Research Progress in Remediation of Heavy Metal Pollution by Iron-based Biochar Composites

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Abstract: Biochar has been widely used in remediation of water and soil polluted by heavy metals, but its poor catalytic performance, low aromatics and few adsorption sites limit its application. The iron based biochar composite prepared by the iron based compound and biochar can improve the defects of the iron based material easy oxidation and agglomeration while optimizing the performance of biochar, and show good passivation effect of heavy metals. The possible problems in the practical application of iron based biochar composites are analyzed through the research in this paper. The aim is to provide a theoretical basis for the application of iron based biochar composites in remediation of heavy metal pollution.
***Keywords*:** biochar, iron based materials, iron based biochar, heavy metal pollution, environmental remediation

1. Introduction

With the rapid development of China's modern social and economic construction, although the industrial production technology continues to improve, the problem of heavy metal pollution has become increasingly prominent. Around some industrially developed cities, a large number of people are threatened by heavy metal pollution. Especially through the circulation of the food chain, some excessive heavy metals cause serious damage to the health of the local population, and some individual cases even directly threaten the safety of life. On the other hand, heavy metals are persistent and stable in the natural environment. Excessive heavy metals penetrating into groundwater and soil react chemically with other minerals, causing certain damage to the healthy and stable development of the natural ecosystem, and environmental problems such as environmental pollution, water pollution and air pollution are becoming more and more prominent[1].

In different kinds of remediation technologies, biochar biochar has a large specific surface area, controllable porous structure and rich oxygen-containing functional groups, and is widely used in the remediation of heavy metal pollution in the environment. However, the original biochar still has some limitations in the selective adsorption of high concentrations of heavy metals, including low adsorption capacity, poor catalytic performance, difficult to separate and reuse. Iron based biochar (Fe/BC) composite has been proved to have excellent adsorption properties for heavy metals such as chromium, cadmium, mercury, lead, nickel and arsenic in the environment due to its large specific surface area, abundant adsorption sites and high reactivity.

2. Preparation Method of Iron Based Biochar Composite

2.1 Dip Pyrolysis Method

The main operation of the impregnation pyrolysis method to prepare Fe/B°C is the absorption of iron ions by raw materials, that is, the original biomass is soaked in a water-soluble iron salt solution or a suspension of iron minerals, so that it is fully adsorbed, and then it is fully pyrolyzed in a tube furnace under oxygen-free conditions, and the resulting product is Fe/BC![2]. The impregnation pyrolysis method can complete the pyrolysis and magnetization in one step, and the properties of the resulting Fe/BC can be controlled by adjusting the reaction conditions, such as pyrolysis temperature, pyrolysis time and gas flow rate.

2.2 Precipitation Method

The preparation of Fe/BC by precipitation is divided into co-precipitation method and reduction co-precipitation method, the main difference between the two lies in the reagent added by drops [3]. The biomass raw materials were pyrolyzed to produce BC by co-precipitation method, and then soaked in iron salt solution, and adjusted pH to alkaline (9.0~110) by stirring drops and adding alkali solution such as sodium hydroxide (NaOH), and then formed iron oxide precipitate after washing and drying to obtain Fe/BC composite materials. The difference of reduction co-precipitation method is that strong reducing substances such as sodium borohydride (NaBH4) are added. After sufficient reaction, the supernatant is removed,

the solid substance is washed and vacuum dried, and finally Fe/BC composite material is obtained. Compared with dip pyrolysis method, precipitation method is more controllable, and the obtained Fe based particles can be more stably loaded on BC matrix.

2.3 Hydrothermal Carbonization Method

Hydrothermal carbonization is an efficient and cost-effective method, usually performed by a solution of biomass and metal ions at relatively low temperatures (100 to 300 °C) and under the high pressure generated by the reaction itself. Hydrothermal carbonization consumes less energy than other methods and places fewer restrictions on the state of the feedstock (wet biomass feedstock can be used without the drying process).

3. Application of Iron-based Biochar Composites in Remediation of Heavy Metal Pollution

In the process of modern industrial development, heavy metal pollution in the natural environment has attracted much attention. A large number of heavy metal polluting elements in groundwater and soil cannot be biodegraded, and their persistence in the natural environment is relatively durable. This special stability is of great harm to human beings and organisms. At present, according to research, Fe/BC composite material has become an advantageous material for repairing heavy metal pollution in the environmental field because of its reduction ability of iron based particles and adsorption performance of biochar, and has played an important role in building an environmentally friendly and resource-saving society.

At present, according to the research of biological scientific research institutions, lake sediment is a good adsorbent. Naturally occurring lake sediments are a good adsorbent. This discovery has led some researchers to prepare iron-based biochar (MBC) by pyrolysis using pecan peel as raw material for biomass, and to use it to improve the original sediment according to environmental changes. The experimental results show that the modified sediment has obvious adsorption properties for copper (C*), and its removal rate is 88%, which is significantly higher than that of the original sediment. When the pH is 5 and the salt concentration is 10mg, the modified sediment has a positive effect on C? The maximum adsorption capacity of + was 70.02mg/g.

On this basis, in order to further improve the adsorption capacity of biochar to heavy metal element arsenic. Some researchers prepare iron-based modified biochar (SFCSB) at 300℃ by using sulfuric acid and ferric sulfate as raw materials from coconut husks. The experimental results showed that the specific surface area of biochar was increased by 1.56 times by the modification of sulfuric acid and ferric sulfate. When pH=5, the maximum adsorption capacity of SFCSB for arsenic (As) is 14.65mg/g, which is 238 times higher than that of unmodified CSB.

As scientists continue to break through the technology, the joint repair technology is the focus of current industry research. The experimental researchers took the mercury (Hg) contaminated soil of a mine as the research object, and used iron-based biochar as the absorbing material to strengthen microwave remediation of mercury contaminated soil. The experimental results show that the Hg removal rate can reach 91.10% under the conditions of 8% iron biochar addition weight, 180°C thermal desorption temperature and 120min thermal desorption time. Compared with single microwave restoration (Hg removal rate was only 30.12%), adding biochar material to soil can effectively improve the microwave heating effect, and the wave absorption capacity of iron-based biochar is better than that of original biochar.

4. Conclusion

The balanced and healthy development of natural ecology is the basic guarantee for the development of human society. Heavy metal environmental pollution is not a problem of a certain country or region, but a problem faced by all mankind. Through a large number of scientists' experimental research on iron based biochar composites in heavy metal pollution remediation, it provides technical support for solving this problem[4]. However, the practical application in reality is not the same as the research in the laboratory, at this stage, the application of Fe/BC composite materials on heavy metal pollution in the environment is mostly limited to laboratory research, and the conditions in the actual environmental application process are very different. Therefore, the optimal parameters of materials in actual heavy metal pollution control still need to be further studied.

References

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