Supporting Information

Performance and mechanism of a bioelectrochemical system for the reduction in heavy metal cadmium ions

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TEXT (1)

FIGURES (8)

TABLE (3)

PAGES (7)

S1. Materials and methods

1. Current density (A/cm^2):

$$I_D = I/S \quad (1)$$

2. Total coulombs transferred (CT):

$$Q = \int_0^t Idt \quad (2)$$

3. Cathodic coulomb efficiency（CEca）：

$$CE_{ca}cd = \frac{a \times V_{ca} \times \Delta C_{cd} \times F}{M_{cd} \times \int_0^t Idt} \times 100\% \quad (3)$$

4. Cathode energy efficiency：

$$\eta_{E_{cd}} = \frac{a \times n_{cd} \times E_{cd} \times F}{\int_0^t Idt \times E_{ps}} \times 100\% \quad (4)$$

5. The unit energy consumption of the cathode (kwh/kg)：

$$energy\ consumption = \frac{1000 \times E_{ps} \times \int_0^t Idt}{n_{cd} \times M_{cd} \times 3600 \times 1000} \quad (5)$$

In the above formula：

a—number of electrons consumed to reduce a unit amount of Cd;

F—Faraday's constant（$9.64853 \times 10^4 C \cdot mol^{-1}$）;

I—current (A);

S—Cathode electrode area（cm^2）;

Δt—running time per cycle (s);

V_{ca}—an effective volume of the cathode chamber of the MECs(V);

ΔCd—the difference in Cd(II) concentration between the inlet and outlet water of the

MECs cathode ($mg\cdot L^{-1}$);

M_{Cd}—relative atomic weight of cadmium ($g\cdot mol^{-1}$);

n_{cd}—amount of Cd(II) removed by MECs per cycle (mol);

E_{cd}—the standard electrode potential of Cd(II) (V);

E_{ps}—applied voltage (V);

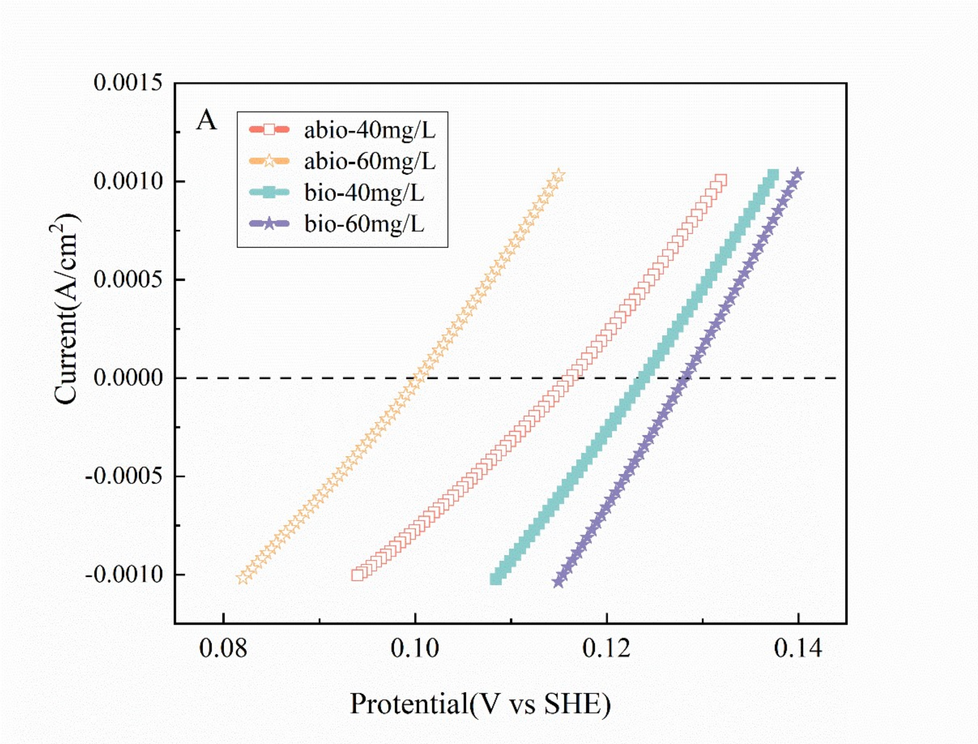
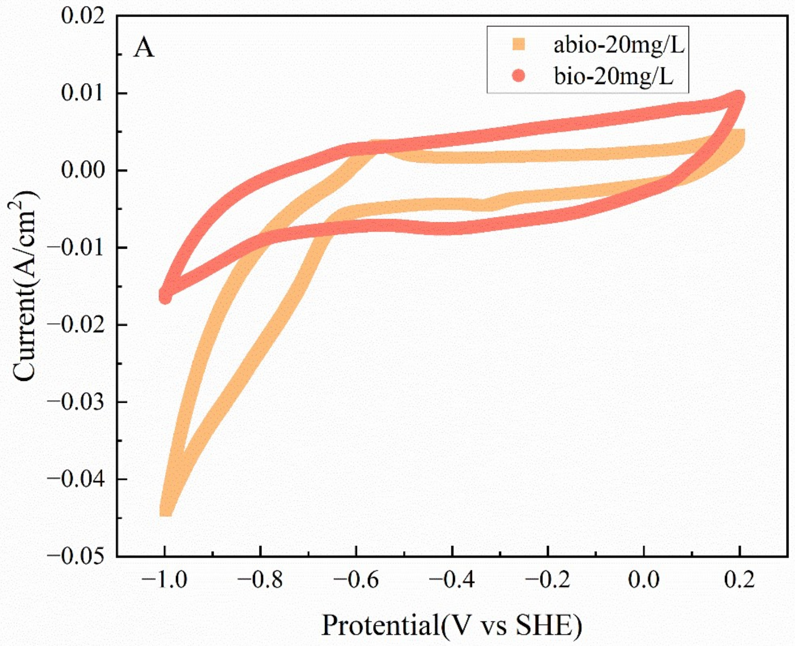
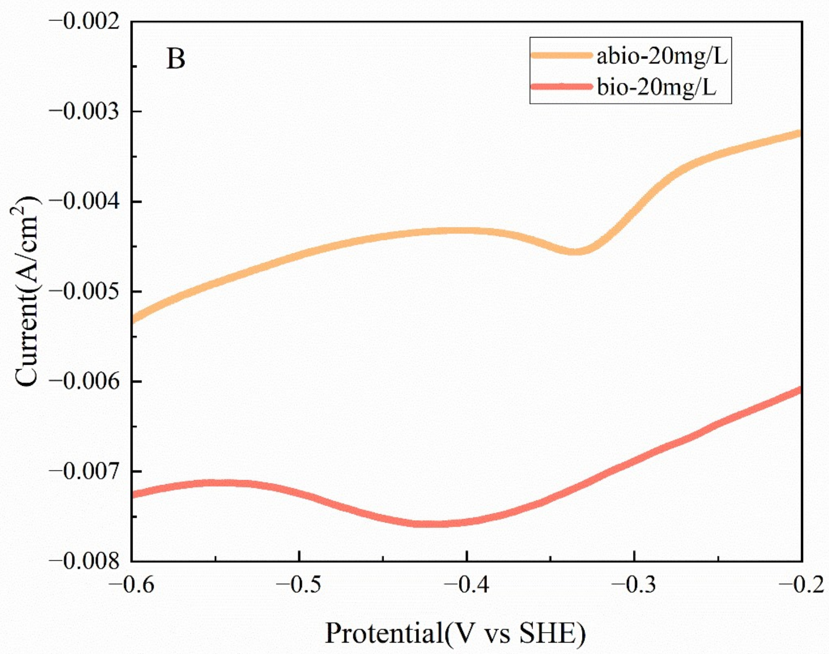


Fig.S 1 Part of Cyclic voltammograms (A) for biocathodes and non-biocathodes (initial Cd(II): 40 mg·L-1, 60 mg·L-1; applied voltage: 0.5 V).


A
abio-20mg/L
bio-20mg/L
0.02
0.01
0.00
−0.01
−0.02
−0.03
−0.04
−0.05
Current(A/cm2)
−1.0
−0.8
−0.6
−0.4
−0.2
0.0
0.2
Protential(V vs SHE)


B
abio-20mg/L
bio-20mg/L
−0.002
−0.003
−0.004
−0.005
−0.006
−0.007
−0.008
Current(A/cm2)
−0.6
−0.5
−0.4
−0.3
−0.2
Protential(V vs SHE)

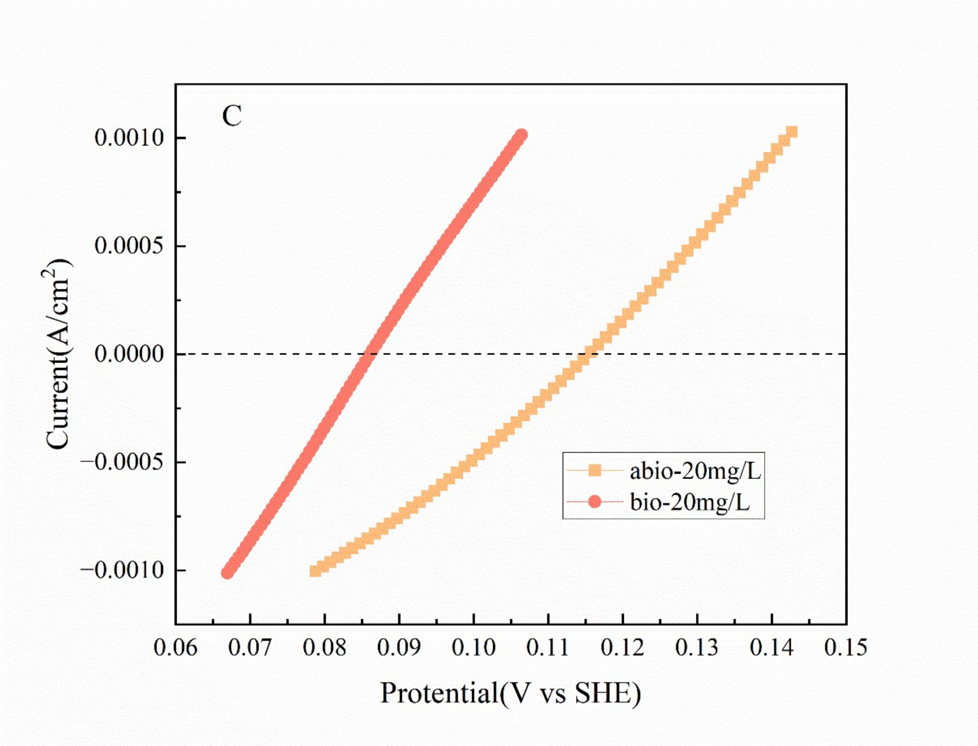
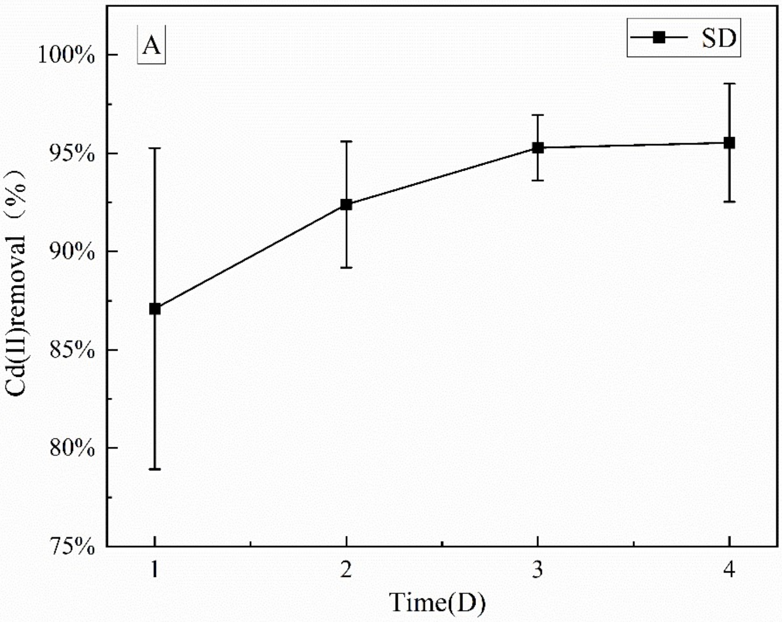


Fig.S 2 Cyclic voltammograms with biocathodes and abiotic cathodes (A、B、C)(initial acetate: 1.0 g·L^{-1}; initial Cd(II): 20 mg·L^{-1}; applied voltage:0.5V).



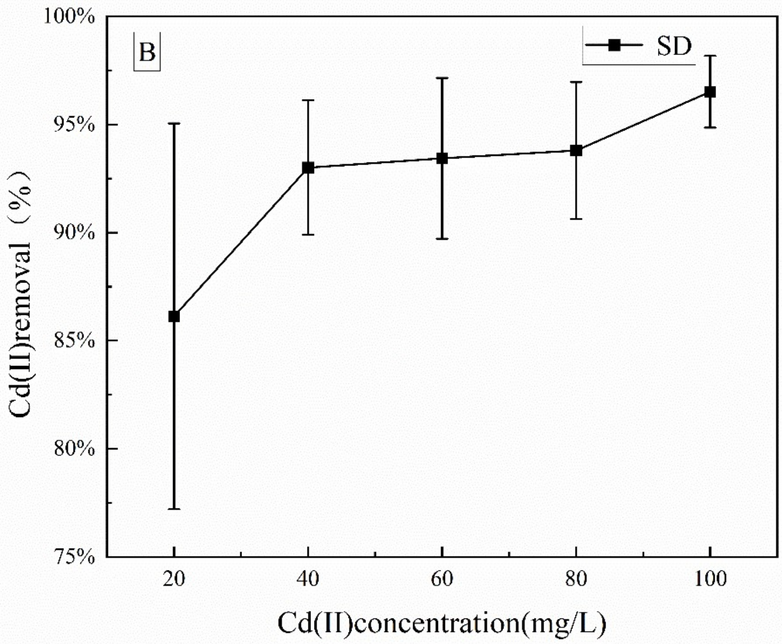
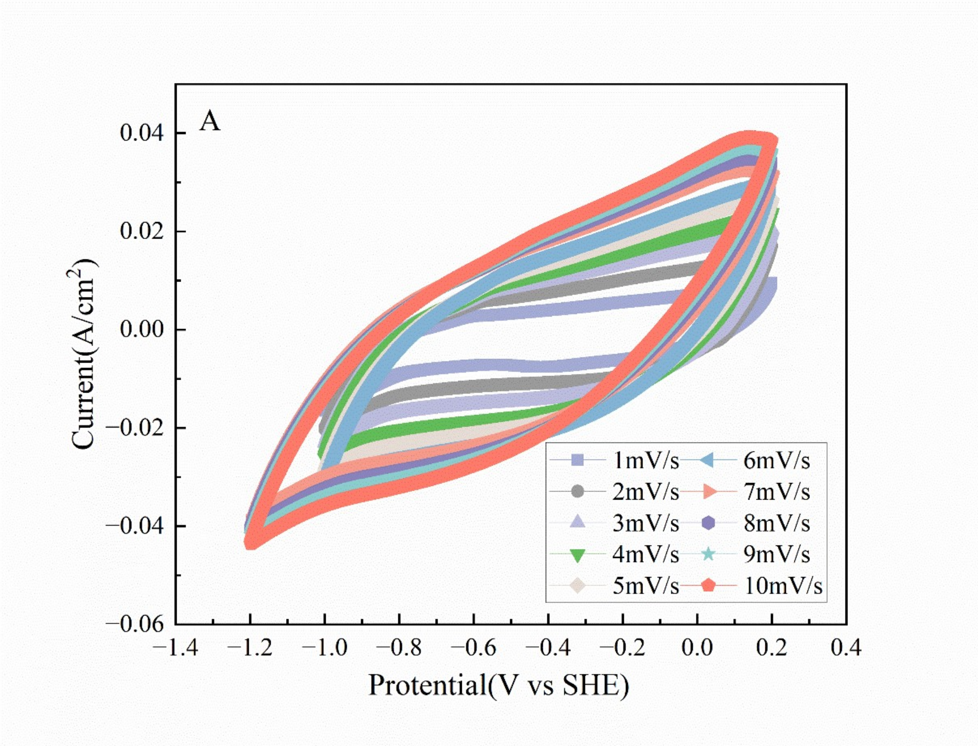


Fig.S 3 Standard deviations are plotted for different times(A)as well as for different concentrations (B).



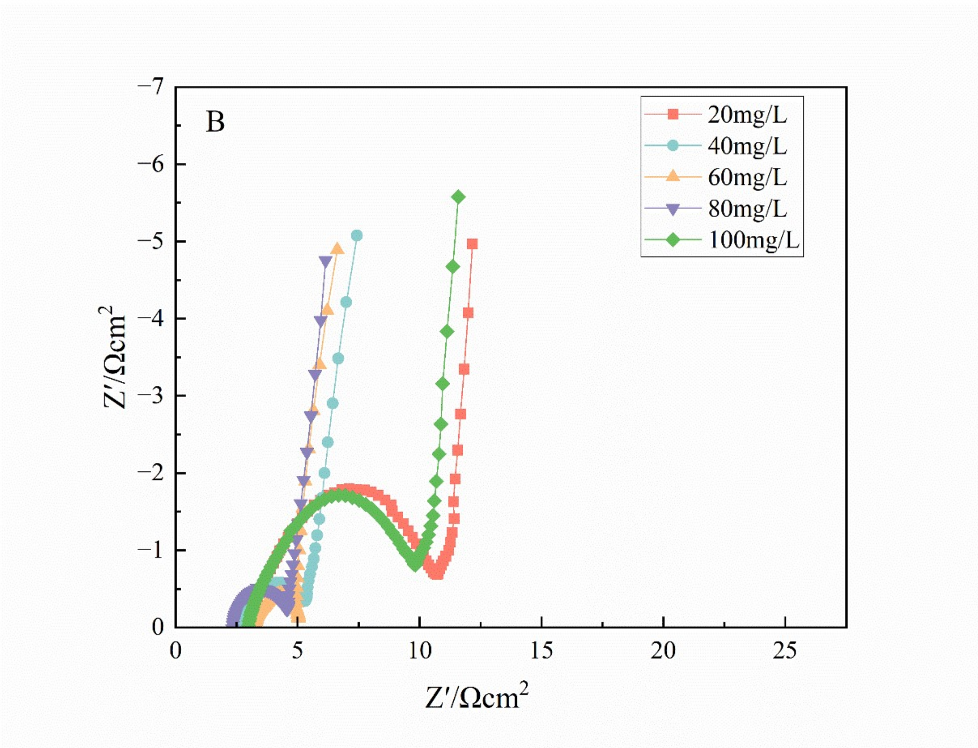


Fig.S 4 Cyclic voltammograms for different scan rates (A)（initial acetate: 1.0 g·L^{-1}; initial Cd(II): 20 mg·L^{-1}; scan rate：1-10mV·s^{-1};）and electrochemical impedance diagram for different concentrations of Cd(II) solutions (B)(initial Cd(II):20-100mg·L^{-1}).

Table.S 1 Equivalent circuit data analysis table for electrochemical impedance spectra of different concentrations of Cd (II) solutions (initial acetate: 1.0 g·L^{-1}; applied voltage: 0.5 V).

	Cd(II)mg/L	Rs/Ω	Rct/Ω	W/Ω
biotic	20	3.0126	7.7990	28.618
	40	2.7346	2.6872	26.255
	60	3.3384	1.7643	20.544
	80	2.3696	2.0566	11.539
	100	2.9131	7.5825	37.940

Table.S 2 Comparison of cathodic electrons for cathodic Cd(II) reduction (CEca, Cd) at different initial Cd(II) concentrations, and energy efficiency of energy consumed for Cd(II) reduction (ηE, Cd), cathodic unit energy consumption (kwh·kg^{-1}).initial acetate concentration: 1.0 g·L^{-1})

Cd(II)(mg·L^{-1})	d	Q(C)	Δcd(mg·L^{-1})	CEca, Cd	η_E, Cd	Kwh·kg^{-1}
20	1	125425.8	14.606	1.60%	1.29%	14.91
	2	224866.8	17.624	1.08%	0.87%	22.15
	3	277160.4	18.514	0.92%	0.74%	25.99
	4	317682	18.159	0.79%	0.63%	30.37
40	1	123832	35.374	3.92%	3.16%	6.08
	2	184182.66	37.528	2.80%	2.26%	8.52
	3	253914.48	38.154	2.06%	1.66%	11.55
	4	297979.56	37.751	1.74%	1.40%	13.70
60	1	162016.5	53.513	4.54%	3.66%	5.26
	2	248972.7	54.88	3.03%	2.44%	7.88
	3	292424.7	57.691	2.71%	2.18%	8.80
	4	315608.7	58.156	2.53%	2.04%	9.42
80	1	79038	72.52	15.75%	12.70%	1.51
	2	215982	73.39	5.83%	4.70%	4.09
	3	264925.8	76.23	4.94%	3.98%	4.83
	4	283933.8	78	4.72%	3.80%	5.06
100	1	75639.42	94.17	17.10%	13.78%	1.39
	2	164903.94	96.81	8.06%	6.50%	2.96
	3	225868.86	97	5.90%	4.75%	4.04
	4	278735.94	98.08	4.83%	3.89%	4.93

Table.S 3 Similarity-based OTUs and species richness and diversity estimates

	OTUs	Shannon	Simpson	ACE	Chaol	Coverage/%
CA_1_Cd	1923	7.59	0.96	1978.27	1956.40	99.78%
OR_1	1658	5.75	0.83	1748.33	1716.26	99.70%

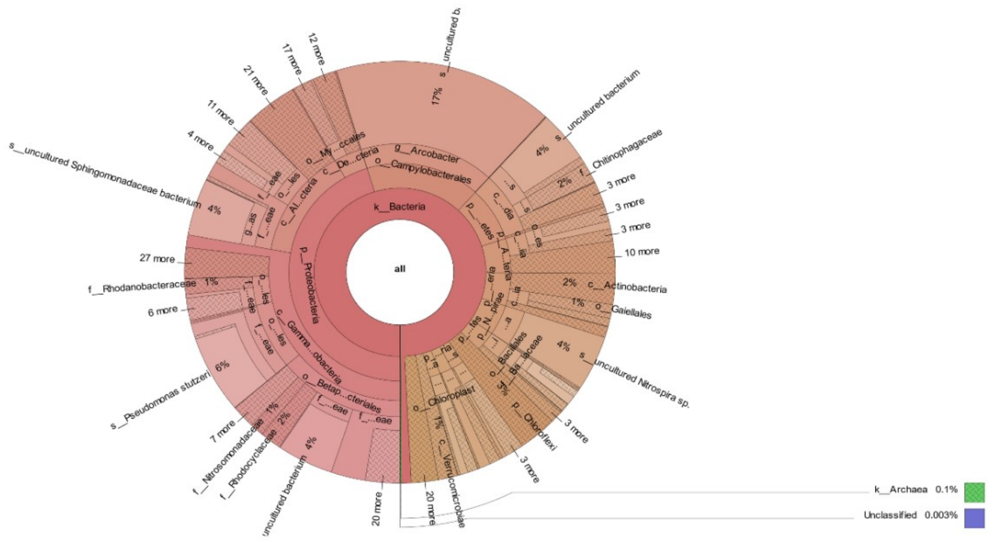


Fig.S 5Krona graph for the order classification of cadmium-containing sludge.

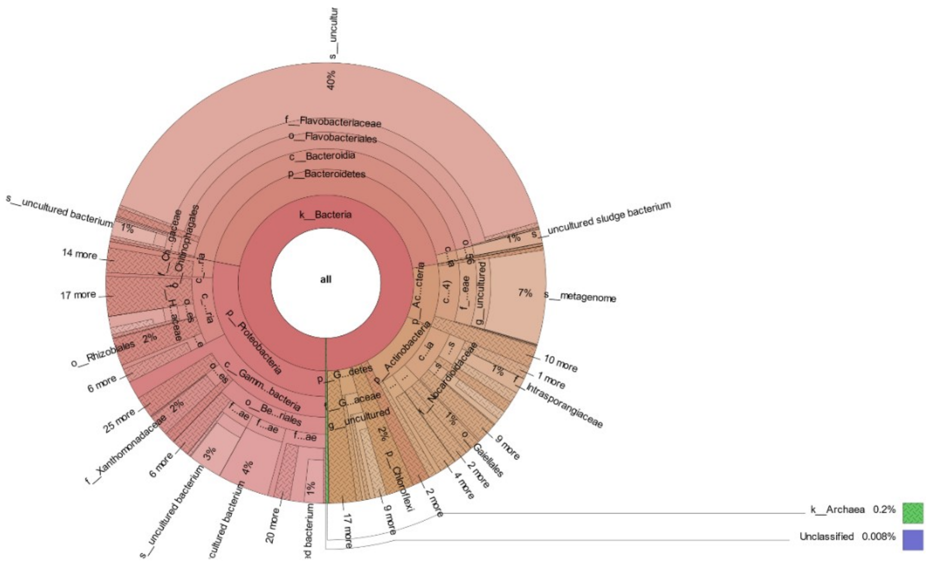


Fig.S 6 Krona graph for the order classification of raw sludge.