Electronic Supplementary Material (ESI) for RSC Advances.

Supplementary Materials

Predicting the high heating value and nitrogen content of torrefied biomass using support vector machine hybrid with sparrow search algorithm

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Table.S1. Dataset.

Biomass	Torrefaction condition	Ref.
olive residue, almond shell	N2, 275 ℃, 60 min	1
olive tree	He, 220~280 ℃, 60~360 min	2
rice husk	Ar, 220~270 ℃, 30~60 min	3
coffee grounds	N2, 200~300 ℃, 30 min	4
banana leaf waste	N2, 220~280 ℃, 1 min	5
rice straw, rice husk	N2, 200~300 ℃, 30 min	6
pearl millet, walnut shell	N2, 230~300 ℃, 30~90 min	7
ash tree, hazelnut shell, refuse-derived fuel	N2, 230~290 ℃, 30 min	8
garden waste	Ar, 200~300 ℃, 30~60 min	9
mixture of municipal organic wastes and biomass	N2, 200~275 ℃, 30 min	10
empty fruit bunches	N2, 225~300 ℃, 40 min	11
oil palm empty fruit bunch	N2, 250~300 ℃, 30 min	12
caragana	N2, 225~275 ℃, 10~20 min	13
pellet consists of 80% larch and 20% oak	anoxic, 200~270 ℃, 20~40 min	14
rice straw, bamboo dust	N2, 250 ℃, 15 min	15
pine sawdust	N2, 260~300, 11 min	16
ananas comosus peel, annona squamosa peel	N2, 210~300 ℃, 30~60 min	17
eucalyptus grandis	N2, 230~290 ℃, 60 min	18
leucaena leucocephala	N2, 260~300 ℃, 0~30 min	19
moso bamboo	N2, 200~300 ℃, 60~120 min	20
rice husk, rice straw	N2, 200~300 ℃	21
pongamia seed pods	N2, 200~300 ℃, 60 min	22
rubberwood	N2, 200~300 ℃, 20~60 min	23
cellulose	N2, 200~290 ℃, 30 min	24
fruit waste	N2, 210~300 ℃, 30~60 min	25
empty fruit bunches	N2, 225~300 ℃, 20~60 min	26
mustard crop residue	N2, 200~300 ℃, 30~60 min	27
pine, kenaf	N2, 250 ℃, 30 min	28
prosopis juliflora	N2, 230~270 ℃, 30 min	29
sugarcane bagasse	N2, 230~280 ℃, 30~45 min	30
orange peel	N2, 220~280 ℃, 30 min	31
rice husk, rice straw	N2, 200~300 ℃, 60 min	32
poplar wood	N2, 200~300 ℃, 60 min	33
olive kernel	N2, 300 ℃, 60 min	34
rice husk	oxygen-deficient, 240~280 ℃, 0~90 min	35
miscanthus, hops waste	oxygen-deficient, 250 ℃, 60 min	36
waste vine shoots	N2, 220~280 ℃, 10~60 min	37
almond shells, olive stones	N2, 250~300 ℃, 45 min	38
sugarcane leaves	N2, 225~300 ℃, 30 min	39
corncob	N2, 210~300 ℃, 30 min	40
bamboo forest residues	N2, 200~300 ℃, 60 min	41

Biomass	Torrefaction condition	Ref.
leftover rice, leftover cabbage, leftover pork, watermelon peel	Ar, 200~300 ℃, 30 min	42
wooden block	N2, 220~280 ℃, 40 min	43
sugarcane bagasse	N2, 200~275 ℃, 60 min	44
sorghum straw	N2, 230~300 ℃, 30~108 min	45
pigeon pea stalk, eucalyptus	N2, 200~300 ℃, 30 min	46
sorghum straw	N2, 230~300 ℃, 10 min	47
rice straw	N2, 200~250 ℃, 45 min	48
pine wood, rice husk	N2, 210~300 ℃, 30 min	49
rice husk	N2, 220~300 ℃, 30 min	50
mixture of waste wood, oak waste wood and sewage sludge	oxygen-deficient, 220~300 ℃, 120 min	51
corncob, rice husk	N2, 200~300 ℃, 30~60 min	52
ponkan peel waste	N2, 200~300 ℃, 15~60 min	53
black alder	N2, 250~300 ℃, 30~60 min	54
Norway spruce	N2, 225~275 ℃, 30~60 min	55
sugarcane bagasse	N2, 200~300 ℃, 15~60 min	56
pigeon pea stalk	N2, 225~275 ℃, 15~45 min	57
rice husk	N2, 210~300 ℃, 30 min	58
wood biomass	Ar, 230~290 ℃, 60 min	59
pine wood	N2, 250~290 ℃, 30~60 min	60
vine pruning, olive tree pruning, corn stalk, poultry litters	N2, 300 ℃, 30 min	60
rice straw, cotton stalk	N2, 210~290 ℃, 20~60 min	62
cotton stalk, corn stalk	N2, 200~290 ℃, 30 min	63
oil palm fiber, Eucalyptus	N2, 250~300 ℃, 60 min	64
willow, reed canary grass, wheat straw	N2, 230~290 ℃, 30 min	65
rice straw	N2, 200~300 ℃, 60 min	66

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Table S2. Dataset description.

Feature	Name	Unit	Count	Range	Mean	Median	Std
Volatile content	VM	wt.%	515	32.2~96.4	77.02	78.9	8.28
Ash content	ASH	wt.%	515	0~32.58	5.48	3.3	5.76
Fixed carbon content	FC	wt.%	510	1.67~61.4	14.72	15.47	5.91
Carbon content	C	wt.%	497	29.59~54.16	44.83	45.1	4.73
Hydrogen content	H	wt.%	497	3.92~8.78	5.99	6.03	0.69
Oxygen content	O	wt.%	488	11.37~61.55	43.83	44.46	7.57
Nitrogen content input	Ni	wt.%	488	0~14.29	1.24	0.59	2.09
Temperature	Temp	°C	515	200~300	255.27	250	32.63
Duration time	time	min	491	10~360	46.78	30	35.20
Nitrogen content output	No	wt.%	379	0~8.32	0.94	0.65	1.066
High heating value	HHV	MJ/kg	491	13.48~30.3	21.45	20.67	9.76

Table S3. Pearson correlation coefficient between any two features

	VM	ASH	FC	C	H	O	Ni	Temp	time	No	HHV
VM	1	-0.7317	-0.43149	0.285685	0.352266	0.285826	-0.33873	-0.02405	-0.06716	-0.35123	0.298119
ASH	-0.7317	1	-0.12584	-0.42392	-0.41282	-0.46098	0.459565	-0.03273	0.090307	0.487347	-0.45297
FC	-0.43149	-0.12584	1	0.079571	-0.10953	0.258776	-0.10976	0.084657	-0.11562	-0.12312	0.08098
C	0.285685	-0.42392	0.079571	1	0.408945	-0.3595	-0.11518	0.052636	0.089709	-0.07764	0.352604
H	0.352266	-0.41282	-0.10953	0.408945	1	-0.09801	-0.20271	-0.01187	-0.16022	-0.17366	0.190531
O	0.285826	-0.46098	0.258776	-0.3595	-0.09801	1	-0.493	-0.02632	-0.24606	-0.50098	0.07209
Ni	-0.33873	0.459565	-0.10976	-0.11518	-0.20271	-0.493	1	0.019569	0.083976	0.926905	-0.07889
Temp	-0.02405	-0.03273	0.084657	0.052636	-0.01187	-0.02632	0.019569	1	-0.03492	0.036689	0.455955
time	-0.06716	0.090307	-0.11562	0.089709	-0.16022	-0.24606	0.083976	-0.03492	1	0.153204	0.312025
No	-0.35123	0.487347	-0.12312	-0.07764	-0.17366	-0.50098	0.926905	0.036689	0.153204	1	-0.01633
HHV	0.298119	-0.45297	0.08098	0.352604	0.190531	0.07209	-0.07889	0.455955	0.312025	-0.01633	1