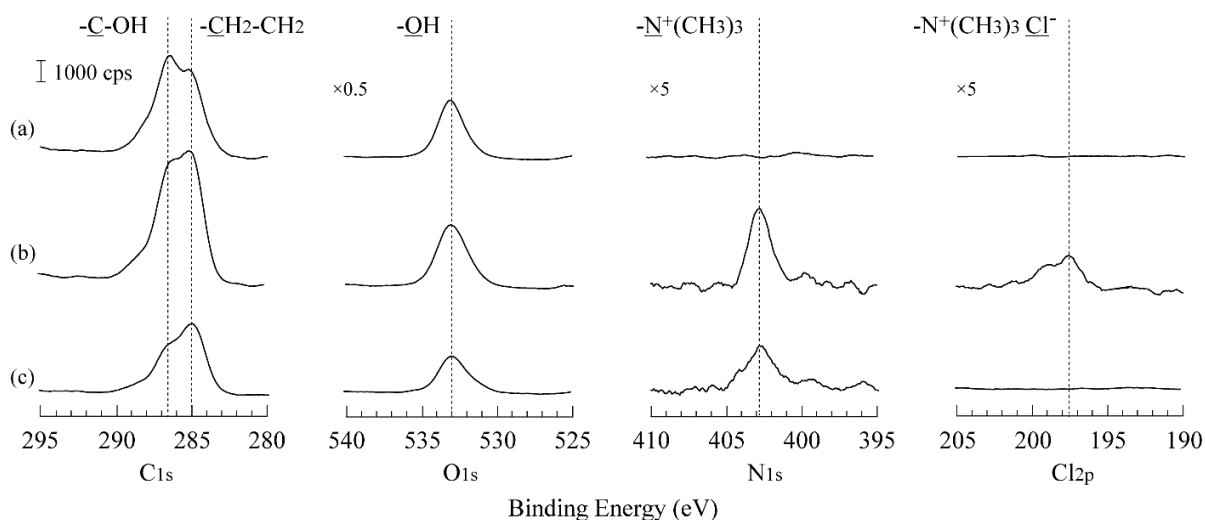


Figure S2. The XPS high-resolution spectra of C_{1s}, O_{1s}, N_{1s}, and Cl_{2p} for (a) the untreated cellulose beads and the quaternized cellulose beads with 0.231 mmol/g (b) before and (c) after treatment with NaOH.

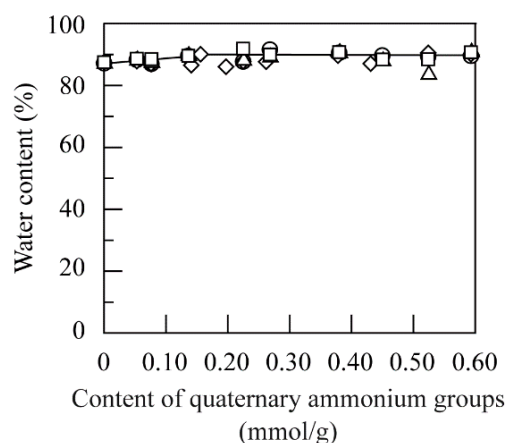


Figure S3. Change in the water content with the content of quaternary ammonium groups at 25°C.

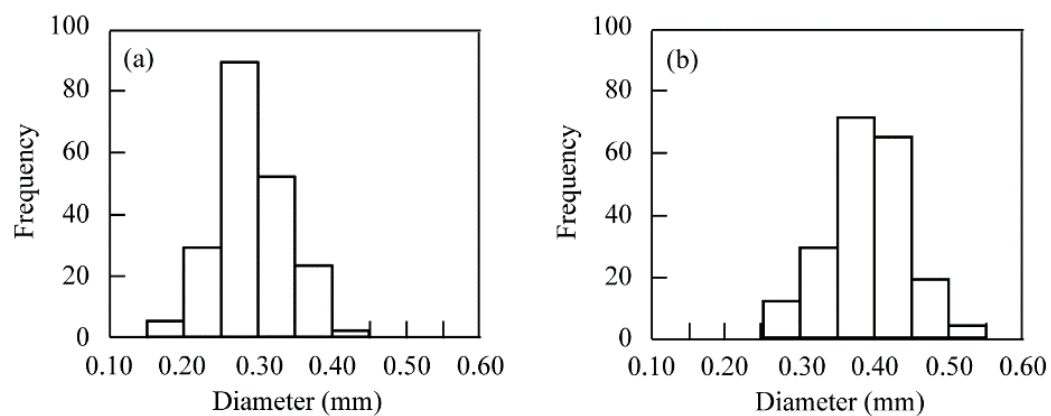


Figure S4. The particle distributions for the quaternized cellulose beads with 0.231 mmol/g in the (a) dry and (b) water-swollen state at 25°C.

Table S1. The particle sizes of the untreated and quaternized cellulose beads with different contents of quaternary ammonium groups in the dry and water-swollen states.

A_{Qcell} (mmol/g-Q-cell)	untreated	0.053	0.231	0.380	0.524
in the dry state (mmol/g)					
minimum (mm)	0.185	0.185	0.184	0.193	0.193
maximum (mm)	0.435	0.441	0.425	0.440	0.400
average (mm)	0.298	0.299	0.293	0.302	0.294
standard deviation (mm)	0.046	0.050	0.048	0.041	0.038
in the water swollen state (mmol/g)					
minimum (mm)	0.285	0.278	0.277	0.288	0.283
maximum (mm)	0.577	0.563	0.550	0.545	0.565
average (mm)	0.395	0.394	0.393	0.405	0.399
standard deviation (mm)	0.047	0.049	0.050	0.045	0.047

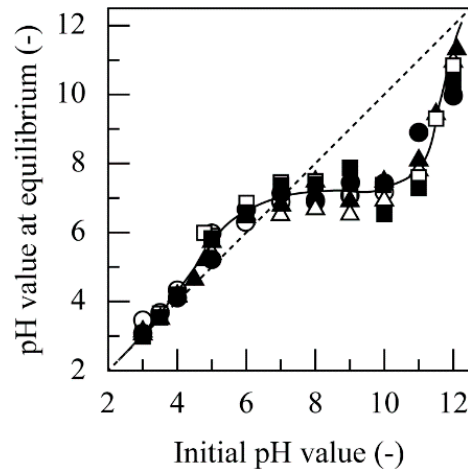


Figure S5. Changes in the pH value for adsorption on the quaternized cellulose beads with 0.053 (○), 0.095 (●), 0.156 (△), 0.231 (▲), 0.380 (□), and 0.524 (■) mmol/g-Qcell in a 100 mg/L HA solution at 25°C.

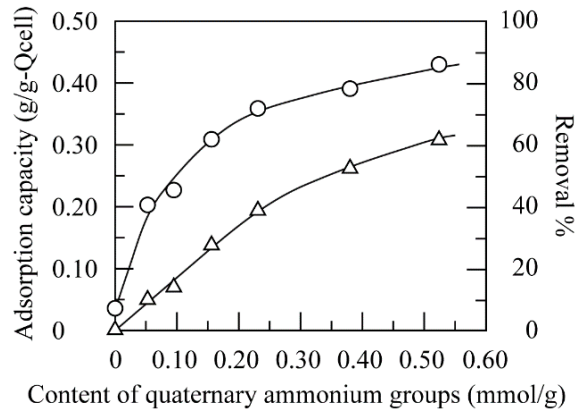


Figure S6. Changes in the adsorption capacity and removal % with the content of quaternary ammonium groups in a 100 mg/L HA solution at pH 3.0 (○) and 6.0 (△).

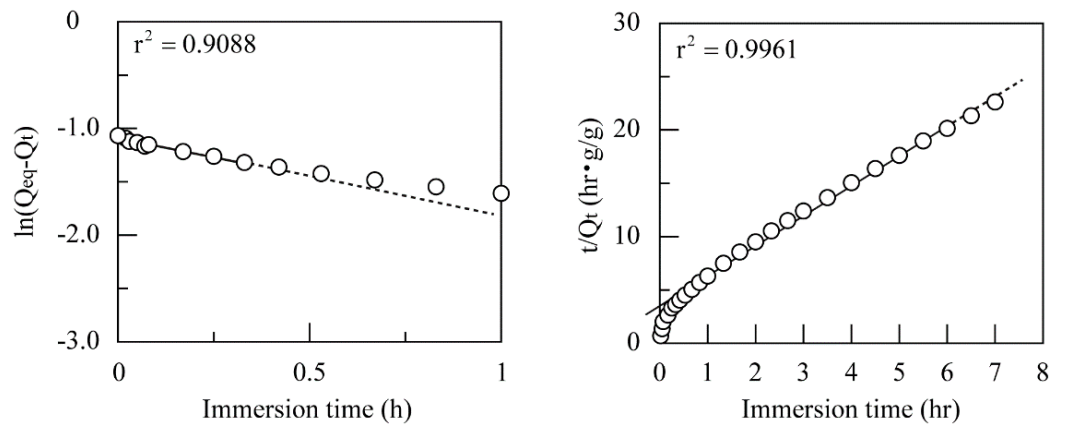


Figure S7. Determination of (a) the pseudo-first order constant, k_1 , and (b) pseudo-second order constant, k_2 , for adsorption of HA on the quaternized cellulose beads with 0.231 mmol/g in a 100 mg/L HA solution at pH 3.0 and 30°C.