Available online at www.sciencedirect.com

ScienceDirect

Procedia Environmental Sciences 31 (2016) 325 – 329

Procedia Environmental Sciences

The Tenth International Conference on Waste Management and Technology (ICWMT)

Effect of simulated radionuclide strontium on geopolymerization process

Xi Peng [a,c]*, Yahong Xu[c], ZhonghuiXu [a,c], DandanWu [c], Dou Li[b]

a .Fundamental Science on Nuclear Waste and Environmental Security Laboratory, Southwest University of Science and Technology, Mianyang SiChuan 621010, PR China
b. CPI Yuanda Environmental-protection Engineering Co., Ltd., Chongqing 401122, PR China
c. Key Laboratory of Solid Waste Treatment and Resource Recycle, Ministry Education, Southwest University of Science and Technology, Mianyang Sichuan 621010, PR China

Abstract

Safety treatment of the nuclear wastes is an important and challenging task troubled scholars for years. In this work, geopolymer was prepared to solidify simulated radionuclide strontium by 4A zeolite and metakaolinite. The effect of radionuclide strontium with different solidification conditions on electrical conductivity and final setting time were investigated and the variation tendency of electrical conductivity has well been in accord with the "three stage" during the whole geopolymerization process. Meanwhile, the mineral phases and chemical bonds of the geopolymer were analyzed by XRD and FTIR respectively. Results show that: (I)the electrical conductivity during the geopolymerization process has the same variation tendency as the final setting time, (II)strontium caused hysteresis effect on geopolymerization process, (III)strontium takes part in the polymerization reaction according to the XRD of geopolymer, and there's little chemical bond vibration effect with the addition of strontium according to the IR result. The results indicated that zeolite-like minerals are synthesized during the geopolymerization process. The immobilization of simulated radionuclide strontium is mainly attributed to absorption, ion exchange, and physical encapsulation.

Peer-review under responsibility of Tsinghua University/ Basel Convention Regional Centre for Asia and the Pacific

Keywords: Geopolymer ; Electrical conductivity; Final setting time; hysteresis effect

1. Introduction

low- and intermediate-level radionuclide waste water is a kind of inescapable product when using radio energy.

* Corresponding author. Tel.: +86-151 8231 2077.
E-mail address: pengxi@mail.ustc.edu.cn

Peer-review under responsibility of Tsinghua University/ Basel Convention Regional Centre for Asia and the Pacific
doi:10.1016/j.proenv.2016.02.043

These years, harmless disposal of the nuclear waste water is a hot point in world environment safety field. Traditional dispose technology is at first adsorbing the waste water by micros, ion-exchange resin, and other inorganic absorption material (eg. zeolite, bentonite), then concentrating and solidifying in cement, which leads high enlargement ratio, high leaching efficiency, and poor long-stable ability. Geopolymer, as with high anti-acid, high resistant to corrosion ability, low cost and little CO_2 let out, attracts more and more attentions from scholars .

Nowadays, scholars studied a lot about the properties of geopolymer solidified some radionuclide [1], while there's little research in the process of the formation of geopolymer. However, make clear the influence of nuclide on the process of the formation of geopolymer can help researchers study the long-term stability and safety of geopolymer further. John L. Provis[2] simulated the kinetic curve of geopolymer formation by AC impedance measurement, Zhang Yunsheng[3] measured the electrical conductivity of geopolymerization reaction and indirectly traced the reaction process. The above two researches showed that polymer process can be shown by analysis its electrochemistry properties.

Therefore, this work aims to study the geopolymerization reaction process of geopolymer containing strontium, discuss the influence of strontium on the geopolymerization reaction process by measuring the variation of electrical conductivity, the final setting time and analyzing samples' mineralogy characterization.

2. Experimental

2.1. Materials

Metakaolin(MK, produced by calcining kaolin at 800℃ for 2h), 4A zeolite, Sodium silicate(liquid state, M=3.3, solid content is 37%), NaOH(analytically pure), Strontium nitrate(analytically pure). The main chemical composition of 4A zeolite and metakaolin as determined by X-Ray fluorescence are given in Table 1.

Table 1. The main chemical composition of 4A zeolite and metakaolin（%）

Raw material	SiO_2	Al_2O_3	Na_2O	MgO	Fe_2O_3	The rest
4A zeolite	54.25	43.92	0.14	0.02	0.39	1.28
metakaolin	54.6	27.8	11.67	2.77	1.51	1.65

2.2. Methods

2.2.1 Preparation of zeolite with strontium (namely, it is the process of strontium absorbed by zeolite)

Two samples of 50g 4A zeolite were weighted, which later absorbing 1g/L and 5g/L strontium nitrate solution for 30min at room temperature respectively, filtered and dried, marked as Z_1 and Z_2. Adsorption rates were calculated according to the concentration of filtrate, measured by atomic absorption spectrometer. The adsorption rate of Z_1 was 2% and that of Z_2 was 7.16%, zeolite with no Sr^{2+} marked as Z_0.

2.2.2 Measure the final setting time

Four kinds of Geopolymer were prepared according to the experimental parameter as table2. Zeolite and metakaolin were mixed sufficiently, added alkali-activator and distilled water(Strontium nitrat was dissolved in distilled water), stirred for 3~5min, and last the mixed slurry were injected molding 20mm*20mm*20mm[4]. Moldings were Curing at high temperature(85℃, relative humidity no less than 90%) for 20min, measured by Vicat apparatus every 2min until final set. Forms were removed after 24h and the geopolymer were gone on curing for 28d.

Table 2. Experimental parameter

Num.	zeolite	Zeolite mass(g)	Metakaolin(g)	strontium nitrate(g)	The content of Sr^{2+} in solid(%)	---
A	Z_0	22.5	22.5	---	0	No Sr^{2+} added
B	Z_1	22.5	22.5	---	1	New technology
C	Z_2	22.5	22.5	---	3.58	New technology
D	Z_0	20.89	22.5	3.89	3.58	tradition technology

2.2.3 Measure the electrical electrical conductivity

The four kinds of mixed slurry, prepared according (2.2.2), were put into the teflon beakers (Fig.1). The teflon beakers were placed in high temperature curing box, conductor at both ends connected to the two poles of Avometer.