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ScienceDirect

Procedia Environmental Sciences 31 (2016) 375 – 381

Procedia Environmental Sciences

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

Removal of radionuclides from laundry wastewater containing organics and suspended solids using inorganic ion exchanger

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Abstract

Inorganic ion exchanger has the advantages of inexpensive, secondary solid waste easy to handle and certain selectivity. It also has an excellent performance on water purifying. In order to study laundry wastewater treatment, use natural zeolite, zeolite 4A and vermiculite for adsorption experiments. We found that zeolite 4A has the best ability to treatment radioactive waste water contains Sr^{2+}, Cs^{+} and Co^{2+}. At room temperature and neutral environment, the adsorption percentage of zeolite 4A adsorb simulated radionuclides Sr^{2+}, Cs^{+} and Co^{2+} reached 90%,and in alkaline environment, the adsorption percentage > 98.7%. In order to investigate the range of suspended solids and organics on zeolite 4A remove radionuclides from the radioactive waste water, utilize zeolite 4A to adsorb simulate radionuclides aqueous solution contains clay, sodium oleate to study the influence factors and levels. By orthogonal experiment, the effect of zeolite 4A on the adsorption order was suspended solids concentration > organics concentration > radionuclides species.

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

Keywords: Inorganic ion exchanger;Organics;Suspended solids ;Adsorption;Zeolite 4A

1 .Introduction

With the development of the nuclear industry, it generated a lot of radioactive wastewater. The radioactive waste water mainly from nuclear reactors, uranium mining, nuclear technology utilize units, and radioactive clothes washing. A large amount of radioactive wastewater is low-level of radioactivity. The methods for treatment low-level radioactive wastewater are evaporation, flocculation, ion exchange, biological treatment, adsorption, membrane technology etc. Each method has its own advantages, disadvantages and application scope [1–7].

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Peer-review under responsibility of Tsinghua University/ Basel Convention Regional Centre for Asia and the Pacific
doi:10.1016/j.proenv.2016.02.053

Radioactive liquid waste must be treated and transformed into solid waste then disposal[8–12].

Inorganic ion exchange material to adsorb radioactive nuclides from wastewater had been researched many in recent years. Organic resin has disadvantages of heat resistance properties, radiation-resistant, secondary solid wastes treatment difficulty etc. In China, a large number of organic ion exchange resins were stored in the nuclear facilities waiting for treatment almost decades. Inorganic ion exchange material has the advantages of low prices, strong anti-radiation performance, higher exchange and adsorption properties, secondary solid wastes can grouting directly and so on. Therefore, the study of inorganic ion exchange material which suitable for radioactive wastewater treatment is particularly important[6,7].

In the low-level radioactive wastewater, it has amount of radioactive laundry wastewater. Radioactive laundry wastewater has a low activity concentration and can discharge to the sea on coastal nuclear facility sites when meet the national standards. But it can't discharge on inland sites because of the higher standards. Radioactive laundry wastewater contains Sr^{2+}, Cs^{+} Co^{2+} and other radionuclides, also has suspended solids and organics in it[13,14]. Inorganic ion exchange adsorption radionuclides has a great advantages in treatment radioactive laundry wastewater[15]. But the suspended solids and organics in wastewater may have some influence on the adsorption process. This paper studies on the effect of suspended solids, organics, radionuclides species on adsorption process of inorganic ion exchange material.

2. **Experimental**

2.1 Chemicals and reagents

The cesium nitrate, strontium nitrate, cobalt nitrate and zeolite 4A (Both from Tianjin Kermel Chemical Reagent Co., AR). Natural zeolite (Zhejiang, China, 200 mesh). Vermiculite (Hebei, China, 200 mesh). Clay (Mianyang, China, Sichuan Province, 200 mesh). Sodium oleate (klamar®,AR).

2.2. Adsorption studies

2.2.1 The Selection of inorganic ion exchange material

At room temperature and neutral environment , inorganic adsorbent material was weigh of 1g respectively to adsorb aqueous solution which containing Sr^{2+}, Cs^{+} ,Co^{2+} respectively. Then the solution was shaking at 100rpm. When the adsorption time reached to 45min, 60min, 120min and 180min, at each time sample 10mL of the adsorption solution respectively, samples from the solution were centrifugal 5min on 4500r/min at the same time, then the supernatant of the was samples and the original solution before the adsorption were analyzed after the filtration.

2.2.2 Effect of suspension of organics and organics

Suspended solids were simulated by clay and organics simulated by sodium oleate. Natural zeolite, zeolite 4A and vermiculite were weigh of 1g respectively to adsorb original aqueous solution 25ml which containing Sr^{2+}, Cs^{+} ,Co^{2+}. The concentration of Sr^{2+}, Cs^{+}, and Co^{2+} was 1mg/L respectively. The original aqueous solution also containing clay and sodium oleate with each concentration of 5mg/L, 15mg/L, 30mg/L and 100mg/L respectively. The reaction solutions were shaking at 100rpm last 1h. The samples and original aqueous solution were centrifugal 5min on 4500r/min. Then the supernatant of the all samples were analyzed after the filtration.

2.2.3 Orthogonal experiment design

Design three factors and three levels orthogonal experiment, The simulate radionuclides, clay and sodium oleate were designed as factors, the simulated radionuclides, sodium oleate and clay of different concentration were set as levels, then taken 25mL of solution containing the above-mentioned factors and levels to do orthogonal experiment. The adsorption reaction zeolite 4A was 1g. The reaction was 100rpm shaking then centrifugal and sampling to analyzed.

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