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Analysis of the Influence of Geopolymers in Curing Heavy Metals

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Abstract

Microalgae have attracted extensive attention in biodiesel, wastewater treatment, food health care, medicine and other fields due to their advantages of short generation cycle, no competition with crops for cultivated land and rich in lipid, protein and polysaccharide. Especially in the current situation of accelerating urbanization and deepening industrialization, the combination of microalgae cultivation and pollution control can not only deal with wastewater and waste gas generated by human activities, but also accumulate lipid, protein and polysaccharide by microalgae themselves, so as to realize the purose of recycling waste resources.

Keywords

Geopolymer; Environmental; Application.

1. Introduction

Geopolymer is a new non-cement-based green inorganic cement material that has emerged as one of the most promising alternatives to cement in recent research hotspots [1]. The concept of geopolymer was first proposed by French professor Joseph Davidovits in 1978 [2], and it is prepared by chemical reaction of natural minerals or industrial wastes rich in silica and aluminates (e.g. kaolin, slag, fly ash, etc.) under the action of alkaline exciters (e.g. NaOH, sodium silicate, sodium carbonate, etc.), so geopolymer is also called alkali-initiated cementitious material. It is important for the construction industry to achieve sustainable development and green construction. Geopolymer is widely available, low cost and can be recycled from industrial waste (e.g. fly ash, blast furnace slag powder, etc.), so it does not require large consumption of mineral resources. The production process of geopolymer is simple and does not require high-temperature calcination, thus reducing energy consumption significantly. The carbon emission of geopolymer production is about 20% of that of cement, and it produces almost no harmful gas, which basically achieves zero pollutant emission.

2. Factors Influencing the Immobilization of Heavy Metal Ions by Geopolymers

2.1. Effect of Additives on Fixed Heavy Metal Ions

In the process of geopolymer curing of heavy metal ions, the geopolymer prepared by pure alkali excitation is relatively ineffective in curing some ions The leaching rate of direct fixation of some ions, such as Cr 6+, in most cases the leaching rate of direct fixation is seriously not in accordance with national standards. However, by adding some reductive additives, the leaching rate of the cured However, by adding some reductive additives, the leaching of heavy metal ions from the curing body can play a synergistic role and fully improve the curing effect. Tian Quanzhi et al [3] addressed the problem of low Cr 6+ curing efficiency was low. The effect of CaO, MgO and Fe 2+ salts on geopolymer curing of Cr 6+, and the results showed that the Cr 6+ leaching rate without additives The results showed that the leaching rate of Cr 6+ without additives was more than 60%, while the leaching rate of Cr MgO, CaO and Fe 2+ salts were found to play an important role in the leaching of Cr 6+ leaching in the cured body. The effect of MgO, CaO and Fe2+ salts on the leaching of Cr6+ from the curing body was synergistic.

2.2. Effect of Alkali Exciter Type and Doping Amount on Fixed Heavy Metal Ions

The most widely used excitation method for geopolymers is alkaline excitation, usually with sodium silicate in combination with NaOH. Researchers have broadened the types of alkaline exciters, and both NaOH and KOH solutions can be excited in combination with sodium silicate; NaOH can also be excited in combination with silicate and aluminate exciters, so that broadening the types of exciters has an important effect on curing. KOH solutions (with a volume ratio of 1:2) for the preparation of bottom ash and metakaolin-based polymers for curing heavy metal ions. The leaching tests revealed that the best results were obtained by using 8 mol/L KOH solution to excite the geopolymer with 99.99% immobilization efficiency. Lee et al [4] compared the immobilization ability of aluminate and silicate exciters, and now the geopolymer with a silicon-to-aluminum ratio of 2.0 was prepared from sodium aluminate and NaOH, which was more suitable for curing lead.

2.3. Effect of Silicon to Aluminum Ratio on Immobilization of Heavy Metal Ions

The silica-alumina ratio of geopolymers is one of the most important factors controlling the final structure and properties of geopolymers, including chemical stability, mechanical strength, fire resistance and durability. The fixation efficiency of geopolymers with different silica-alumina ratios varies. When the silica-alumina ratio of geopolymers is 2.0, the structure is relatively stable and more suitable for curing metal ions. Kränzlein et al found that geopolymers with a silica-alumina ratio of 2.0 were the most effective and structurally stable for curing heavy metals by comparing the effects of geopolymers with different silica-alumina ratios on curing Pb2+ and Zn2+. Lee [4] also found that geopolymers with a silica-alumina ratio of 2.0 were the most effective for curing lead. Lee also found that geopolymers with a silica-alumina ratio of 2.0 were the most effective in curing lead. Therefore, the effectiveness of the geopolymer for immobilizing heavy metal ions depends on the silica-alumina ratio, and making the silica-alumina ratio as close to 2.0 as possible in the experiment can effectively improve the immobilization efficiency.

2.4. Effect of Maintenance Temperature on Fixed Heavy Metal Ions

Temperature can have a large effect on the geopolymer structure during the maintenance process. When the curing temperature is too low, it may produce the typical microstructure associated with low geopolymerization rate, get lower compressive strength, fail to produce a dense and complete geopolymer, and therefore poor fixation. And when the maintenance temperature is too high, it may lead to degradation of the dense matrix, forming more micropores and visible wide cracks, which likewise affects the fixation of heavy metal ions. Therefore, it is particularly important to choose a suitable curing temperature for the geopolymer. Hu et al. set the curing temperature at 60 °C in the preparation of tailings matrix polymer, and obtained a geopolymer with a dense and uniform internal structure without obvious pores and cracks, and successfully fixed the heavy metal ions Pb2+. The geopolymer

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with dense and uniform internal structure and no obvious pores and cracks was obtained and successfully fixed heavy metal ions Pb2+and Ba 2+.

2.5. Effect of Heavy Metal Ions on Fixation

Geopolymers have excellent properties in immobilizing heavy metal ions, but the suitability of geopolymers for immobilization varies for different heavy metal ions. The suitability of geopolymers for immobilization varies for different heavy metal ions. Researchers have tried to immobilize heavy metal ions for various industrial solid wastes containing silica and aluminum, and the toxic heavy metal ions The main toxic heavy metal ions are Pb, Zn, Cr, Cd, etc. It was shown that the immobilization efficiency of geopolymers prepared from industrial solid wastes containing silica-alumina for heavy metal ions The immobilization efficiency of the geopolymers prepared from industrial solid waste containing AlSi was relatively high, above 90%, and the immobilization ability of fly ash-based polymers for Pb was above 99%. This indicates that the geopolymers exhibited The use of solid waste as raw material for fixing heavy metal ions in industrial production is conducive to the protection of the environment and the recycling of resources. The use of solid waste as a raw material in industrial production can help protect the environment and realize the recycling of resources.

3. Conclusion

Recent studies have shown that geopolymers can be used for the modification of carbon paste electrodes, electrochemical detection of trace lead ions in aqueous solutions, or as antimicrobial agents to inhibit the biological corrosion of concrete in sewage pipes, which further expands the application fields of geopolymers. The range of raw materials for geopolymer can be further expanded by making full use of local characteristics, such as gold tailings, acid phosphate, etc. can be used as raw materials for geopolymer preparation; in addition, the geopolymer structure still lacks a unified calculation model, and the optimization of geopolymer structure can be considered by combining simulation and experiment in the future.

Due to the instability of geopolymer materials and the lack of systematic research on geopolymer materials, only a very small number of them have entered the pilot stage, and further breakthroughs in raw materials, methods and long-term stability are needed for large-scale applications of geopolymers.

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