

Supplementary Data

Nanobiochar: Production, Properties, and Multifunctional Applications

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Table S1. Basic operation parameters and estimated methods capital costs (The appropriate values should be used depending on the country and production method of biochar and nanobiochar) ¹

Description	Method I (Milling and nano fraction extraction)	Method II (Microwave pyrolysis)	Method III (Thermal-flash exfoliation)
Operating parameters			
Operating time per day	Daily operating time	Daily operating time	Daily operating time
Annual operating time	Operating time/day x no. of working days/year	Operating time/day x no. of working days/year	Operating time/day x no. of working days/year
Process time (including preparation time, reaction time, cooling down process, collecting product)	Total time to take ground biochar and separate the nano fraction	Total time to take microwave pyrolyzed nanobiochar	Total time to take microwave pyrolyzed nanobiochar
Amount of feedstock	Feedstock (Kg) needed to obtain the specific weight of nanobiochar	Feedstock (Kg) needed to obtain the specific weight of nanobiochar	Feedstock (Kg) needed to obtain the specific weight of nanobiochar
Measurement of capital cost			
Fixed Capital Investment (FCI) ²	^a (Y ₁ USD x 1.1) + (X ₁ USD x 1.3)	^b (Y ₂ USD x 1.1) + (X ₂ USD x 1.3)	^c (Y ₃ USD x 1.1) + (X ₃ USD x 1.3)
Total plant cost (TPC) ²	^d Sum of FCI + 15% FCI	^e Sum of FCI + 15% FCI	^f Sum of FCI + 15% FCI
Measurement of operating cost			
Feedstock	Amount of feedstock/day x working days	Amount of feedstock/day x working days	Amount of feedstock/day x working days

Electricity	(Z ₁ USD/kWh x operating time x working days)	(Z ₂ USD/kWh x operating time x working days)	(Z ₃ USD/kWh x operating time x working days)
Maintenance	3% of FCI	3% of FCI	
Labour cost	(m ₁ USD/h x operating time x working days)	(m ₂ USD/h x operating time x working days)	(m ₃ USD/h x operating time x working days)
Production cost ³			
	Annual operating cost/Annual production cost	Annual operating cost/Annual production cost	Annual operating cost/Annual production cost

- a. FCI for scaled-up system (Method I): The sum of the total equipment cost multiply with a direct factor of 1.1 (USD × 1.1), added to the total cost of design, installation, fabrication and modification on the system and multiply by an indirect factor of 1.3 (USD × 1.3)
- b. FCI for scaled-up system (Method II): The sum of the total equipment cost multiply with a direct factor of 1.1 (USD × 1.1), added to the total cost of design, installation, fabrication and modification on the system and multiply by an indirect factor of 1.3 (USD × 1.3)
- c. FCI for scaled-up system (Method III): The sum of the total equipment cost multiply with a direct factor of 1.1 (USD × 1.1), added to the total cost of design, installation, fabrication and modification on the system and multiply by an indirect factor of 1.3 (USD × 1.3)
- d. FCI + 15% of FCI of scaled-up system of nanobiochar (method I)
- e. FCI + 15% of FCI of scaled-up system of nanobiochar (method II)
- f. FCI + 15% of FCI of scaled-up system of nanobiochar (method III)

X₁, X₂, X₃. Equipment cost*

Y_1, Y_2, Y_3 . The sum of the total equipment cost*

z_1, z_2, z_3 . Total cost for kilo watt per hour*

m_1, m_2, m_3 . Labor cost per hour*

* Values depends on the country and the method

References

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