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Resorcinol modified hypercrosslinked poly(styrene-co-divinylbenzene) resin and its adsorption equilibriums, kinetics and dynamics towards *p*-hydroxylbenzaldehyde from aqueous solution

Jianhan Huang [a,b,*], Li Yang [a], Yunyi Zhang [a], Chunyue Pan [a,b], You-Nian Liu [a,b]

[a] College of Chemistry and Chemical Engineering, Central South University, Changsha 410083, China
[b] Key Laboratory of Resources Chemistry of Nonferrous Metals, Ministry of Education, Changsha 410083, China

HIGHLIGHTS

- Novel carbonyl and hydroxyl groups modified hypercrosslinked resins were synthesized.
- These resins possessed different adsorption selectivity.
- Surface energy heterogeneity of the resin could be described by Do's model.
- The dynamics matched the equilibrium and kinetics very well.
- The dynamic data could be described by Thomas model.

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ABSTRACT

A series of resorcinol modified hypercrosslinked poly(styrene-co-divinylbenzene) (PS) resins, named as HJ-H00, HJ-H02, HJ-H05, HJ-H10 and HJ-H15, were synthesized from macroporous cross-linked chloromethylated PS by adding 0%, 2%, 5%, 10% and 15% of resorcinol in the Friedel–Crafts reaction, and these resins were characterized and evaluated for adsorption of *p*-hydroxylbenzaldehyde from aqueous solution. The characterization indicated that these resins possessed different chemical structure and pore structure, indicative of their adsorption selectivity. HJ-H02 had the largest adsorption capacity towards *p*-hydroxylbenzaldehyde among the five resins and the mechanism was a combination of hydrogen bonding, micropore filling, capillary condensation and π–π stacking. Freundlich equation was suitable for fitting the equilibrium data and the isosteric adsorption enthalpies were applied to describe the surface energy heterogeneity of the resin. The pseudo-second-order rate equation-I was appropriate for the kinetic data and Thomas model was suitable for the dynamic data. The dynamic adsorption capacity was calculated to be 225.5 mg/g dry resin, very close to the equilibrium capacity of 241.4 mg/g and the resin column could be desorbed by 60 mL of 1% of sodium hydroxide and 75% of ethanol completely.

1. Introduction

p-Hydroxylbenzaldehyde (C_6H_4CHO(*p*-OH)) is a kind of typical aromatic aldehyde and one of the most useful compound in industry. It can be synthesized from phenol by the Reimer–Tiemann or Gattermann reaction and it can also be prepared from *p*-nitrotoluene by a continuous redox, diazotization and hydrolysis reaction. In fact, *p*-hydroxylbenzaldehyde is the primary raw materials for producing a lot of medicines such as amoxicillin, trimethoprimand (TMP), 3,4,5-trimethoxybenzaldehyde and *p*-hydoxygylcine as well as some perfumes such as vanillin, heliotropin and syringaldehyde. However, it is toxic to mankind and it has bad effects on eyes, respiratory system and skins, and hence efficient removal of *p*-hydroxylbenzaldehyde from wastewater is of great importance.

Various porous materials such as zeolites, active carbons, silica gels, metal–organic frameworks (MOFs) and macroporous polymeric adsorbents are very important in many research areas, especially in adsorption, catalysis, energy storage and electrochemistry [1–5]. Among these porous materials, macroporous polymeric adsorbents, especially the newly developed hypercrosslinked poly(styrene-co-divinylbenzene) (PS) resins in 1970s, have been extensively used in various industrial adsorption and separation processes of organic aromatic compounds such as benzene, toluene, β-naphthol and phenol from aqueous solutions [6–8],

* Corresponding author at: College of Chemistry and Chemical Engineering, Central South University, Changsha 410083, China.
E-mail address: jianhanhuang@csu.edu.cn (J. Huang).

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