

Supplementary materials

S1 TN and TP removal of the ABR during the operation period

Fig. S1 showed TN and TP in the influent and effluent during the ABR operation. In this work, the TN and TP in the influent were fairly high, both of them ranged from 100 to 150 $\text{mg}\cdot\text{L}^{-1}$, from 4.02 to 19.07 $\text{mg}\cdot\text{L}^{-1}$, respectively. During ABR operation period, their removal efficiencies fluctuated and the average values were 10.28% and 12.49%, respectively.

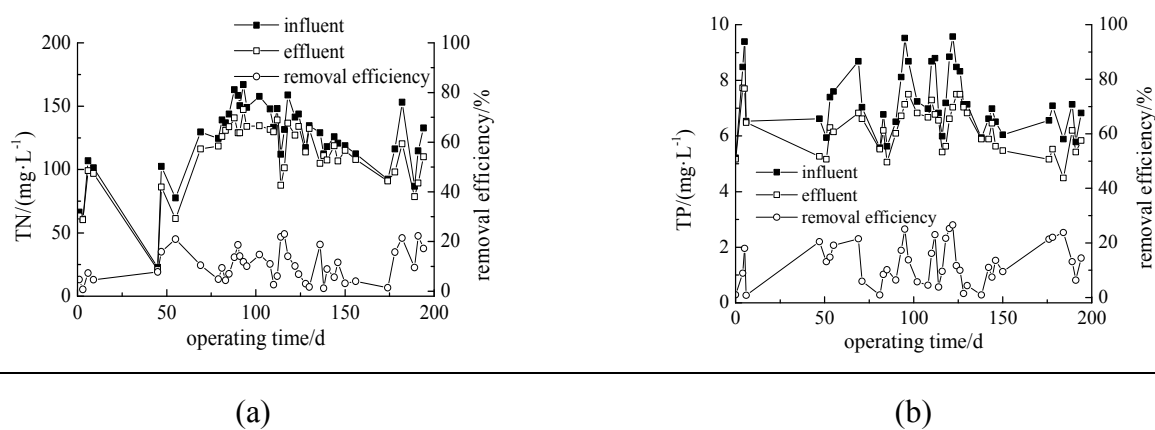
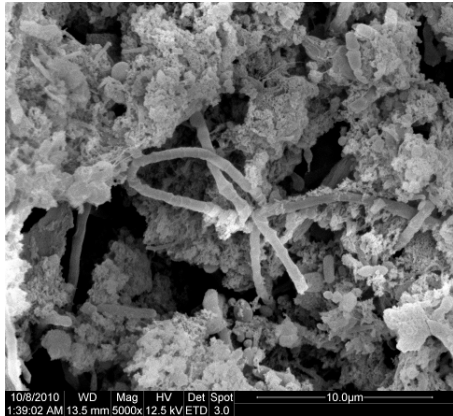
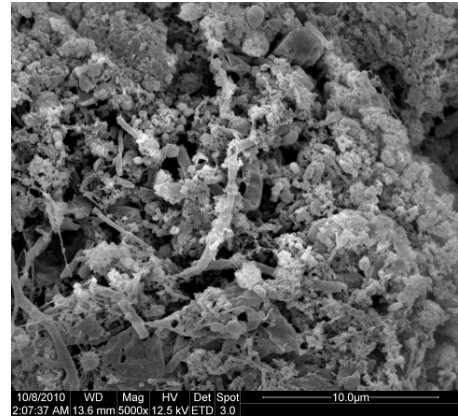


Fig. S1 Evolution of TN (a) and TP (b) with operation time

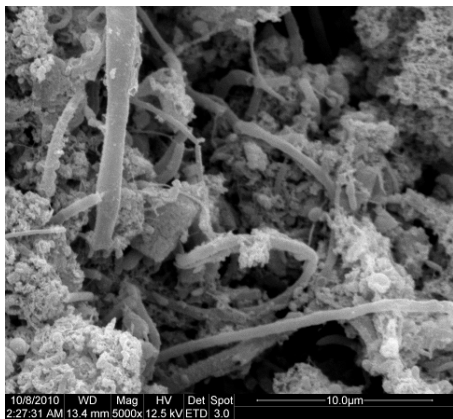
S2 SEM images of the microorganisms in the ABR after 231 days of operation



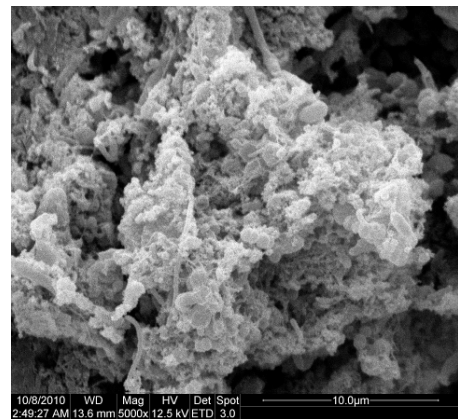
(a)



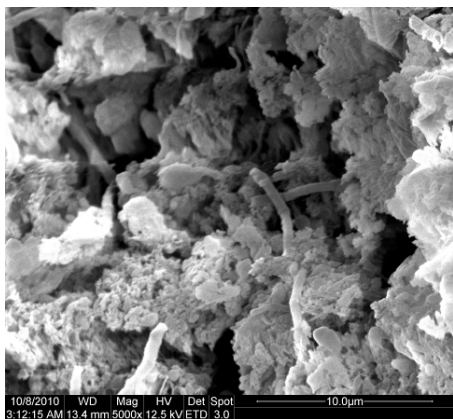
(b)



(c)



(d)



(e)

Fig. S2 SEM micrographs of the seed sludge and the anaerobic sludge withdrawn from the ABR on the 231st day. (a) to (e) sludge in compartments I to V on the 231st day. The scale bar represents 10 µm

S3 Tentative identification and location of the microorganisms observed in the ABR

Table S1 Tentative identification and location of the microorganisms observed in the ABR

shape	size/ μm	possible species	possible primary substrates [25]	location in ABR
filamentous	0.5 to 1.0 in diameter	not clear	not clear	compartments I to V
rod shaped	2.0 to 3.0 in length	<i>Syntrophomonas</i>	butyrate	compartment I
small cocci	0.5 to 1.0 in diameter	<i>Methanococcus</i>	acetate, formate, H_2	compartments I to V
large cocci	1.0 to 2.0 in diameter	<i>Methanococcus</i>	acetate, formate, H_2	compartments II and V
bamboo shaped	2.0 to 4.0 in diameter	<i>Methanosaeta</i>	acetate	compartment III

S4 Regression and ANOVA results of Figs. 4 (A–E)

Table S2 Regression and ANOVA results with model of $d_{\text{GM}} = 0.05 + \exp(-k \times (t_{\text{lag}} - t))$

compartment	reduced	adjusted	fitting parameters		F value	P value
	Chi-square	R -square	t_{lag}	k		
I	0.00123	0.85026	215.17	0.033	98.13703	9.11E-06
II	2.84E-04	0.92734	240.78	0.026	273.8506	1.80E-07
III	2.21E-04	0.93922	244.05	0.025	384.7633	4.75E-08
IV	4.95E-04	0.89606	246.38	0.023	199.9954	6.08E-07
V	7.15E-04	0.82331	246.15	0.024	127.7755	3.38E-06

S5 Aspect ratios of the bioparticles during growth in the ABR operation

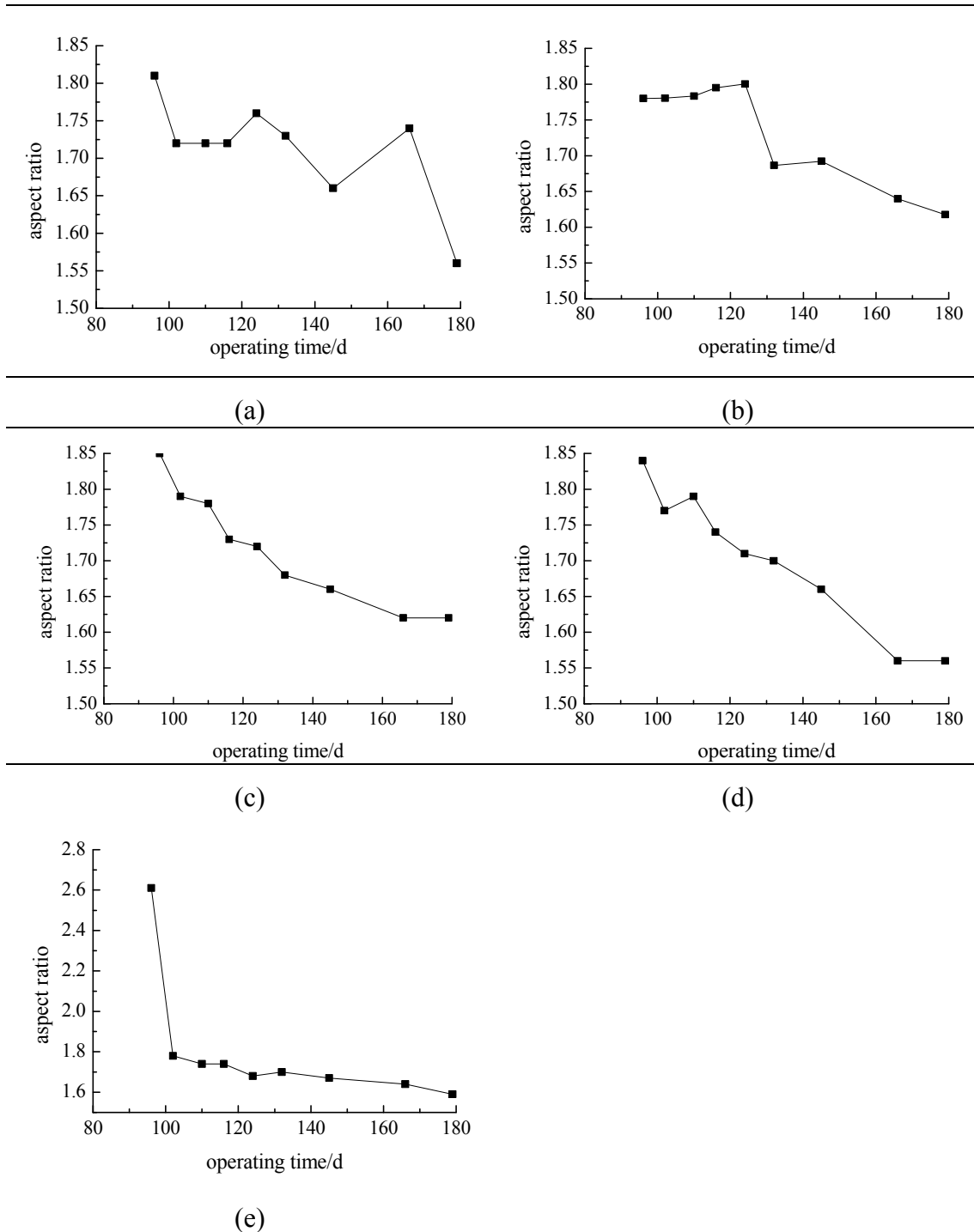


Fig. S3 Plot showing the variations in the aspect ratio of the bioparticles as a function of ABR operation time. (a)–(e) represent compartments I to V, respectively

S6 Porosity of the bioparticle sections

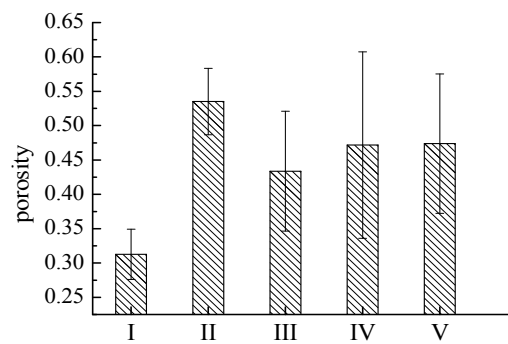


Fig. S4 Porosity of the bioparticle sections in the different ABR compartments on the 179th day

S7 D_{BC} of the bioparticle sections

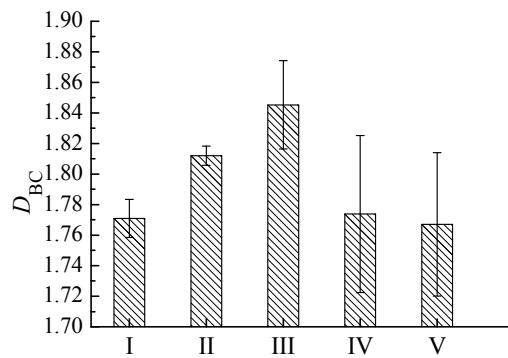


Fig. S5 D_{BC} of the bioparticle sections in the different ABR compartments on the 179th day