新型无机高分子絮凝剂含铁聚硅酸的研制及其性能

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摘要 以水玻璃、无机酸和氯化铁为原料制备了含铁聚硅酸(FPS), 对其制备过程中的若干影响因素进行了研究. 结果表明: 以活化时间为1h、Fe/Si 比为1时, 所制备的 FPS 具有最佳混凝性能. 同时对其混凝特性进行了初步研究, 表明 FPS 具有较宽的 pH 适用范围, 并且形成絮体速度快、絮体结实粗大. 与聚合铁进行混凝对比表明, FPS 具有更优的混凝除浊性能.

关键词 无机高分子絮凝剂, 活化硅酸, 氯化铁, 混凝机理.

活化硅酸即聚硅酸是一类阴离子型无机高分子絮凝剂[1], 通常作为助凝剂在现场制备来强化水解混凝剂的水处理过程, 具有高效、原料便宜和丰富且对人体无害的优点[2]. 在活化硅酸中引入一定量的硫酸铝, 经过适当反应熟化, 便可获得具有较好性能的混凝剂(PSAA)[3,4]. 然而, 铝盐在水处理中的应用尚存在毒性问题[5], 处理水的余铝后沉淀问题[6]以及低温除浊能力的降低[7]等等. 因此如何提高铁系混凝剂的效能成为研究重点. 本文主要探讨以水玻璃、无机酸以及氯化铁为主要原料进行活化硅酸的改性, 以研制新型高效的无机高分子絮凝剂.

1 实验方法与材料

1.1 主要仪器与试剂

恒温磁力搅拌机(78HW-1型), 721型分光光度计, pHS-3C 型 pH 计, DXD-1显微电泳仪. 模数 M 为3.20的水玻璃, 其它试剂均为分析纯, 所用水皆为蒸馏水.

聚硅酸溶液: 含 SiO_2 1.6% 水玻璃, 以稀硫酸中和其碱度至83%, 室温活化1h 即得.

聚合铁(PFC) 溶液: 制备碱化度为1.0, 含铁量为0.13mol/L 的产品, 室温熟化24h[8].

1.2 含铁聚硅酸(Ferric Polysilicate, FPS) 的制备

将上述活化1h 后的聚硅酸溶液加入一定浓度的 $FeCl_3$ 溶液中, 搅拌反应1h 左右, 静置熟化即得.

1.3 混凝试验

硅藻土悬浮液的配制和混凝过程 pH 的控制均参照文献[9]的方法, 只是电解质改用0.001mol/L NaCl, 硅藻土浓度为1g/L. 搅拌试验于磁力搅拌机上进行, 每次实验水样用量为500ml. 于快速搅拌中投加混凝剂, 搅拌3min 后, 改为慢速搅拌8min, 而后静置沉降15min, 于上清液液面下2—4cm 处取样进行浊度测定. 浊度测定采用文献[10]方法, 于721型分光光度计中进行.

快速搅拌结束后即刻取样, 注入电泳池中, 选用下静止液层测定电泳值速率. 每次观察12个正负方向运动的颗粒. 在电泳速率接近0时, 适当调高电极两端的电压, 以加快粒子运动速度, 最后电泳值取其平均值.

2 结果与分析

2.1 制备过程中若干影响因素

(1) 活化时间对产品性能的影响 用稀 H_2SO_4 中和其碱度至83%, 制备500ml 含

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$SiO_2$1.6%的水玻璃溶液. 而后按0, 15, 30, 45, 60, 90, 120min 分别从中移取50ml 溶液, 加入一定浓度的 $FeCl_3$水溶液中, 搅拌反应1h, 然后用水稀释至100ml, 即得0.1mol/L 的 FPS. 均以0.1ml 的相同投加量进行混凝实验, 所得结果如图1所示. 从图1曲线分析, 活化时间对样品的混凝效果有较大影响, 活化时间过长、过短都会降低其混凝效能. 因此选用活化时间为1h 比较适宜.

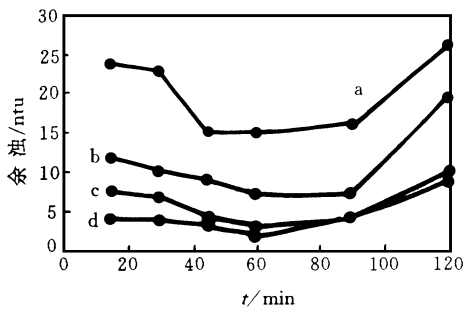

图1 活化时间对产品性能的影响

a. 0.05ml b. 0.1ml c. 0.5ml d. 1ml

(2) Fe/Si 值对产品性能的影响 用稀 H_2SO_4 中和其碱度至83%, 分批制备100ml 含 $SiO_2$1.6%的水玻璃溶液. 固定活化时间为1h, 按 Fe/Si 分别为0.125, 0.25, 0.5, 1, 2, 4加入一定浓度的 $FeCl_3$溶液中, 熟化备用. 以投药量均为0.1ml 进行混凝实验, 所得结果如图2所示. 由图2曲线可见, 铁盐含量对混凝效果有较大的影响作用. 随着 Fe/Si 的增加, 混凝除浊效果也随着增加, 当 Fe/Si 达到1以后, 渐趋平缓. 因此选用 Fe/Si 为1比较合适.

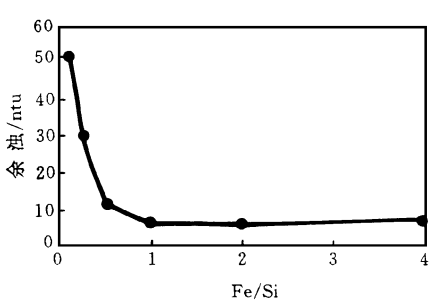

图2 Fe/Si 比对产品性能的影响

2.2 FPS 的混凝性能及其作用机理分析

(1) pH 对混凝效果的影响 制备 Fe/Si 为1的 FPS, 固定其投加量为0.1ml, 以 NaOH 与 HCl控制悬浮液的 pH 值, 探讨不同 pH 条件对其混凝效能的影响, 结果如图3所示. 图3曲线表明, FPS 具有较宽的 pH 适用范围, 在 pH 值为4—9范围内均有较好的混凝效果.

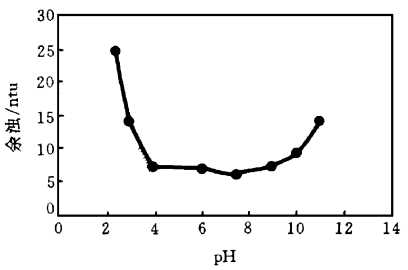

图3 pH 对 FPS 混凝效果的影响

(2) FPS 与聚合铁(PFC) 混凝效果的对比 制备含铁量均为0.13mol/L 的 FPS 与 PFC (B 值为1.0), 分别以0.01, 0.02, 0.04, 0.08, 0.10, 0.20, 0.50, 1.00ml 的相同投加量进行混凝对比实验, 所加药剂量均为0.2ml, 分别在慢速搅拌结束后逐时测定其余浊, 如图4所示. 从图4曲线来看, 随着混凝剂用量的增加, 余浊迅速减少. 在较大的区域范围内, FPS 均表现出更为优越的除浊能力. 实验过程中表现为絮体出现速度快、絮体粗大(如图5), 表明 FPS 具有优于 PFC 的混凝性能.

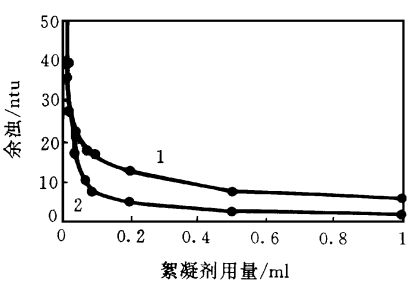

图4 FPS 与 PFC 的混凝性能对比

1. PFC 2. FPS

(3) FPS 的混凝作用机理探讨 在 pH=5.5条件下, 分别就 Fe/Si 为0∶1, 1∶1, 1∶3种情形进行电泳值的测定实验, 得到图6结果. 对聚

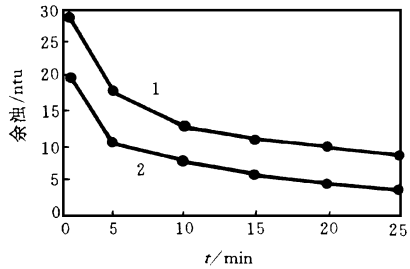

图5 FPS 与PFC 的絮体沉降性能对比

1. PFC 2. FPS

硅酸而言,随着滴定量的增加,颗粒物的电泳速度略为加快,说明聚硅酸带有一定量的负电荷.改用铁盐滴定时,颗粒物电荷迅速发生逆转,改变了其表面特性且得以重新稳定.而在FPS 的滴定过程中虽然也发生颗粒物荷电的逆转,但处于一较低的幅度,说明FPS 已成为阳离子型絮凝剂,但其电中和能力下降.

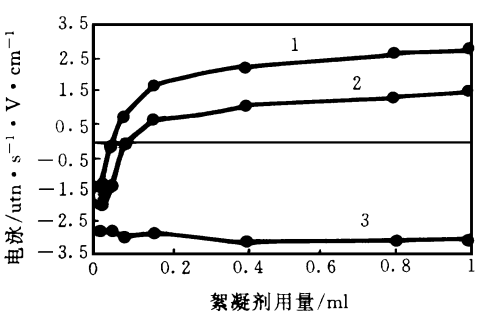

图6 不同絮凝剂的电泳滴定曲线

1. Fe/Si= 1·0 2. Fe/Si= 1·1 3. Fe/Si= 0·1

对于传统铝、铁盐的混凝作用机理的认识可以分为早期的多种机理过程和近期的综合机理过程[11].然而均存在其不足之处,有待于进一步的深入研究[1].对于无机高分子絮凝剂,则认为其经预制所形成的优势形态具有较强的吸附电中和能力,且同时具有一定的架桥絮凝作用[12].FPS 具有更优的混凝性能归因于其同时具有这2种性能.且由于聚硅酸高分子具有适当的颗粒尺寸,经改性后具有更强的吸附能力,从而更好地发挥其架桥絮凝作用.

3 小结

(1)水玻璃的活化时间对FPS 的合成有较大的影响,采用1h 的活化时间可以获得具有最佳混凝性能的产品.

(2)铁离子含量对FPS 的混凝性能有较大的影响,当Fe/Si 比为1时即可取得良好的混凝效果.

(3)FPS 具有较宽的pH 使用范围,絮体形成速度快、粗大密实,沉降性能好,与聚合铁相比具有较强的除浊性能.

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Key words: Lake East Tahu, aquatic plants, silting-up, phosphorous.

Study on Characteristics of Organics in the Eutrophic Source Water of Shaoxing City. Xiaohong Luo, Lili Cao, Zhansheng Wang (Dept. of Environ. Eng., Tsinghua University, 100084): *Chin. J. Environ. Sci.*, **18**(3), 1997, pp. 13_16

Ultrafiltration was used in this study to determine the organics molecular weight(MW) distribution in the eutrophic source water of Shaoxing City. The devotion to color and UV254 of organics in each MW range was also investigated. Then the characteristics of organics in the three typical source water (Huai River, Miyun Reservoir and Shaoxing's eutrophic lake) were compared. It was found that the characteristics of organics in the water relate closely to its source. Organics in Miyun Reservoir are mainly of low MW, with MW< 3000 occupying 96.7%, while organics in Shaoxing source water and Huai River cover a more wide MW range, organics with MW> 3000 in the source water is 28.37% and 38.28% respectively.

Key words: organic, MW, SUVA, eutrophic.

The Preparation and Characterization of a New Kind of Inorganic Polymer Flocculant—— Ferric Polysilicate (FPS). Wang Dongsheng, Wu Qifang, Wei Chaohai (Department of Applied Chemistry, SCUT, Guangzhou 510641): *Chin. J. Environ. Sci.*, **18**(3), 1997, pp. 17_19

A new kind of inorganic polymer flocculant —— Ferric Polysilicate (FPS) was prepared by using water glass, ferric chloride and inorganic acid as material. Several factors of preparation were discussed. The experimental results showed that FPS was best prepared at Fe/Si ratio of 1 and activation time of one hour. Compared with PFC, FPS showed better capability of turbidity removal.

Key words: inorganic polymer flocculant, activated silica, ferric chloride, coagulation mechanism.

Study on Biodegradability of Refractory Organics Under the Condition of Mixed Substrates. He Miao, Zhang Xiaojian et al. (Dept. of Environ. Eng., Tsinghua University, Beijing 100084): *Chin. J. Environ. Sci.*, **18**(3), 1997, pp. 20—22

A systematic study was conducted on the biodegradability and the co-effect of refractory organics for several typical refractory heterocyclic compounds under the condition of mixed substrate. The experimental results showed that pyridine, quinoline and homologous compound have similar biodegradation and inhibitory mechanism, of which co-effect shows additive one; while the co-effect of the irreversible inhibitory substrates shows a cooperative effect, the co-effect of irreversible mixed with reversible inhibitory substrates shows a contradictory effect.

Key words: refractory organics, biodegradability, co-effect, hetorocyclic compounds, mixed substrate.

Pollution of Nitrogen and Phosphorus in the Region of Wastewater Irrigation along Kui River. Jiang Cuiling, Xia Ziqiang and Liu Ling (Dept. of Hydrology and Water Resources, Hehai Univ., Nanjing 210098), Wang Lei and Wan Zhengcheng (Xuzhou Hydrology and Water Resources Survey Section, Xuzhou 221006): *Chin. J. Environ. Sci.*, **18**(3), 1997, pp. 23_25

Simulated test of wastewater irrigation in the field and chemical analysis of nitrogen and phosphorus in the soil and groundwater at wastewater irrigation area and control area showed that high contents of nitrogen and phosphorus in the wastewater had markedly improved soil fertility and the croup in irrigation area growed very well, but nitrogen and phosphorus which could pollute surface and ground water were accumulated in the soil. Ammonium ion was easily intercepted, sorbed and transformed by soil, but high concentration of ammonium ion could slowly transporte downward and accumulate in upper levels of phreatic water. Wastewater irrigation and rainfall drip can wash nitrite and nitrate ions produced by nitrification in the soil and pollute groundwater. The contents of nitrite and nitrate ions in shallow groundwater were still seriously beyond standard at condition of saturating irrigation after experience of three months.

Key words: nitrogen, phosphorus, wastewater irrigation, Kui River Area.

Study of the Effect of Simulated Acid Rain on the Physical and Chemical Properties of Main Soil Types in Shandong Province. Xiao Yuefang, Shi Yanxi, Liu Chunsheng et al. (College of Resources and Environment, Shandong Agricultural University, Taian 271018), Song Guohan (Institute of Soil and Fertilizer, Shandong Provincial Academy of Agricultural Science, Jinan 250100): *Chin. J. Environ. Sci.*, **18**(3), 1997, pp. 26_29

Five types of soils i.e. brown earth, cinnamon soil, chao soil(cultivated fluviogenic soil), lime concretion black soil, salt-affected soil were leached by earth volume test with simulated acid rain of which the value of pH are 2、3、4、5, separately from one year to ten years. The results showed that the pH values of the leacheated four soil types which had been