

Self-activation for activated carbon from biomass: Theory and parameters

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Supplementary Information

Proximate and ultimate analysis

Kenaf core and PAC (1,000°C, 10 h) were dried before testing. Volatile matters of kenaf core and PAC (1,000°C, 10 h) were examined in accordance with the procedures described in ASTM E872 and D5832 standards, respectively. Ash contents of kenaf core and PAC (1,000°C, 10 h) were analyzed in accordance with the procedures described in ASTM E1755 and D2866 standards, respectively. The residues of the matters were fixed carbon. Ultimate analysis was performed by a Vario EL III Element Analyzer.

Table S1.

Proximate analysis and ultimate analysis of kenaf core and activated carbon through self-activation process.

Sample	Proximate analysis (%)			Ultimate analysis (%)				
	Volatile matter	Fixed carbon	Ash	C	H	O	N	S
Kenaf core	82.85	15.41	1.74	48.00	6.37	42.10	0.35	0.07
PAC (1,000°C, 10 h)	0.68	80.47	18.85	92.14	0.54	0.12	0.16	0.02

Mass spectrometry

Mass spectrometry (MS) analysis was performed by Inficon CPM residual gas analyzer (RGA). After the self-activation of kenaf core at 1,000°C for 30 h (cooling down to room temperature), the gas sample was collected in a bag from the furnace by a 1-liter Tedlar bag (Zefon International Inc., USA) for analysis.

Fig. S1 shows the MS of emitted gases from self-activation of kenaf core, with the possible components, including H₂, CO₂, CO, H₂O, CH₄, etc. In Fig. S1, it showed that the H₂ amount was very little. This could be due to that some H₂ was diffused out through the Tedlar bag. The m/z peaks shown in Fig. S1 at 12, 28, and 32 (C, CO, O₂) would have included those decomposed from CO₂, since the electron ionization was used.

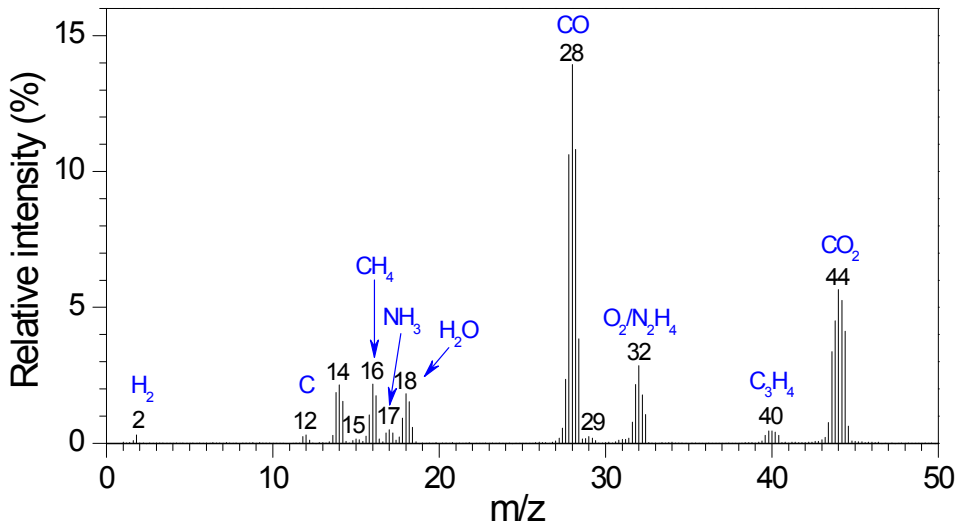


Fig. S1. Mass spectrometry of the emitted gases from the self-activation of kenaf core at 1,000°C for 30 h.

Fourier transform infrared spectroscopy

Fourier transform infrared spectroscopy (FT-IR) was carried out by a Thermo-Fisher Nicolet 6700 FTIR analyzer, employing a 20-mL Pike flow cell. Two gas samples were collected by 1-liter Tedlar bags, including the emitted gases after the self-activation processes at 1,000°C for 2 h and 30 h, respectively.

FT-IR was employed to examine the concentration changes of CO₂ and CO during the time (Fig. S2 and Table S2). The peaks at 2360 and 2341 cm⁻¹ belong to CO₂, and those at 2171 and 2117 cm⁻¹ are attributed to CO.¹ Comparing the gas components from self-activation at 1000°C for 2 h with those for 30 h, the CO/CO₂ ratio was increased by 128.8%, indicating that the CO₂ was reacted with C to generate CO with an increase of self-activation time.

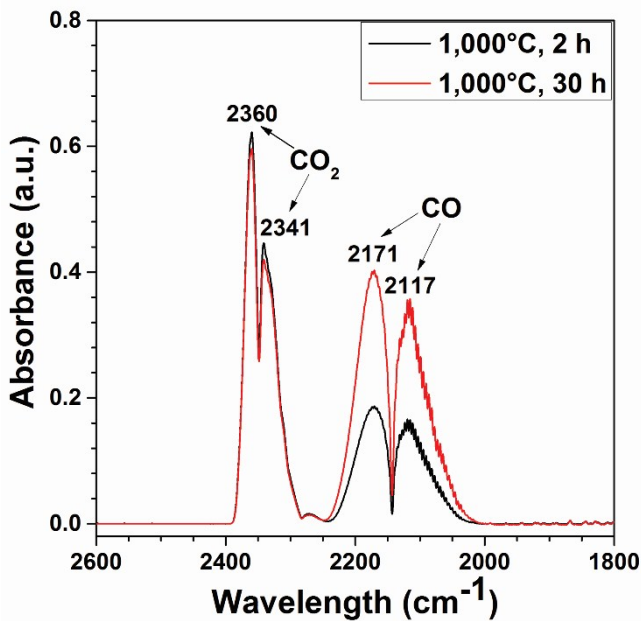


Fig. S2. FT-IR absorbance of the emitted gases from self-activation processes at 1,000°C for 2 h and 30 h.

Table S2.

FT-IR absorbance of CO₂ and CO in the emitted gases after self-activation processes at 1,000°C for 2 h and 30 h.

Parameter	FT-IR absorbance (a.u.) ^a				Value of CO/CO ₂
	CO ₂		CO		
	2360 cm ⁻¹	2341 cm ⁻¹	2171 cm ⁻¹	2117 cm ⁻¹	
1,000°C, 2 h	0.622	0.446	0.185	0.156	0.319
1,000°C, 30 h	0.596	0.420	0.400	0.342	0.730
Increase (%) ^b	-	-	-	-	128.8

^a The four wavelengths are corresponding to the peaks in Fig. S2;

^b The increase of CO/CO₂ ratio from “1,000°C, 2 h” to “1,000°C, 30 h”.

Reference

- 1 H. Yang, R. Yan, H. Chen, D. H. Lee and C. Zheng, *Fuel*, 2007, **86**, 1781–1788.