Water Uptake in Biochars: The Roles of Porosity and Hydrophobicity

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Abstract

We assessed the effects of porosity and hydrophobicity on water uptake by biochars. Biochars were produced from two feedstocks (hazelnut shells and Douglas fir chips) at three production temperatures (370 °C, 500 °C, and 620 °C). To distinguish the effects of porosity from the effects of surface hydrophobicity on water uptake, we compared uptake of water (which is prevented from entering porous hydrophobic materials by capillary forces) to uptake of ethanol (which is completely wetting and not affected by hydrophobic materials). For both feedstocks, low temperature chars took up less water than high temperature chars but the same amount of ethanol, suggesting that differences in water uptake based on production temperature reflect differences in hydrophobicity, not porosity. Conversely, Douglas fir chars took up more water than hazelnut shell chars due to greater porosity. Thus designing biochars for water holding applications requires two considerations: (a) creating water holding capacity (i.e., porosity) through feedstock selection, and (b) determining a production temperature that is sufficient to reduce surface hydrophobicity to an acceptable level.

Summary bullets:

- Total porosity of granular biochars increases only slightly with increasing production temperature
- Water uptake by biochars depends on both feedstock selection and production temperature
- Residual porosity is a function of feedstock selection and provides substantial porosity for water uptake
- Surface hydrophobicity prevents water from entering biochar pores, but is reduced at higher production temperatures, allowing greater water entry