

Conversion of Biomass into Hydro Char from Hydrothermal Process

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Background information

India has a rapidly growing demand for renewable energy, driven by the country's commitment to reduce greenhouse gas emissions, increase energy security, and provide electricity to millions of people who currently lack access to it. India has set a target of achieving 450 GW of renewable energy capacity by 2030, which includes 280 GW of solar, 140 GW of wind, and 10 GW of biomass. The Indian government has introduced a range of policies and incentives to encourage investment in renewable energy, including feed-in tariffs, tax incentives, and subsidies for renewable energy projects. The government has also launched a number of initiatives to promote the adoption of renewable energy technologies, such as the National Solar Mission, which aims to achieve 100 GW of solar capacity by 2022. Overall, the demand for renewable energy in India is expected to continue to grow rapidly in the coming years, driven by the country's ambitious renewable energy targets, favourable policies and incentives, and the declining costs of renewable energy technologies.

Why biomass conversion technologies are important?

- ✚ **Renewable energy source:** Biomass is a renewable energy source that can be continuously replenished, making it an important alternative to non-renewable fossil fuels such as coal, oil, and natural gas.
- ✚ **Reduced greenhouse gas emissions:** Biomass conversion technologies can help to reduce greenhouse gas emissions and mitigate climate change. Biomass is a carbon-neutral energy source, meaning that the carbon dioxide released during combustion is balanced by the carbon dioxide absorbed by the plants during their growth.
- ✚ **Waste reduction:** Biomass conversion technologies can help to reduce waste by converting agricultural, forestry, and municipal waste into energy. This reduces the

amount of waste sent to landfills, which can help reduce greenhouse gas emissions and environmental pollution.

- ✚ **Energy security:** Biomass conversion technologies can improve energy security by reducing dependence on imported fossil fuels. Biomass is a locally available resource that can be used to produce energy, reducing the need for energy imports and increasing energy independence.
- ✚ **Rural development:** Biomass conversion technologies can provide economic opportunities in rural areas by creating jobs and supporting local industries. This can help to promote rural development and reduce poverty.

Conversion of biomass into hydrochar

The conversion of biomass into hydrochar is a promising technology for producing a renewable and carbon-neutral fuel from organic waste materials. Hydrochar is a solid material that is similar to charcoal, but is produced through a hydrothermal carbonization process that uses water and high temperatures and pressures to break down the biomass. The process involves heating the biomass in the presence of water in a closed reactor vessel, which leads to the formation of a slurry. The slurry is then dried and the resulting hydrochar can be used as a heating or electricity generation fuel. The conversion of biomass into hydrochar has several advantages. Firstly, it is a renewable and carbon-neutral fuel source, which can help reduce greenhouse gas emissions and mitigate climate change. Secondly, it can be produced from a wide range of organic waste materials, including agricultural waste, forestry residues, and municipal solid waste, making it a versatile and locally available resource. Finally, hydrochar can be used in a variety of applications, such as energy production, soil amendment, and water treatment. The process flow chart of hydro char production as shown in Fig. 1. However, there are also some challenges associated with the conversion of biomass into hydrochar. These include the high capital costs of the hydrothermal carbonization equipment, the need for consistent and high-quality biomass feedstock, and the potential for environmental impacts if the waste products of hydrochar production are not properly managed. In General, the conversion of biomass into hydrochar is a promising technology that can provide a sustainable and renewable source of energy from organic waste materials. Further research and development, as well as policy support, will be needed to overcome the challenges and maximize the benefits of this technology.

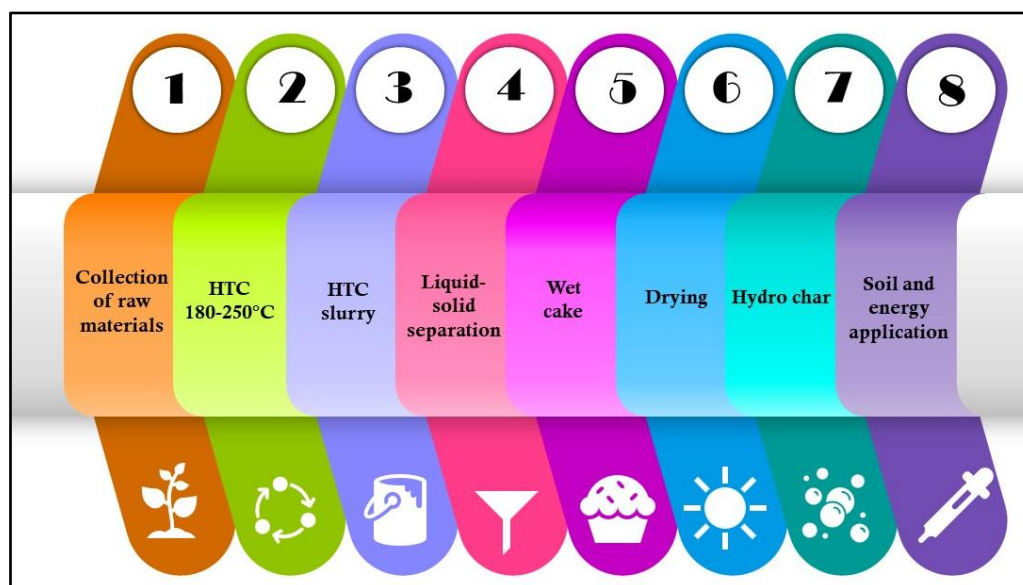


Fig. 1 Process flow chart of hydro char production

Factor affecting hydrochar properties

- Feedstock composition:** The type and composition of the biomass feedstock used in hydrochar production can affect the properties of the resulting hydrochar. Different feedstocks have different chemical compositions and properties, which can impact the energy content, stability, and other characteristics of the hydrochar.
- Temperature and residence time:** The temperature and residence time during the hydrothermal carbonization process can affect the properties of the hydrochar. Higher temperatures and longer residence times generally lead to the production of hydrochar with higher energy content and more stable properties.
- Moisture content:** The moisture content of the biomass feedstock can affect the properties of the hydrochar. Higher moisture content can lead to lower energy content and less stable properties in the hydrochar.
- pH and other process conditions:** The pH and other process conditions, such as pressure, can affect the properties of the hydrochar. For example, low pH can lead to the production of hydrochar with higher acidity, which can impact its suitability for certain applications.
- Post-treatment:** Post-treatment processes, such as washing and drying, can affect the properties of the hydrochar. Washing can remove soluble compounds and reduce the

ash content, while drying can increase the energy content and stability of the hydrochar.

Difference between hydro char and biochar

Biochar and hydrochar are both produced through the thermal treatment of biomass, but there are several differences between the two:

	Hydro char	Biochar
Production method	Hydrochar, is produced through hydrothermal carbonization, which involves heating biomass in the presence of water at high temperatures and pressures (usually around 180-250°C and 20-30 bar) for several hours. This process converts the biomass into a solid, black, carbon-rich material called hydrochar. The presence of water in the process allows for the production of hydrochar without the need for external drying, making it a more energy-efficient process than pyrolysis.	Biochar is produced through a process called pyrolysis, which involves heating biomass in the absence of oxygen to a temperature of around 400-800°C. This causes the biomass to break down into solid char, liquid tar, and gaseous by-products, such as methane and carbon monoxide. The solid char, which is biochar, is then cooled and collected for use. The absence of oxygen during pyrolysis prevents combustion and the production of greenhouse gases.
Chemical properties	Hydrochar, on the other hand, has a higher moisture content (usually between 10-50%) and more functional groups, such as carboxylic and phenolic groups. These functional groups make hydrochar more reactive and suitable for certain applications, such as wastewater treatment, soil amendment, and energy production.	Biochar is typically produced at higher temperatures and longer residence times than hydrochar, resulting in a material with higher carbon content (typically 60-90%) and more stable properties. It is also low in moisture content, ash content, and volatile organic compounds. The high carbon content of biochar makes it an

	Hydrochar also contain more nutrients and minerals than biochar, which can make it a valuable soil amendment.	effective tool for carbon sequestration and mitigating climate change.
Application	Hydrochar has a wider range of potential applications than biochar, including energy production, water treatment, and soil amendment. Hydrochar can be used as a solid fuel, as a feedstock for the production of biogas, or as a soil amendment to improve soil structure and fertility. It can also be used in wastewater treatment to remove contaminants and nutrients from water.	Biochar is commonly used as a soil amendment to improve soil fertility, water retention, and carbon sequestration. It can also be used in animal feed, water treatment, and as a fuel source. Biochar has been shown to improve crop yields, reduce the need for synthetic fertilizers, and increase soil carbon storage.
Environmental impact	Both biochar and hydrochar have the potential to reduce greenhouse gas emissions by sequestering carbon in the soil or in products, such as bioplastics. The production of biochar and hydrochar from biomass also has the potential to reduce waste and create a more circular economy. However, the environmental impact of each material depends on the specific production and application methods used. For example, the use of certain feedstocks, such as palm oil or other monoculture crops, for biochar or hydrochar production can have negative environmental impacts, such as deforestation, habitat destruction, and loss of biodiversity. The use of sustainable feedstocks and production methods is therefore important to ensure the environmental benefits of biochar and hydrochar production are maximized.	

Conclusion

In conclusion, the conversion of biomass into hydrochar through hydrothermal carbonization is a promising technology with numerous potential applications. Hydrochar has

unique chemical properties, such as higher moisture content and more functional groups, which make it suitable for various uses, such as energy production, water treatment, and soil amendment. The properties of hydrochar can be influenced by factors such as feedstock composition, temperature, pressure, and residence time. However, more research is needed to fully understand the effects of these factors on the properties and applications of hydrochar. Overall, hydrochar production can offer several environmental benefits, such as reducing waste and greenhouse gas emissions, as well as promoting sustainable agriculture and circular economies.

Reference

Zhang, Z., Zhu, Z., Shen, B. and Liu, L., 2019. Insights into biochar and hydrochar production and applications: A review. *Energy*, 171, pp.581-598.

