

Supplementary Information

Table S1 Characteristics of raw sludge

Parameter	Value (standard error)
pH	~7
tCOD	13182 ± 260 mg/L
sCOD	164 ± 20 mg/L
tTOC	3886 mg/L
sTOC	65 mg/L
TS	1.5% ± 0.01%
TSS	14448 ± 28.3 mg/L
VSS	9310 ± 12.5 mg/L
TDS	690 ± 38 mg/L
Sludge volume index	56.75 mL/g
Proteins	0.5 mg/L
NH ₄ ⁺ - N	14.7 mg/L

Notes: In ultimate analysis of oven-dried sludge, the percentages by dry weight are: C, 26.2%; H, 3.1%; N, 3.64%; O, 15.5%; S, N.D. (Not detected)

Table S2 Comparison of solids concentration after hydrothermal pretreatments of sewage sludge

Mass balance	Initial solids (mg/L)	Reaction temperature (°C)	TSS (mg/L)	VSS (mg/L)	TDS (mg/L)	Reference
TH	TSS = 14448 VSS = 9310 TDS = 690	140	9367	5160	5677	Present study
		160	7097	4067	6007	
		180	6197	3032	6082	
WO (oxygen pressure = 4.2 kg/cm ² , n = 0.5)		140	6172	3095	6480	
		160	5051	1935	6775	
		180	4158	1237	5875	
WO (oxygen pressure = 8.4 kg/cm ² , n = 1)		140	6198	2733	7137	
		160	5095	1452	6090	
		180	4000	902	4730	
WO (oxygen pressure = 20 kg/cm ²)	TSS = 10340 VSS = 8400	220	2700	1400	–	Baroutian et al. (2015)
		230	2400	850		
		240	1600	500		
WO (oxygen pressure = 30 kg/cm ²)		220	2650	1250	–	
		230	2200	650		
		240	1600	300		
WO (oxygen pressure = 40 kg/cm ²)		220	2200	800	–	
		230	2100	600		
		240	1500	300		

Table S3 Comparison of kinetic constants for sewage sludge pretreatment by hydrothermal processes

Hydrothermal reaction	Lumped parameter	T (°C)	Rate constant (s ⁻¹)	E _a (kJ/mole)	A (s ⁻¹)	Reference
TH	TOC	140	4*10 ⁻⁵	35.75	1.359	Present study
		160	7*10 ⁻⁵			
		180	1*10 ⁻⁴			
WO (oxygen pressure = 4.2 kg/cm ² , n = 0.5)	TOC	140	4.2*10 ⁻³	72.3	72.35*10 ⁵	
		160	1.17*10 ⁻²			
		180	2.74*10 ⁻²			
WO (oxygen pressure = 8.4 kg/cm ² , n = 1)	TOC	140	4.9*10 ⁻³	77.9	36.76*10 ⁶	
		160	1.51*10 ⁻²			
		180	3.63*10 ⁻²			
WO (oxygen pressure = 10 kg/cm ²)	TOC	200	10 *10 ⁻⁴	51.1	450	Mucha and Zarzycki (2008)
		220	18.1 *10 ⁻⁴			
		240	25.5 *10 ⁻⁴			
WO (oxygen pressure = 61 kg/cm ²)	COD	160	8.56*10 ⁻⁷	53	–	Urrea et al. (2014)
		180	1.35*10 ⁻⁶			
		200	3.29*10 ⁻⁶			
TH	TOC	180	3.52*10 ⁻⁴	27.17	0.3714	Yin et al. (2015)
		220	5.31*10 ⁻⁴			
		260	7.4 *10 ⁻⁴			
		300	1.05*10 ⁻³			

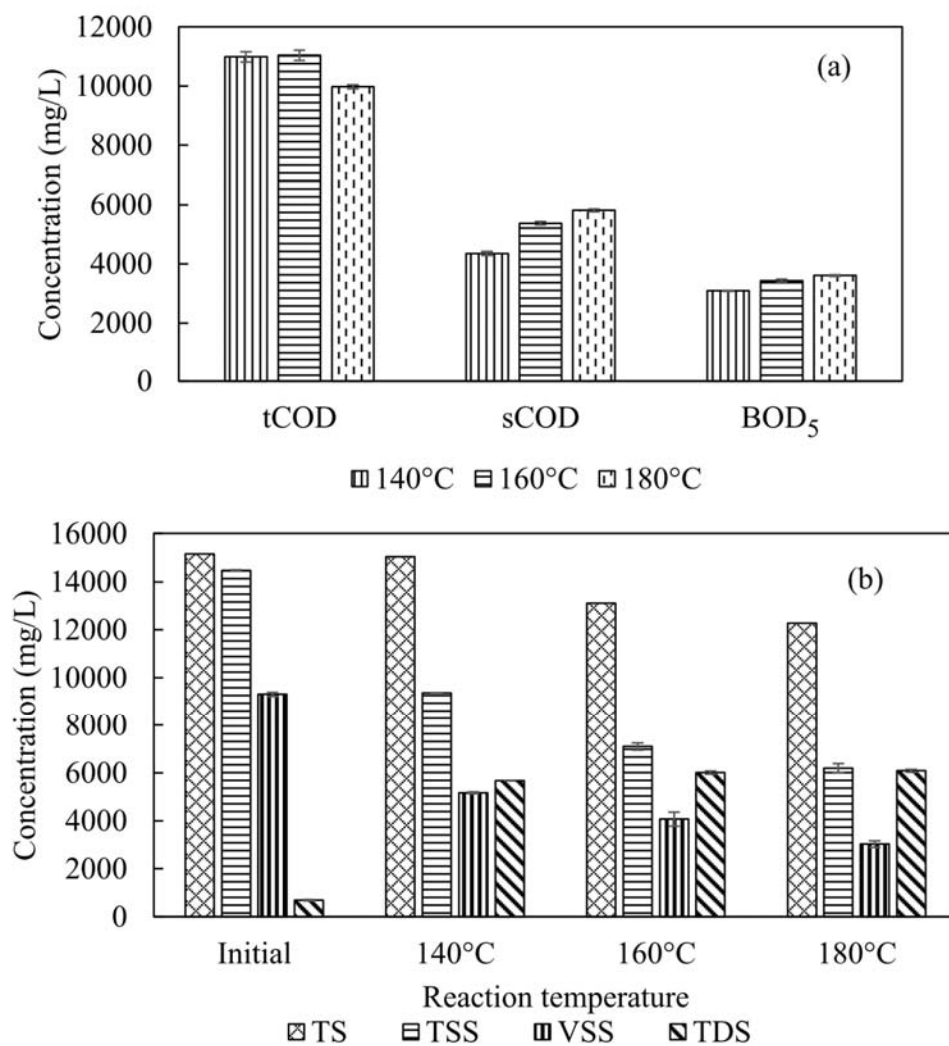


Fig. S1 Effect of temperature on (a) tCOD, sCOD and soluble BOD₅ and (b) solids of sewage sludge after TH treatment

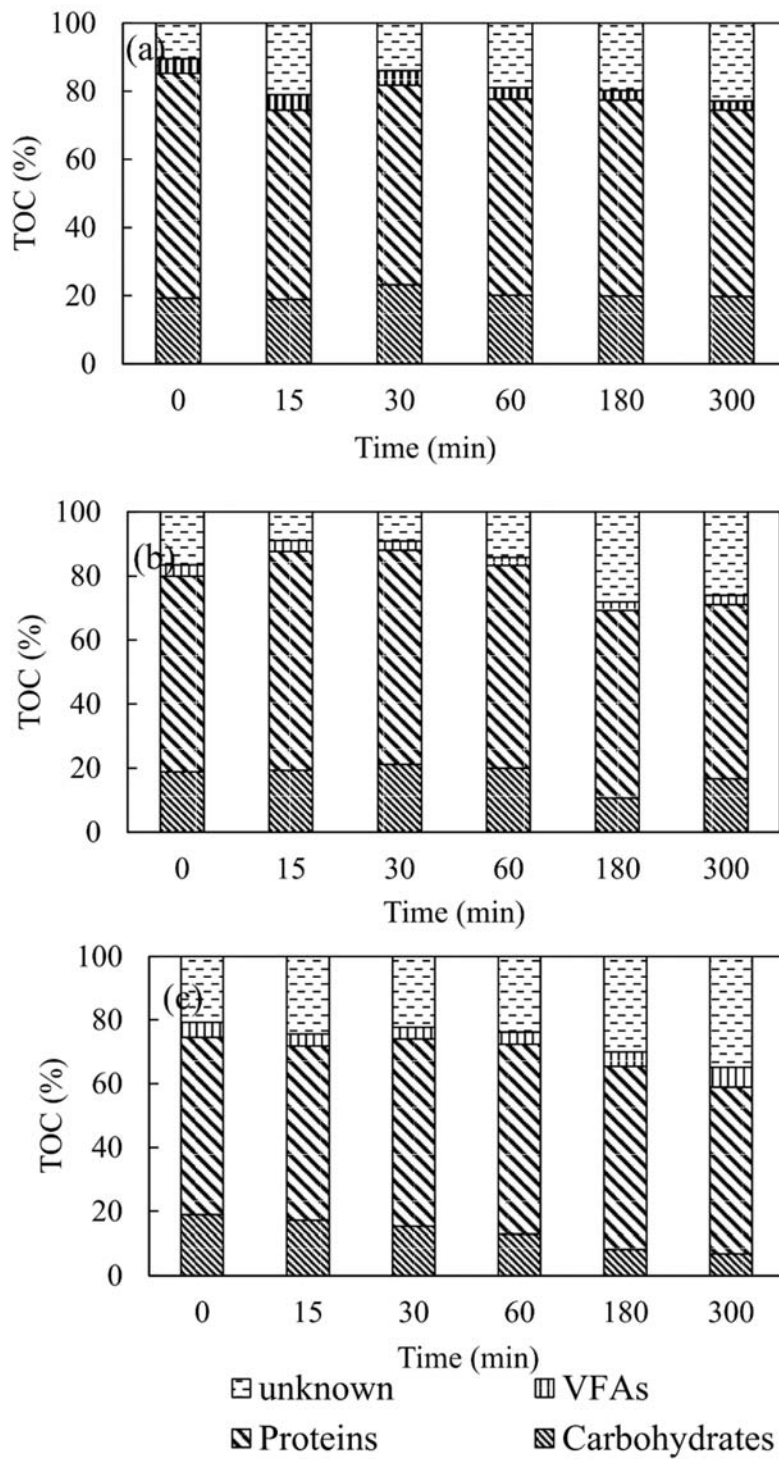


Fig. S2 Major fractions of macromolecules in terms of soluble TOC at different temperatures: (a) 140°C, (b) 160°C and (c) 180°C

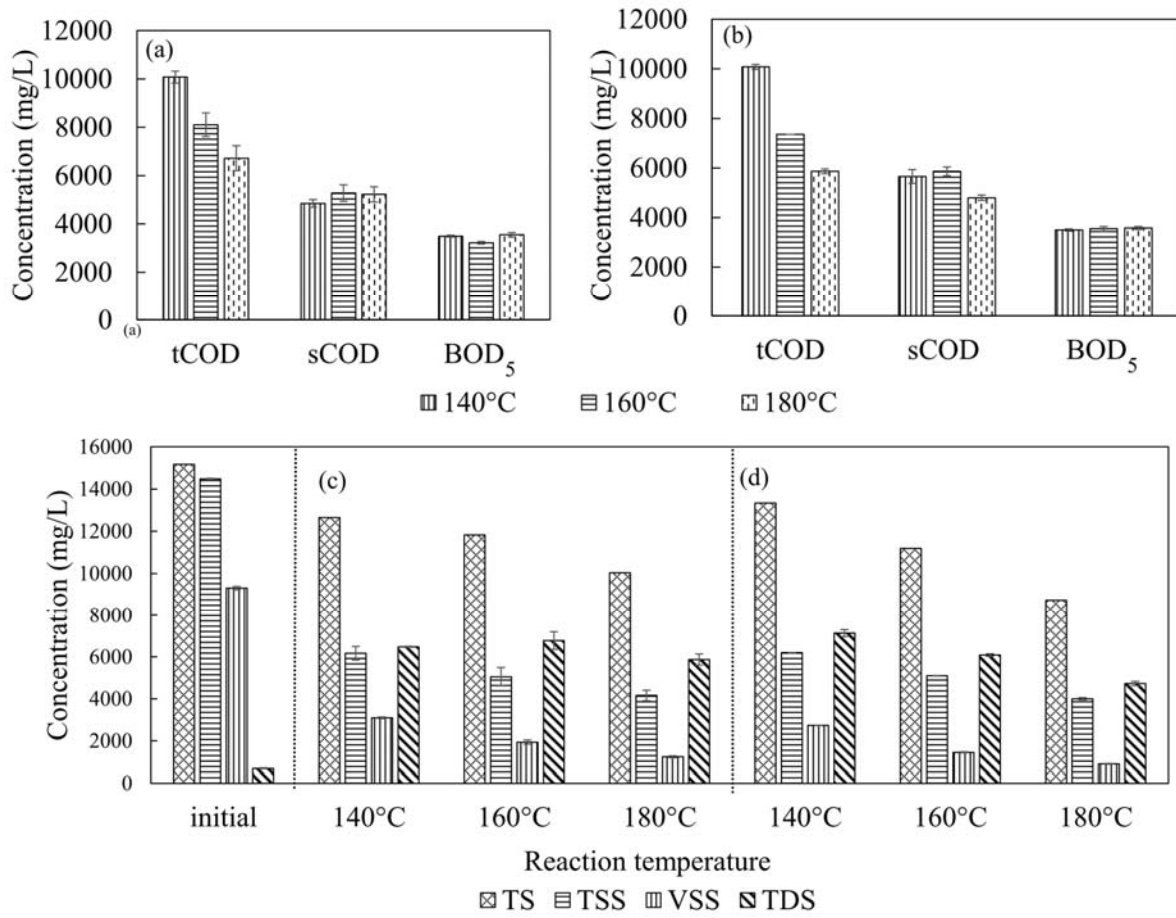


Fig. S3 Change in tCOD, sCOD and BOD₅ different temperatures after WO (a) $n = 0.5$, (b) $n = 1$, (c) solids balance after WO treatment at oxidation coefficient = 0.5 and (d) oxidation coefficient = 1

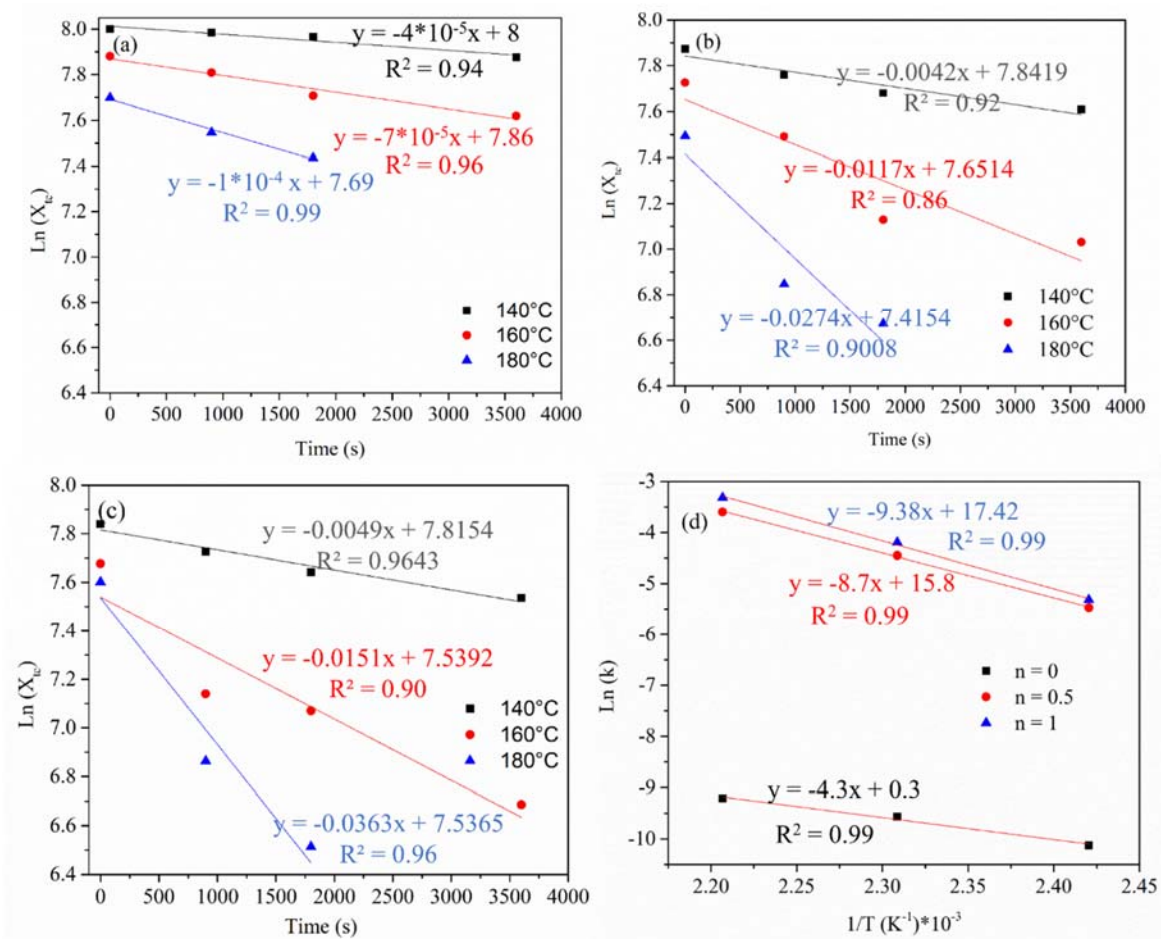


Fig. S4 Prediction of (a) first order rate constant for TH ($n = 0$), (b) first order rate constant for WO ($n = 0.5$), (c) first order rate constant for WO ($n = 1$) and (d) activation energies for TH and WO reactions

References

- Baroutian S, Smit A M, Andrews J, Young B, Gapes D (2015). Hydrothermal degradation of organic matter in municipal sludge using non-catalytic wet oxidation. *Chemical Engineering Journal*, 260: 846–854
- Mucha J, Zarzycki R (2008). Analysis of wet oxidation process after initial thermohydrolysis of excess sewage sludge. *Water Research*, 42(12): 3025–3032
- Urrea J L, Collado S, Laca A, Díaz M (2014). Wet oxidation of activated sludge: Transformations and mechanisms. *Journal of Environmental Management*, 146: 251–259
- Yin F, Chen H, Xu G, Wang G, Xu Y (2015). A detailed kinetic model for the hydrothermal decomposition process of sewage sludge. *Bioresource Technology*, 198: 351–357