Electronic Supplementary Material (ESI) for RSC Advances.

Supporting Information

Adsorption of perrhenate ion by bio-char produced from *Acidosasa edulis* shoot shell in aqueous solution

Hui Hu, Bangqiang Jiang, Jubin Zhang, Xiaohui Chen*

School of Chemical Engineering, Fuzhou University, Fuzhou, 350116, China. E-mail: huhui@fzu.edu.cn.

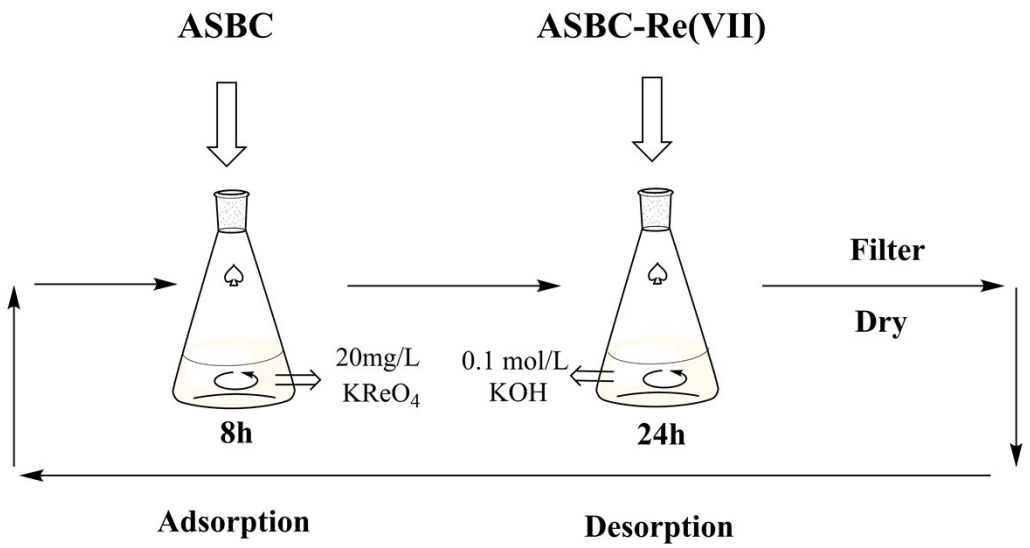

Fig. S1. Experimental setup for the metal adsorption-desorption cycles with ASBC.

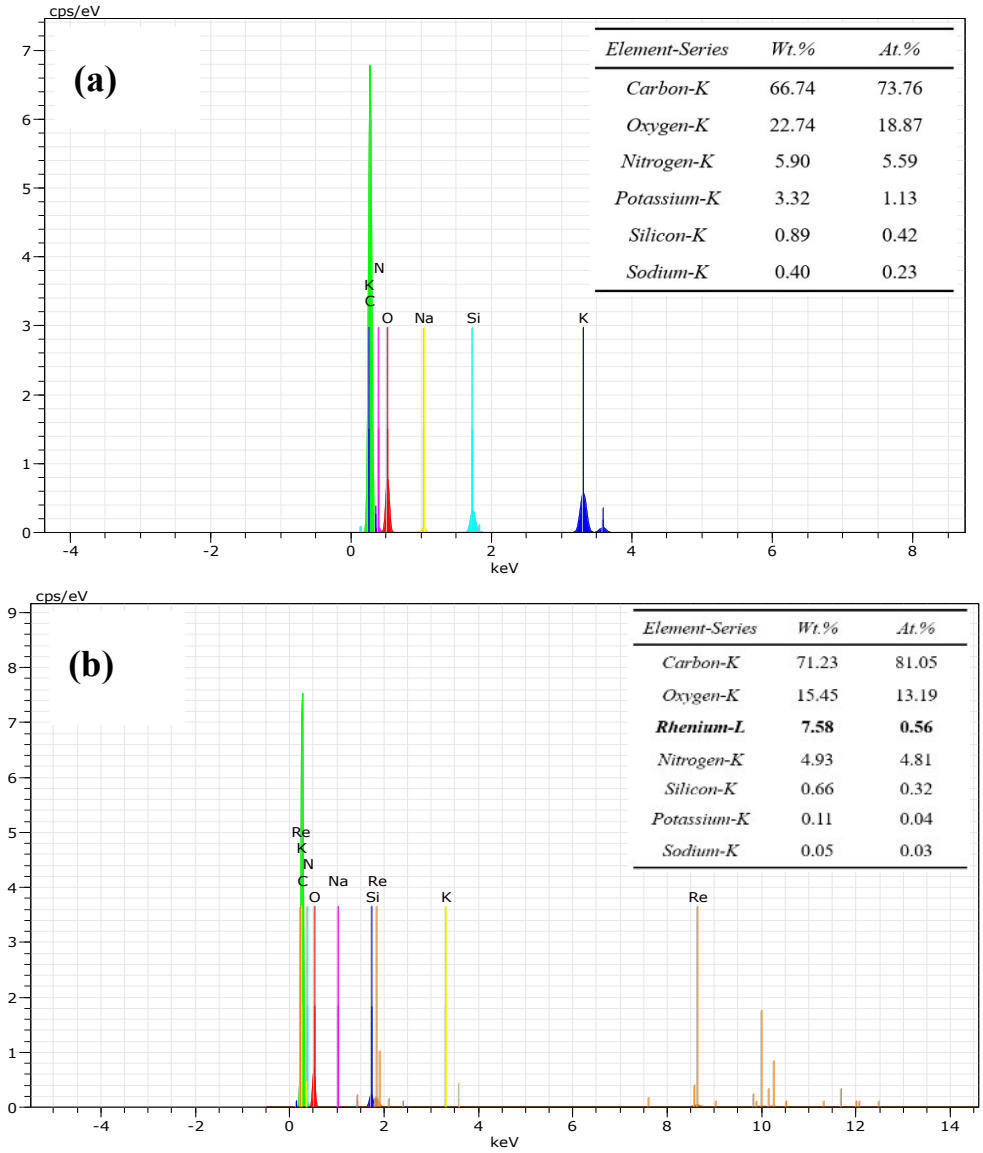

Fig. S2. EDX analysis of ASBC (a) before and (b) after rhenium (VII) adsorption.

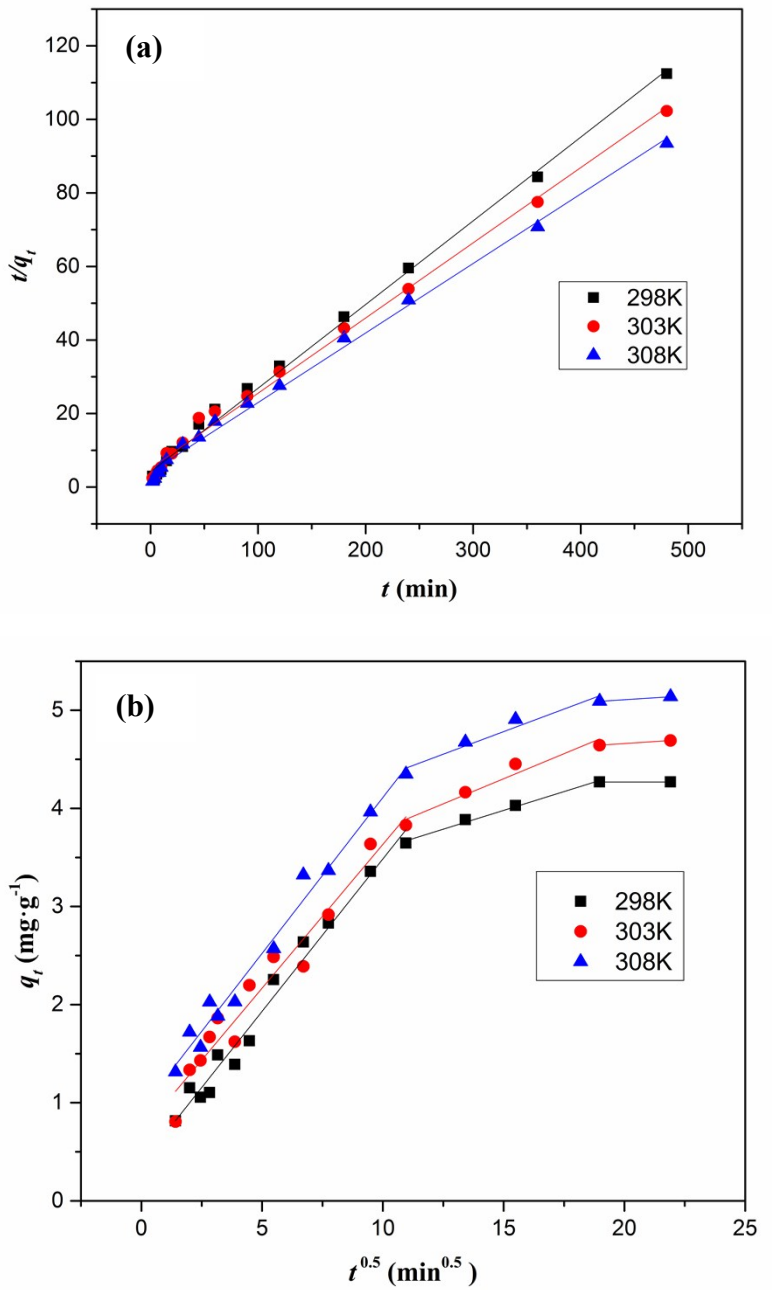

Fig. S3. Plot of the PSO (a) and IPD (b) equation for the adsorption of Re (VII) on the ASBC at different temperature. Conditions: adsorbent dosage, 3 g·L^{-1}; initial Re (VII) concentration, 20 mg·L^{-1}; pH, 1.0; equilibrium time, 8 h.

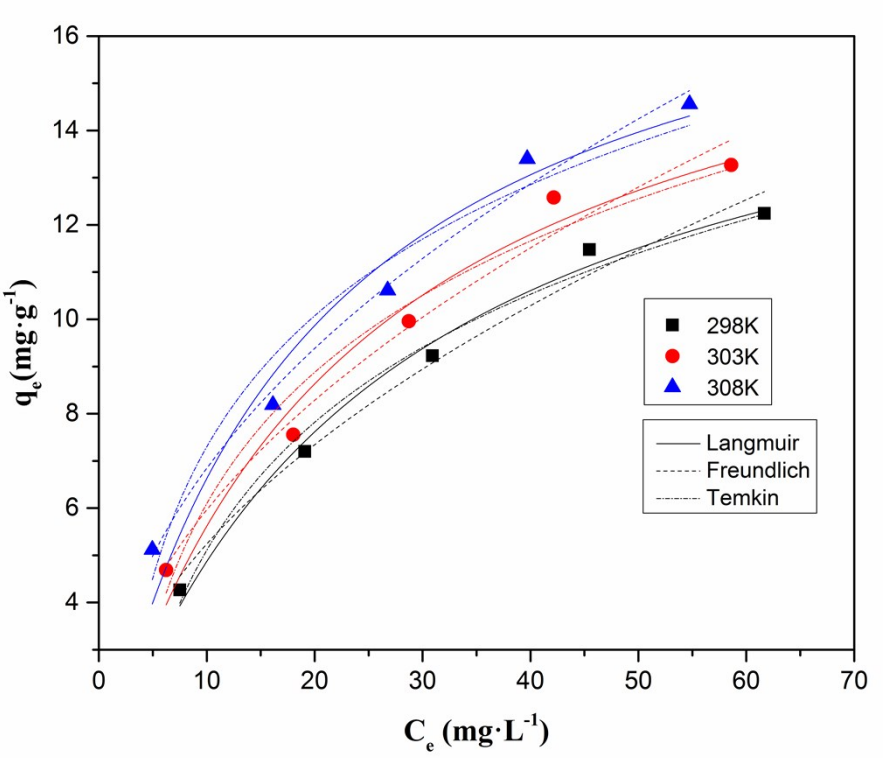

Fig. S4. The adsorption isotherms for the adsorption of Re (VII) on the ASBC at different temperature. Conditions: adsorbent dosage, 3 g·L^{-1}; initial Re (VII) concentration, 20, 40, 60, 80, 100 mg·L^{-1}; pH, 1.0; equilibrium time, 8 h; temp., 298, 303,308 K.

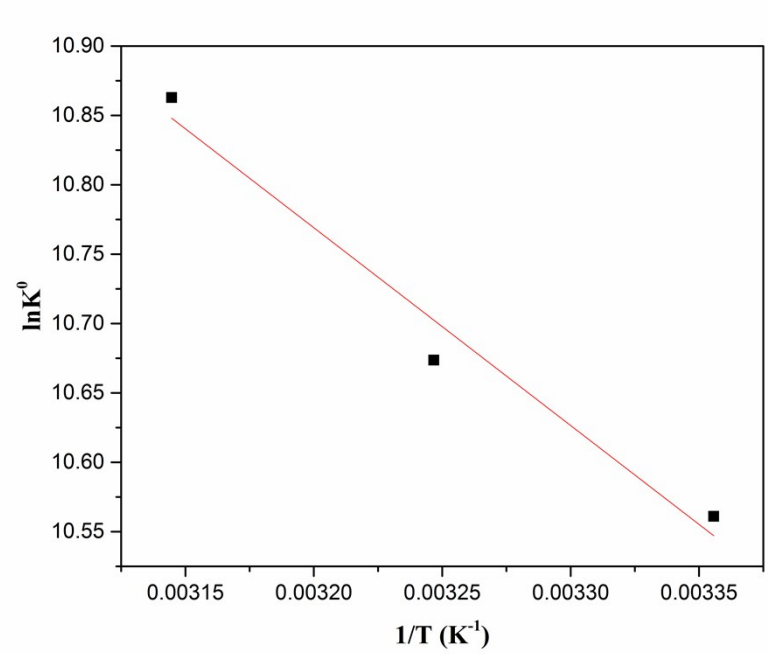

Fig. S5. The Plot of $\ln K^0$ vs 1/T for the estimation of thermodynamic parameters.

Table S1 Physico-chemical characteristics of ASBC.

Properties of ASBC	Value
pH	9.41
pH_{PZC}	7.74
S_{BET} (m^2/g)	6.3680
V_t (m^3/g)	0.008516
D (nm)	5.34896

S_{BET}: BET-N_2 specific surface area. V_t: Total pore volume. D: Average pore size.

Table S2 Surface acidic functional groups of ASBC.

Sample	Acidic functional groups' content (mmol·g^{-1})			
	Carboxylic	Lactonic	Phenolic	Total
ASBC	0.0381	0.0193	0.3941	0.4515

Table S3 Functional groups of ASBC and ASBC-Re and the corresponding infrared absorption frequencies.

Wavenumber (cm^{-1})		Functional groups
ASBC	ASBC-Re	
3340	3349	O-H stretching vibration
-	1700	C=O stretching vibration
1571	1577	C=C asymmetric stretching vibration
1359	-	the bending vibration of O-H and C-O stretching vibration
1061	1074	
881	894	C-H stretching vibration
749	752	

Table S4 Kinetic parameters of Re (*VII*) adsorption onto the ASBC.

Temp.	**Pseudo-first-order** q_e (mg·g^{-1}) k_1 (min^{-1})	**Pseudo-second-order** q_e (mg·g^{-1}) k_2 (g·mg^{-1}·min^{-1}) h (mg·g^{-1}·min^{-1})	**Elovich** α (mg·g^{-1}·min^{-1}) β (g·mg^{-1})	**Intra-particle** k_p (mg·g^{-1}·min$^{1/2}$)	
298K	$q_{e,cal}$ = 3.14	$q_{e,cal}$ = 4.51	α = 0.585	k_{p1} =0.31	k_{p2} =0.08
	k_1 = 0.0117	k_2 = 0.0083 h = 0.24	β = 1.341	C_1=0.38	C_2=2.83
	R^2 = 0.9766	R^2 = 0.9978	R^2 =0.9574	R^2 =0.9778	R^2 =0.9877
303K	$q_{e,cal}$= 3.47	$q_{e,cal}$ = 4.89	α = 0.790	k_{p1} =0.29	k_{p2} =0.10
	k_1 = 0.0116	k_2 = 0.0084 h = 0.20	β = 1.311	C_1=0.70	C_2=2.77
	R^2 = 0.9922	R^2 = 0.9964	R^2 =0.9622	R^2 =0.9535	R^2 =0.9277
308K	$q_{e,cal}$= 3.61	$q_{e,cal}$ = 5.29	α = 1.171	k_{p1} =0.32	k_{p2} =0.09
	k_1 = 0.0119	k_2 = 0.0088 h = 0.25	β = 1.253	C_1=0.93	C_2=3.40
	R^2 = 0.9963	R^2 = 0.9961	R^2 =0.9605	R^2 =0.9803	R^2 =0.9288

Table S5 Langmuir, Freundlich and Temkin isotherms parameters for Re (*VII*) adsorption on ASBC.

	Langmuir q_{max} (mg·g^{-1}) K_L (mg·L^{-1})	**Freundlich** K_f (L·mg^{-1}) n	**Temkin** A (L·mg^{-1}) b	**K_d**
298K	q_{max} = 17.47	n = 2.05	A = 0.37	0.57
	K_L = 0.0386	K_f = 1.709	b = 633.09	0.30
	R^2 = 0.9886	R^2 = 0.9812	R^2 =0.9825	0.20
303K	q_{max}= 18.63	n = 2.11	A = 0.46	0.75
	K_L = 0.0432	K_f = 1.997	b = 617.26	0.35
	R^2 = 0.9648	R^2 = 0.9734	R^2 =0.9553	0.23
308K	q_{max}= 19.31	n = 2.19	A = 0.62	1.03
	K_L = 0.0522	K_f = 2.397	b = 618.32	0.40
	R^2 = 0.9472	R^2 = 0.9877	R^2 =0.9463	0.27

K_d values were calculated at different equilibrium concentrations of rhenium (20, 60 and 100 mg·L^{-1}), L·g^{-1}. $K_d = Q_e/C_e$.