铅在棉秆基活性炭上的吸附动力学与热力学

摘要点击 212 全文点击 124 投稿时间：2009/7/22 最后修改时间：2009/9/29

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中文关键词 磷酸活化 棉秆 活性炭 吸附等温线 吸附机制

英文关键词 H_3PO_4 activation cotton stalk activated carbon adsorption isotherm adsorption mechanism

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中文摘要

以棉秆与棉秆纤维为原料，利用磷酸活化法制备了低成本的高比表面微孔棉秆基活性炭,通过静态实验研究了活性炭对水溶液中铅的吸附特性,测定了溶液pH值、吸附时间、溶液温度对吸附的影响,探讨了吸附动力学、热力学及吸附机制.根据低温液氮(N_2/77K)吸附测定数据,以BET方程、BJH法及H-K法对活性炭孔结构进行了表征,以Boehm滴定、FTIR、零电荷点pH_{PZC} 测定及元素分析定量表征活性炭表面含氧官能团.结果表明,以棉秆和棉秆纤维为原料制备的活性炭的比表面积分别为1570和1731 $m^2 \cdot g^{-1}$,含氧酸官能团含量分别为1.43和0.83 $mmol \cdot g^{-1}$, 均高于商业活性炭ST1300. 静态吸附实验表明,棉秆基活性炭对铅有较大的吸附容量和吸附效率,最大吸附量超过120 $mg \cdot g^{-1}$,溶液pH对吸附有较大的影响,吸附量随时间增大而增大,在5min内可达饱和吸附量的80%;吸附动力学数据符合假二级方程,Freundlich方程能更好地描述等温吸附行为;热力学研究表明，吸附吉布斯自由能(ΔG^0)<0,而焓变(ΔH^0)>0,说明吸附为吸热的自发反应过程,升温有利于吸附,离子交换可能在吸附过程中起了重要作用.

英文摘要

Low-cost high surface area microporous carbons were prepared from cotton stalk and cotton stalk fiber by H_3PO_4 activation. The adsorption of lead ions on the carbons was investigated by conducting a series of batch adsorption experiments. The influence of solution pH value, contact time and temperature was investigated. The adsorption kinetics, thermodynamic behavior and mechanism were also discussed. The surface area and pore structure of the activated carbons were analyzed by BET equation, BJH method and H-K method according to the data from nitrogen adsorption at 77K. Boehm titration, Fourier transform infrared spectroscopy(FTIR), the point of zero charge(pH_{PZC})measurement and elemental analysis were used to characterize the surface properties. The results show that the carbons from cotton stalk and cotton stalk fiber have high surface area of 1570 and 1731 $m^2 \cdot g^{-1}$, and high content of oxygen-containing functional groups of 1.43 and 0.83 $mmol \cdot g^{-1}$. The adsorption experiments show that the carbons have high adsorption capacity for lead, and the maximum adsorption equilibrium amount was found to be 120 $mg \cdot g^{-1}$. The adsorption amount increased with contact time, and almost 80% of the adsorption occurred in the first 5 min. The pseudo-second-order model describes the adsorption kinetics most effectively. The Freundlich isotherm was found to the best explanation for experimental data. The negative change in free energy(ΔG^0) and positive change in enthalpy (ΔH^0) indicate that the adsorption is a spontaneous and endothermic process, and the adsorption of lead ions onto the carbons might be involved in an ion-exchange mechanism.