Advanced Materials Research *Online: 2011-05-12*
ISSN: 1662-8985, Vols. 239-242, pp 2558-2561
doi:10.4028/www.scientific.net/AMR.239-242.2558

Preparation and Properties of Amino Acid Chelating Resin from the Waste Plastic of Polystyrene

Guanghua Zhang [a], Weixin Dong [b], Junfeng Zhu [c]

Key Laboratory of Light Chemical Additives Chemistry and Technology in Ministry of Education in Shaanxi University of science & technology, Xi'an 710021, China

[a] email: zhanggh@sust.edu.cn, [b]emai:0806026@sust.edu.cn, [c]email:zjfeng123123@163.com

[*]Corresponding author: Weixin Dong

Key words: Chloromethylated polystyrene; Amino acid resin; Synthesis; Adsorption properties.

Abstract: Waste polystyrene plastic as raw material was reacted with chlorine methyl polystyrene, then reacted again with the iminodiacetic acid, an environment-protecting amino acid type chelating resin was prepared. The structure of resin was characterized by IR and thermal analysis represents. The adsorption capacity of resin was measured by Atomic Absorption Spectrometer. The results showed that the resin could adsorpt Cr^{3+}, Pb^{2+} well. The mechanism of adsorption conforms to Langmuir. Moreover, it can achieve adsorption balance within 30min, the adsorption quantity respectively reached 2.17 mmol/g and 2.11mmol/g at 318K.

Introduction

Now polystyrene products have existed throughout all kinds of fields in people's life. Because it has many characteristics, such as low toxicity, high melting point, high plasticity, production convenient, polystyrene plastic products are random disposed by people after they are used. According to official statistics, there were annual more than 100 tons polystyrene consumed in China's domestic. Because of their poor degradation, few recycling methods, low rate of utilization. It is very significant how to second use polystyrene plastic products rationally. Our research based on the deserted polystyrene foamed plastics as raw materials, prepared an environment-protecting amino acid type chelating resin, then analyzed its structure and evaluated the properties of adsorption for the heavy metal ions Cr^{3+}, Pb^{2+}.

Materials and Methods

Materials and instruments. Iminodiacetic acid(AR); waste plystyren; Cetyltrimenthylammonium bromide(AR); Fourier Transform Infrared spectrograph (FT-IR): VECTOR-22, Germany BRUKER company; SHB-B 95 type vacuum pump: Changzhou circulating water type multipurpose okefenokee instrument co LTD; VECTOR-22 type Fourier infrared spectrometer: Germany Brooke company.

Synthesis of chlorine methyl polystyrene. Polystyrene foamed plastic 0.66g was measured and dissolved with 1,2 methylene chloride. 0.34 g 16 methyl triply co-hydrolyzed brominated ammonium (CTAB) was dissolved in water, in which polystyrene was matched to form 100ml solution. stirred for 5h.Then 20ml formaldehyde and 15ml thick HCl were add in the solution When the mixture solution was heat to 65℃,under mixing, 1h later, 10ml PCl_3 added, polystyrene macromolecular chain of benzene chlorine methylation can be made within 5 hours. Chlorine methyl polystyrene was precipitated using ethanol[1].

Adsorb resin synthesis method. 20g chlorine methyl polystyrene and iminodiacetic acid were dissolved in 30g DMF, then were mixed for 5 hours at 60 ℃. The last set of beads resin was filtered and cleaned thoroughly with water. The final product was attained. Reaction equations as shown in Figure 1.

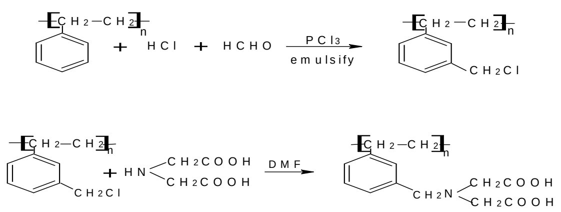

Fig. 1 PSAA reaction equation

Determination of metal ions adsorption performance[2]. Adsorption of PSAA resin for metal ions was determined after it was completely immersed in metal ions aqueous solution at 298K. Cr^{3+}, Pb^{2+} solution each matched into concentration of 0.5 mmol/L, 1000ml volume. Adsorption performance of each ions was measured to be selected for total 300 minutes segments.2,4,6,8,10,13,17,22,26,30,70,100,160,215, 275 min were taken for small time points as basis points to measure Cr^{3+} resin adsorption, Pb^{2+}. 10ml solution was taken to filter when each to a benchmark time. Atomic absorption spectrometer measured concentrations of solution. Metal ions removal A calculation equations are as Equation 1.

$A=100(C_0-Ce)/C_0$

C_0 and Ce is original balance metal content (mmol/L).

Results and Discussion

Infrared spectral analysis. Fig. 2 showed that first submmit area appeared 3102, 3082, 3060, 3026, 3001, 2924, 2850 cm^{-1}, the second peak area appeared 1732cm^{-1} dimer acid indicates that there existed. 1943, 1870, 1830 cm^{-1} suggested benzene telescopic vibration existed, 1493, 1452, 1601 cm^{-1} suggested C-N group existed.

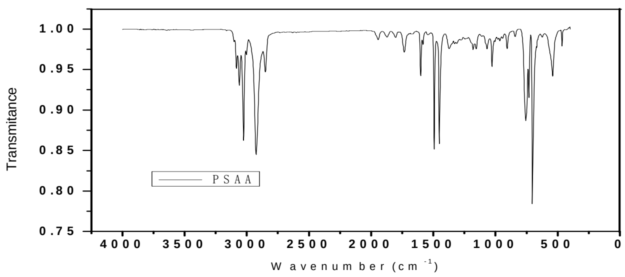

Fig. 2 PSAA resin infrared spectra

pH on adsorption performance. Fig.3 showed that at 288K, that performance of resin's adsorption for Pb^{2+}, Cr^{3+} was best when pH was 5~6. 30.0 mg resin was taken to make ten copies, $Cr(OH)_3$ and $PbNO_3$ solution were matched to iodine Liang Ping, different pH value of HAc - NaAc buffer solution was added under the condition was T=298K, ρ_0=0.20 mg/ml, then solution was intermittent oscillation to balance, which determinated the relationship between the solution's adsorption of Cr^{3+}, Pb^{2+} and the pH value. The adsorption for Cr^{3+}, Pb^{2+} increased fast when pH of solution changed from 2.5 to 5.0. When pH is more than 5, pH tended to be slow [3]. And the most suitable adsorption's pH of Cr^{3+} and Pb^{2+} were 5~6.

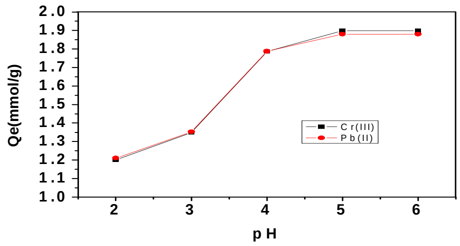

Fig. 3 pH on adsorption effect of Pb^{2+}, Cr^{3+}

Adsorption test

At 288K, metal irons in buffer solution on different concentrations were first prepared, then a certain amount of resin was taken and stuffed 80mL ions solution for 22h in cone shaped stopper of 100ml, then solution standed at constant temperature in oscillation for 2h. The solution was filtered to get filtrate and determinated metal ions solution's concentration before and after the adsoption[4].

Pb^{2+}, Cr^{3+}'s concentration were determined and adsorption capacity was calculated, the solution of Pb^{2+} and Cr^{3+} were matched to be from 0.1 to 5mmol/L in 100ml canister tapered bottle. Resin was filtered by 30-40 purpose sieve. Every bottle was added 0.0200g resin and stayed at the initial temperature for 24 hours. Filtrate which was filtered was mesuread by atomic absorption spectrometry. Nitric acid solution (0.5 mol/L), NaOH solution (0.5 mol/L) and acetic acid salt solution adjusted the initial pH value to be five. Each unit of metal adsorption calculation equation are as Equation 2. :$Qe = (C_0 - Ce)\, V/M$. C_0 and Ce (mmol/L) is the initial metal balance content. M is resin quality (g), V for volume of solution. Qe is quantum efficiencies equilibrium adsorption (mmol/g)[5]. .

Fig.4 showed that removal of metal inons began to increase rapidly within 30min. After 30min, the removal of metal ions stopped changing. From Fig.5 and Fig.6 could see that under the condition of laboratory resin adsorption capacity was determinated at 288 ~ 318K, it was good when raising temperature to improve adsoption, thus adsorption process was heat-sink process, which suggested adsorptive reactions was chemical adsorption [6]. In 288K the biggest adsorption of Cr^{3+} was 1.898 mmol/g, the biggest adsorption of Pb^{2+} was 1.8984 mmol/g. At 318K, the biggest adsorption of Cr^{3+} was 2.18 mmol/g, the biggest adsorption of Pb^{2+} was 2mmol/L.

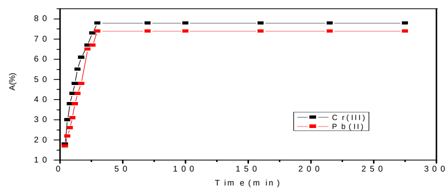

Fig. 4 Metal removal rate changes with time

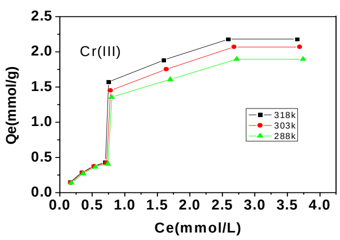

Fig. 5 The influence of different temperature on Cr^{3+} adsorption

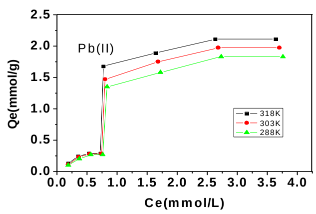

Fig. 6 The influence of different temperature on Pb^{2+} adsorption

Desorption Ability

40.0 mg resin was taken, four copies, and added buffer solution and metal ions, solution total volume was 40.00 ml and shocked to the equilibrium, the resin adsorption of Cr^{3+}, Pb^{2+} was obtained[7]. the water phase was constituted, resin was washed 3 times by using buffer solution and dried, then resin was washed by different concentrations of hydrochloric acid and dilute sulphuric acid solution elution respectively. One-time elution rate can reach 95.8%. After four times adsorption and elution test resin's adsorption rate are no reduction for Cr^{3+} and Pb^{2+}, which explain this resin chemical performance was stable, can be repeatedly reused [8].

Conclusions

a) Resin format chelates through contact metal ions slots, force strong, adsorption stability is good.
b) PSAA resin's adsorption behavior depends on pH value, and the most efficient adsorption on the pH value is 5.
c) Inside 30min, PSAA has shown that the two kinds of heavy metal ions' best adsorption, absorbent adsorption surface activity center increased and metal ions adsorption capacity is getting higher with the increase of temperature.
d) After adsorpting metal ions, PSAA resin has good elution ability, can repeat use of renewable.

Acknowledgements

This work was financially supported by the Shaanxi University of Science and Technology innovation research fund finances projects (2009).

References

[1] Qifa Liu, Baojiao Gao: Journal of High School Chemistry Vol.27 (2006), P.380 in Chinese.

[2] Xin Yang, Fujiang Liu, Xiaosheng Jing etc: Ion Exchange and Adsorption Vol.24 (2008), P.388 in Chinese.

[3] Zeng Shu, Jianjun Mo: Journal of Mineral Technology Vol.28 (2008), P.486 in Chinese.

[4] Xiang Jiang, gnan Jian: Journal of Jiangnan University (natural science edition) Vol.7 (2008) P. 353 in Chinese.

[5] Shengjing, Liua Fuqiang, XinYang: Hazardous Materials Vol.167 (2009), P.590.

[6] Ling Li, Songtao Huang, Jiankang Wen: Journal of Mineral Engineering) Vol. 35 (2008), P. 47 in Chinese.

[7] Hong Chen, Chenghong Zhang: Water Treatment Technology Vol.10 (2009), P.61 in Chinese.

[8] Jianjun Mo, Chunhua Xiong: Chemical Research and Application Vol.14 (2002), P. 340 in Chinese.