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纳米锌去除水体中As(Ⅲ)吸附动力学和影响因素

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Kinetics and Impact Factors for Nanoscale Zinc Adsorption of Arsenite from Water

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中文关键词： 纳米锌 As(Ⅲ) 吸附 动力学 影响因素

英文关键词: nanoscale zinc particles As(Ⅲ) adsorption kinetics impact factors

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中文摘要:

As(Ⅲ)毒性高, 易迁移, 且是厌氧条件下地下水中主要存在形式。纳米铁颗粒在含砷水体处理中受到广泛关注, 而锌具有比铁更低的氧化还原电位且更易保存, 被认为是用于氯代有机化合物还原的最佳金属, 但有关纳米锌用于水体中砷的研究很少。本文研究了纳米锌吸附As(Ⅲ)的反应动力学性质和吸附As(Ⅲ)的主要影响因素。通过应用准一级动力学、准二级动力学和粒内扩散三种模型对吸附过程进行模拟, 结果显示纳米锌吸附As(Ⅲ)的过程更符合二级反应动力学模型, 速率常数k_2为0.18 g/(mg·min), 吸附量为0.47 mg/g, 且去除机理以化学吸附为主。批实验结果表明, 纳米锌对As(Ⅲ)吸附最佳条件为:振荡时间120 min, 纳米锌投加量2.5 g/L, pH值2~7。在最佳实验条件下, 纳米锌对起始浓度为0.565 mg/L As(Ⅲ)和0.568 mg/L As(Ⅴ)进行吸附试验, As(Ⅲ)和As(Ⅴ)的去除率均能达到99.5%以上, 表明纳米锌对As(Ⅲ)和As(Ⅴ)都有很好的去除效果, 可作为处理水体中砷的吸附材料之一。以纳米锌作为吸附材料与传统方法相比, 并不需要将As(Ⅲ)预氧化成As(Ⅴ), 在实际应用中可简化水处理程序, 节约处理成本。

英文摘要:

As(Ⅲ) is a highly toxic, mobile, and predominant arsenic species in anoxic groundwater. The removal of arsenic in contaminated water by using nanoscale iron particles has received extensive attention. The reduction potential and storage of Zn is lower and easier than that of Fe. Therefore, Zn is considered to be the best choice for the reduction of chlorinated organic compounds. To our knowledge, there is little research on the reduction of arsenic with nanoscale zinc in water. The objectives of this study were to investigate kinetics and impact factors by batch

experiments. Pseudo-first-order, second-order kinetics and the intraparticle diffusion model were applied to simulate the sorption process. The sorption process was best fitted by the pseudo-second-order kinetic with reaction rate constants (k_2) of 0.18 g/(mg • min). The adsorption capacity of nanoscale zinc for As(III) was 0.47 mg/g. Chemical adsorption is the main mechanism of As(III) removal by nanoscale zinc. The shaking time for optimum removal of As(III) has been noted as 120 min for nanoscale zinc. The adsorbent dose for nanoscale zinc is 2.5 g/L. Maximum removal of As(III) was observed in the pH range of 2-7. Over 99.5% As(III) and As(Ⅴ) were removed within 120 min in an initial concentration of 0.565 g/L. These results suggest that nanoscale zinc particles can be used for treating As-affected groundwater that contains substantial As(III) without preoxidation of As(III) to As(Ⅴ). In comparison with traditional methods, the removal of As(III) by nanoscale zinc is simple, inexpensive and has a high efficiency for application in water treatment facilities.

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