STUDY OF POSSIBILITY TO FORESEE THE ACTIVATED CHARS PROPERTIES KNOWING THE INTRINSIC CHARACTERISTICS OF RAW BIOMASS

Luis Angel, IMT Atlantique, GEPEA UMR CNRS 6144, F-44307 Nantes, France
luedang9507@gmail.com
Audrey Villot, IMT Atlantique, GEPEA UMR CNRS 6144, F-44307 Nantes, France
Jenny Peña, GEPEA UMR CNRS 6144, F-44307 Nantes, France
Maxime Hervy, GEPEA UMR CNRS 6144, F-44307 Nantes, France
Mohamad Dieme, GEPEA UMR CNRS 6144, F-44307 Nantes, France
Yves Andres, IMT Atlantique, GEPEA UMR CNRS 6144, F-44307 Nantes, France
Claire Gerente, IMT Atlantique, GEPEA UMR CNRS 6144, F-44307 Nantes, France
Manuel Rodriguez Susa, Universidad de los Andes, Bogota D.C., Colombia
Jaime Plazas-Tuttle, Universidad de los Andes, Bogota D.C., Colombia

Key Words: Activated char, correlation, physical activation, physicochemical properties, raw biomass

Activated carbon (AC) is currently one of the most used adsorbents for water and air purification at industrial scale. Although at industrial scale coal and coconut shells are two main sources for the production of AC, several agricultural by-products and wastes have been used as raw materials to produce activated chars (ACH) with similar properties to AC produced by pyrolysis and physical activation. The operating conditions of ACH production affect the textural properties, especially the porosity and the specific surface area.

Overall, the goal of this work is to study the possibility to forecast the physicochemical properties of activated carbons produced knowing the intrinsic properties of the raw biomass. The raw materials used in this study were a wide range of organic wastes from agricultural industries: millet stalks (MS), cashew shells (CS), rice husks (RH), buckwheat husk (BH), millet husk (BH), chontaduro seeds (CS), used wood pallets (UWP), food waste (FW). Also, a coagulation-floculation sludge (CFS) from cruise ships was included. The ACHs have been produced by an environmentally friendly process consisting of a direct physical activation conducted in quartz rotative furnace. Carbonization (or pyrolysis) of raw materials was conducted under an inert atmosphere to 850°C with a temperature ramp of 10 °C min^{-1} in a batch quartz rotative furnace. At 850°C, steam as activating gas (0.7 mL of water min^{-1}) was injected for 80 min.

Several analytical methods were used to determine the physical and chemical features of the raw biomass and ACHs. Proximal and lignocellulosic content analysis were performed; elemental analysis was determined by Thermo Finnigan AE1112 Series Flash elemental analyzer, and to characterize textural properties of materials ACHs porosity was measured twice by nitrogen adsorption at -196 °C using a Micromeritics ASAP 2020. Some properties of raw biomass and ACHs are presented in Table 1.

Table 1. Properties of raw biomass and ACHs

Biomass	Biomass components (% w.t.)			Textural properties of ACH					
	Lignin	Cellulose	Hemicellulose	S_{BET} (m^2g^{-1})	V_{total} (cm^3g^{-1})	V_{micro} (cm^3g^{-1})	V_{meso} (cm^3g^{-1})	$\%V_{micro}$	$\%V_{meso}$
MH	15.7	25.8	20.3	466	0.278	0.206	0.043	74.1%	15.5%
BH	27.0	20.4	18.5	997	0.681	0.419	0.175	61.5%	25.7%
CS	24.1	26.1	19.2	858	0.466	0.379	0.047	81.3%	10.2%
MS	27.0	30.7	24.3	1324	0.665	0.588	0.033	88.4%	4.9%
RH	12.7	34.1	18.1	384	0.257	0.168	0.057	65.6%	22.2%
CS	11.9	43.5	26.7	548	0.252	0.203	0.029	80.6%	11.5%
WP	16.4	41.6	23.5	625	0.314	0.217	0.047	69.1%	15.0%
FW/CFS	10.8	37.2	19.7	221	0.175	0.053	0.099	30.3%	56.6%

The results obtained in this study allow identifying links between the intrinsic proprieties of raw biomass and those presented by the ACH. For example, according to the results, the biomass residue which are rich in lignin (> 20 w.t.%) give the AC with the highest surface area. Also, there is a linear relation between the lignin ratio of the biomass residue and the surface area presented by the AC as Figure 1 shows. Other results show that high ash ratio in the biomass results in ACH with large mesoporosity, or that there is a positive correlation between fixed carbon and the carbon ratio obtained in the ACH.

This kind of study would allow to identify the most appropriate biomass to produce AC and to reorient the others to better routes for it. To go even farther, it would be interesting to study the impact of the mineral composition on the ACHs obtained, or to compare the energy balances for the different biomasses.

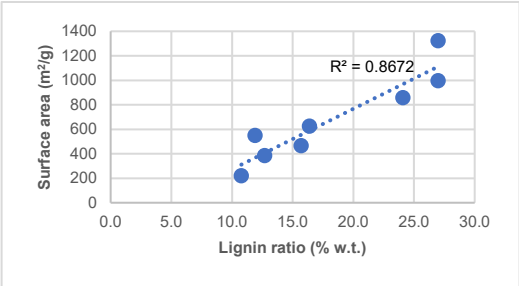

Figure 1. Relation between the lignin ratio of the raw biomass and the surface area of the ACHs