

某垃圾填埋场包气带砂土对 $\text{NH}_4^+\text{-N}$ 的吸附研究

The mechanism of adsorption of ammonium on the sandy soils in the vadose zone of a landfill

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中文关键词: [氨氮](#) [吸附](#) [浸提](#) [水溶态铵](#) [可交换态铵](#) [固定态铵](#)

英文关键词: [ammonium](#) [adsorption](#) [extraction](#) [soluble ammonium](#) [exchangeable ammonium](#) [fixed ammonium](#)

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作者	单位	E-mail
徐基胜	中国地质大学 水资源与环境学院, 北京市重点实验室, 北京 100083	
刘培斌	北京市水利规划设计研究院, 北京 100044	
梁静	中国地质大学 水资源与环境学院, 北京市重点实验室, 北京 100083	
陈坚	中国地质大学 水资源与环境学院, 北京市重点实验室, 北京 100083	
付佳妮	中国地质大学 水资源与环境学院, 北京市重点实验室, 北京 100083	
刘菲	中国地质大学 水资源与环境学院, 北京市重点实验室, 北京 100083	feiliu@cugb.edu.cn

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中文摘要:

对某垃圾填埋场包气带砂土吸附氨氮的机理进行了研究, 通过吸附等温实验主要探讨了其吸附过程、不同粒级土的吸附贡献和吸附氨氮的3种形态。结果表明: 样品土对氨氮的等温吸附线符合Langmuir模式, 原土的计算最大吸附量为435 mg/kg; 中砂、细砂和实验原土的吸附能力大小顺序为: 原土>细砂>中砂; 在样品土中, 粉质粘土随着初始铵溶液浓度的升高吸附绝对量和吸附贡献率都在上升, 由50 mg/L时的43%贡献率上升到400 mg/L时70%的贡献率, 成为原土吸附氨氮的主要贡献者; 随着初始铵溶液浓度的升高, 水溶态铵、可交换态铵和固定态铵的绝对量都大致呈上升趋势, 它们的最大吸附量分别为112.3、97.5和214.0 mg/kg; 铵溶液中的铵离子进入粘土中的大致顺序为: 颗粒表面的扩散层(主要为水溶态铵)→吸附层(主要为可交换态铵)→矿物晶格内部和晶层空间(主要为固定态铵)。

英文摘要:

The ammonium in the vadose zone has remarkable effect on the degree of groundwater contamination, especially in the vadose zone of a landfill with high concentration of ammonium. Thus laboratory experiments were conducted with the tested soils in the vadose zone of a landfill. This paper deals with the mechanism of ammonium adsorption, with emphasis placed on the process of the adsorption, the contribution of different fractions of soils to the adsorption and the forms of the ammonium in soils. Among these factors, different forms of ammonium adsorbed by the soils seemed to be essential. The following results were obtained by the isothermal adsorption experiment and other experiments: ① In the isothermal adsorption experiment, the ammonium adsorbed by the tested soils was fitted well with Langmuir adsorption isotherm and the adsorption maximum reached 435 mg/kg at the temperature of 298 K. The adsorption capacity of different fractions of soils was in decreasing order of raw soils>fine sands>medium sands. The amount of adsorption for the silty clay increased with the increasing influent ammonium concentration of the solution, so did the ratio of adsorption for the silty clay. It is thus held that the silty clay became the most important composition of the tested soils with the value of contribution ratio growing from 43% at 50 mg/L influent ammonium concentration in the solution to 70% at 400 mg/L $\text{NH}_4^+\text{-N}$. ② The ammonium adsorbed on the tested soils comprised three forms i.e., soluble ammonium, exchangeable ammonium and fixed ammonium. The concentrations of the first two forms of ammonium were obtained by different kinds of extractants, distilled water and 1M KCl correspondingly, with the extraction conditions of solid to liquid ratio 1:5, extraction temperature 25°C, vibrating rate 175 r/min and extraction time 1.5 h. As for the fixed ammonium, it was not determined by the Silva-Bremner method but calculated with the rest of ammonium adsorption excluding soluble ammonium and exchangeable ammonium. The results indicated that the amount of each form of ammonium increased with the increasing influent ammonium concentration in the solution and the maximum adsorption for the three forms of ammonium reached 112.3 mg/kg, 97.5 mg/kg and 214.0 mg/kg respectively. ③ On the basis of the amount of ammonium extracted by different extractants, the positions occupied by different forms of ammonium in the clay were also different. The diffusion layer on the surface of the clay was firstly occupied by the ammonium mostly made up of soluble ammonium, then the adsorbed layer was occupied by the exchangeable ammonium and at last the inner of the crystal lattice and the interlayer of the mineral were occupied by fixed ammonium. These findings show that the risk of groundwater contamination caused by different forms of ammonium would be different correspondingly. The soluble ammonium would be very prone to filter down to the aquifer and cause the groundwater contamination. The exchangeable ammonium might remain in the aeration zone to some extent and causes less risk of groundwater contamination compared with the soluble ammonium. It is therefore critical to remove the ammonium in the vadose zone of landfills, otherwise the soluble ammonium would filter down to the aquifer with rainfall and leachate. The fixed ammonium is not the major source of groundwater contamination, because it is difficult for this kind of ammonium to filter down to the aquifer.

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