

Biochar: what it is, how it is produced, and its use

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Biochar, a charcoal-like material, is made from a process called pyrolysis over a range of temperatures from 450 to 700 °C in the absence of oxygen, utilizing a wide variety of sustainably sourced residual and waste biomass feedstocks.

During pyrolysis the biomass does not burn, but the molecules of cellulose, hemicellulose and lignin break down into smaller fragments producing solid biochar, vapors that condense into a liquid called biooil, and gaseous hydrocarbon products.

The condensate (biooil) is a complex mixture of hydrocarbons, and it contains high quantities of acetic acid, other carboxylic acids, furfural, acetol, sugars, aldehydes and phenols. It can be upgraded into biofuels, although the process is costly.

The gas contains hydrogen, methane, carbon monoxide, and numerous light hydrocarbons. Together with the vapors, it can be used for process energy recovery to make the process thermally self-sustained and for heat generation.

If left unprocessed, the biomass exposed to nature would go to waste: crop residues and processing wastes, animal manure, sewage sludge, forest trimmings, and other byproducts of biomass-based industries decompose generating greenhouse gases.

From its origins, biochar production is defined as a 1000+ year-old technique used by Indigenous peoples in the Amazon basin to generate fertile soils (Figure 1).



Figure 1 – Impact of biochar addition to the soil

More recently, biocarbon has been produced from wood to be used as fuels an alternative to coal (Figure 2).



Figure 2 – Biocarbon production in the early days

A sustainable biomass pyrolysis process is illustrated in Figure 3.

Pyrolysis of Biomass and Waste

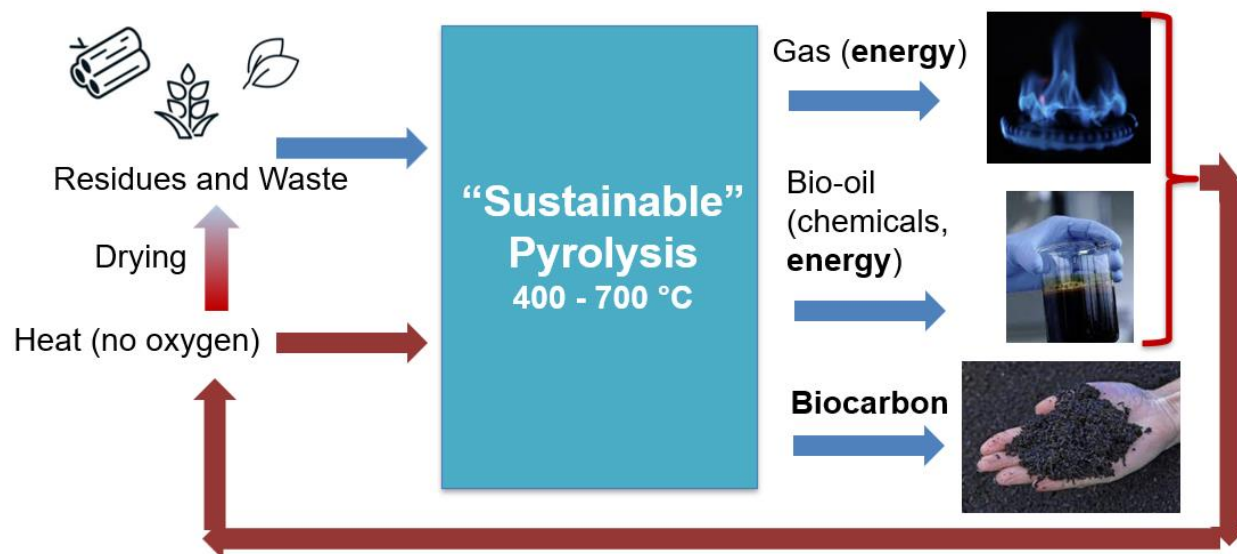


Figure 3 – A thermally self-sustained process using gas and vapors as energy source

Not all biochars are the same! Low Temperatures biochars are rich in volatiles, they contain polyaromatic hydrocarbons, have low porosity and specific surface areas, and include bioavailable carbon that will degrade over time, High Temperatures biochars: are depleted of volatiles, have high porosity, specific surface areas and clean pores (Figure 4), are made up of stable aromatic carbon that may last hundreds of years.

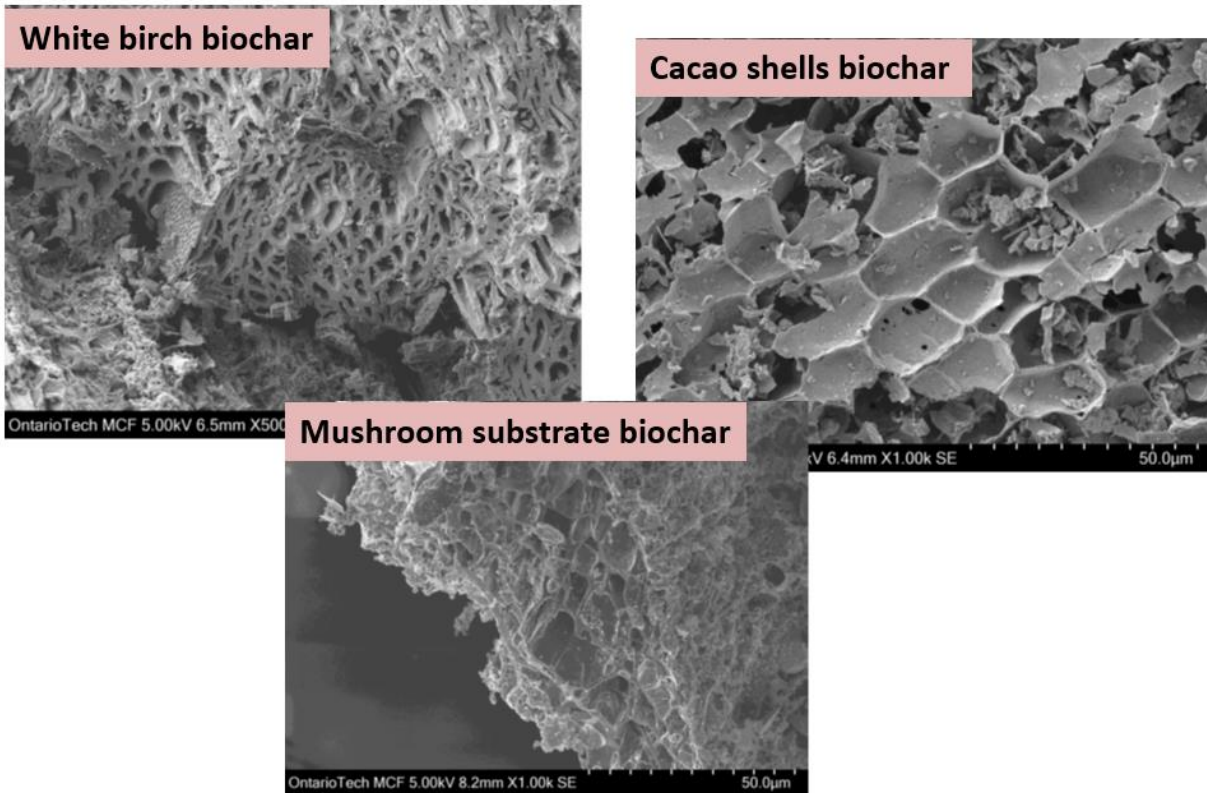


Figure 4 – Micrographs of different types of high temperature biochars

Biochar is produced by pyrolysis without using any external energy source (Figure 5 and Figure 6):

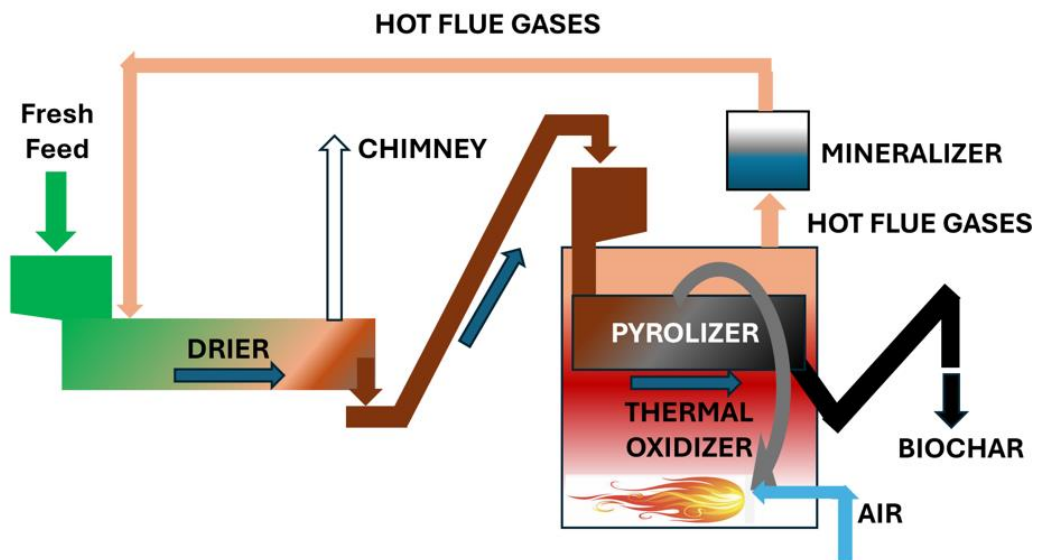


Figure 5 – Schematic of a thermally self-sustained pyrolysis process

