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Biochar

and It's application in agriculture

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Abstract

Biochar is a carbonaceous or carbon rich material which is produced from biomass such as various type of wastes feedstock, agricultural wastes, municipal sewage sludge and crop residues. It is widely used for soil remediation, soil amelioration, carbon sequestration, organic waste composting, decontamination of water and waste water, catalyst activator, electrode material and electrode modifier. The effect of biochar on soil microorganisms have been observed under scientific and academic research. It is improved soil fertility by retaining nutrients and

potentially, enhancing nutrient bioavailability. Different common methods used for preparation of biochar is pyrolysis, gasification, and hydrothermal carbonization.

Introduction

Biochar is a carbon rich by- product produced from organic wastes under hydro thermal reaction. It contains rich carbon and nutrients such as a ammonia, high cation exchange capacity, large surface area and structure. Adsorption is a main mechanism of biochar to remove heavy metals and pollutants. The thermal physiochemical properties of biochar for different environmental processes, can be modified with acids, alkali, oxidizing agents and metals ions. Biochar has been widely used in the environment application such as soil remediation, amelioration, carbon sequestration, water treatment and waste water management. Biochar typically contains volatile and condensed aromatic organic substances and inorganic elements. Laghari *et al.* (2015) reported that biochar application to low fertility sandy soils increased total carbon by 7-11%, K by 37-42%, P by 68-70%, and Ca by 69-75% as compared to no application.

Preparation Methods

Common organic wastes such as sludge-slurry and agricultural wastes are produced in a great amount in the world. Generally common wastes including agricultural crop residues, biomass of crops, sludge and manure wastes can be used as a feedstock to synthesize biochar. For instance, straw derived biochar had a higher K content (961 mg kg^{-1}) and pH (9.5) than the wood biochar (349 mg kg^{-1}) and pH (8.0) Vaughn *et al., (*2013). Conversion of feedstock into char using the carbonization processes including pyrolysis, gasification and hydro thermal carbonization.

Pyrolysis

During pyrolysis process, the solid, liquid and gases products formed. The solid were called biochar, liquid were called bio-oil and gases were called syngas usually contains Co_2, H and nitric oxide.

Gasification

Gasification agents are air, oxygen, steam etc. Gasification agents proceeds to partially oxidized the feedstocks. In gasification required high temperature than pyrolysis and small amount of O_2 and steam. It is similar to pyrolysis process.

Hydrothermal carbonization

In hydro thermal carbonization, the feedstocks were mixed with water in a reactor. The temperature of hydro thermal carbonization was below 250-degree celcius. Then the pressure and temperature were raised.

Characterization

- In terms of physical attributes biochar is black in color, highly porous, light weight, fine-grained and has a large surface area.
- Approximately 70% of its composition is carbon.
- The remaining constituents of N, H and O among other elements.
- Biochar chemical composition varies depend upon the feedstocks used to make it and methods used to heat it.

Environmental Application

Soil remediation and amelioration

Biochar has been used to remediate the pollution of organic pollutants and heavy metals in soil. The soil remediation by biochar proceeds mainly via adsorption. The mechanism of biochar adsorption includes surface complexation, hydrogen binding, electrostatic attractions, acid-base interaction, pi-pi interactions. The addition of biochar can promote the microbial activity in soil. In addition to organic pollutants (toxic molecular compounds), biochar can effectively adsorb heavy metal ions in soil. The adsorption mechanism of heavy metals on the biochar mainly includes surface complexation, precipitation, cation exchange, chemical reduction and electrostatic attraction.

Carbon sequestration

Soil as an important carbon sink plays an important role in global carbon cycle, which directly affects the climate change. Carbon sequestration has been proposed as a way to detract the emission of carbon dioxide in soil. Biochar usually has high resistance to biodegradation due to its highly condensed aromatic structure, high cation and anion exchange capacity and high-water retaining capacity. It is thus considered that biochar has a positive impact on carbon sequestration in the soil. The carbon in the biochar could be divided into recalcitrant and labile carbon. Many studies have been conducted to investigate the effect of biochar on the carbon sequestration in soil.

Additive in organic solid waste composting

The organic solid waste is important for the successful disposal of solid waste. Composting as one of waste treatment methods has attracted much attention due to its own advantages such as low cost. In general, the addition of biochar has positive effect on the composting. In addition, it was found that bacterial consortium combined with biochar could enhances microbial activity to accelerate degradation, enhance the richness and alter the specific selection of bacterial colony.

Catalyst and Activator

Biochar can also be catalysts. It was used as catalyst for biodiesel production. For example, hardwood-derived biochar showed high activity for the esterification of free fatty after sulfonation and smudging. Moreover, the biodiesel had high acid density. Biochar was highly active in esterification, which can decrease the fatty acid content in soil. Moreover, the catalyst could be reused for 10 cycles without obvious loss of catalytic activity. In addition of biochar in soil as a carrier fixed the lipase enzyme excreted by Pseudomonas sp.

Decontamination of water and waste water

Many studies have shown that biochar can remove pollutants including organic pollutants and inorganic pollutants from water and wastewater via adsorption. Antibiotics are becoming ubiquity organic pollutants in the environment. It was to show something clearly by giving proof that sludge-derived biochar was cost-effective and reusable adsorbent for the removal of antibacterial drug. The adsorption of pollutants by biochar in water depends on the physiochemical properties

of targeted pollutants and the types of biochar.

Electrode materials electrode modifier

The ideal electrode materials should possess high surface area and rich porous structure to provide enough active sites for electrochemical oxidation. In carbon sequestration, common carbon materials such as graphite granule, graphene, granular activated carbon and carbon nanotubes can be used as a electrode materials.

Benefits of Biochar

- Enhanced plant growth.
- Increases soil water holding capacity.
- Increases cation exchange capacity.
- Stimulated symbiotic nitrogen fixation in legumes.
- Reduced leaching of nutrients.
- Support soil microbial life and biodiversity.