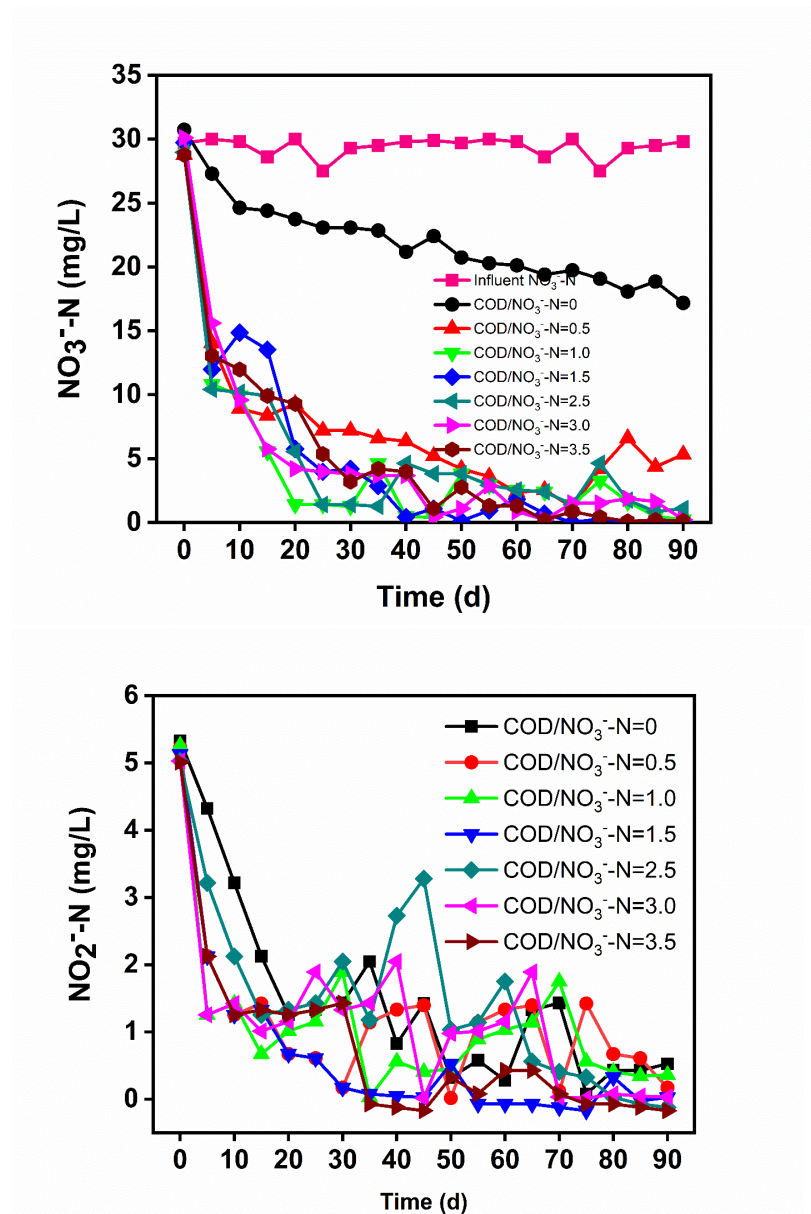
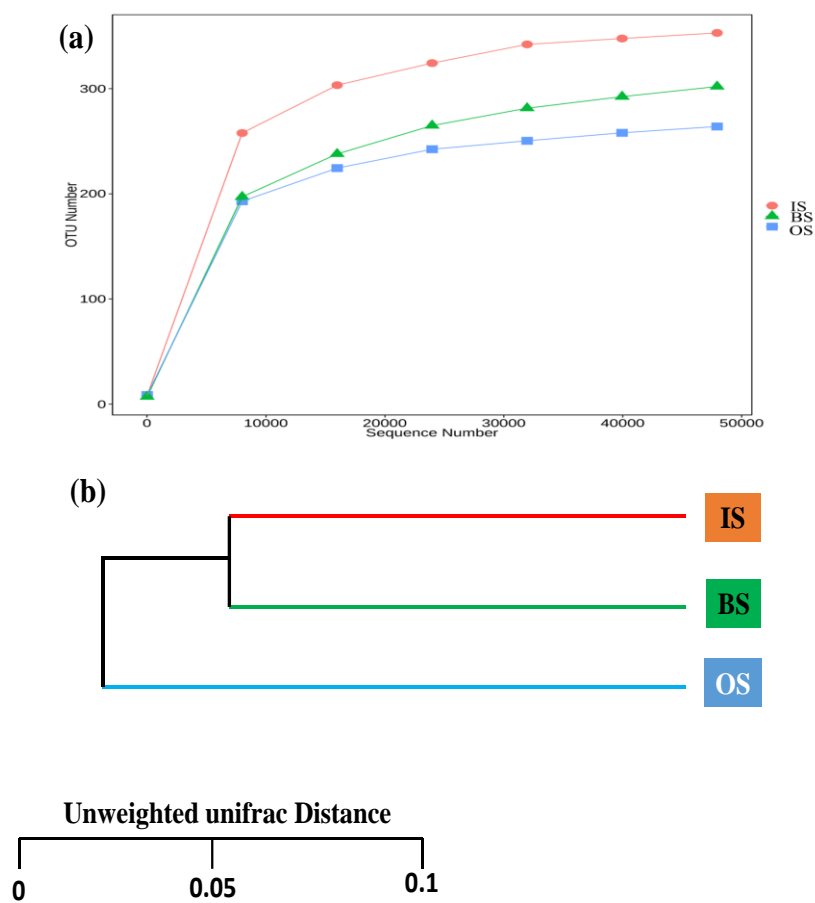


## Supplementary Materials



**Fig. S1.** The changes of nitrate and nitrite concentration during acclimated phase at variation of carbon to nitrogen ratio during heterotrophic denitrification process, under the experimental condition: i.e.,  $\text{pH} = 7.5 \pm 0.4$ , initial concentration of  $\text{NO}_3^- \text{-N} = 30 \pm 0.2 \text{ mgL}^{-1}$ , and the ratio of  $\text{COD}/\text{NO}_3^- \text{-N}$  was 0-3.5, respectively.



**Fig. S2.** Microbial community at rarefaction curves (a) and hierarchical clustering analysis (b) based on Unweighted Unifrac distance of bacterial OTUs.

**Table S1.** The Initial Concentration at Different COD/NO<sub>3</sub><sup>-</sup>-N Ratio in the 3D-BERs with Immobilized GAC Carriers

| Parameters (mgL <sup>-1</sup> )     | Test1 | Test 2 | Test 3 | Test 4 | Test 5 | Test 6 | Test 7 |
|-------------------------------------|-------|--------|--------|--------|--------|--------|--------|
| COD                                 | 0     | 15     | 30     | 45     | 75     | 90     | 105    |
| NO <sub>3</sub> <sup>-</sup> -N     | 30    | 30     | 30     | 30     | 30     | 30     | 30     |
| COD/NO <sub>3</sub> <sup>-</sup> -N | 0     | 0.5    | 1.0    | 1.5    | 2.5    | 3.0    | 3.5    |

**Table S2.** Diversity and Richness Indices of the Microbial Community Structure on the Original Sludge (OS), Inner Surface (IS), and Bottom Surface (BS) of Immobilized GAC Biofilm Carriers in the 3D-BER System

| Sample Name     | Effective sequence number | OTUs number | Ace1 <sup>a</sup> | Chao1 <sup>b</sup> | Simpson <sup>c</sup> | Shannon <sup>d</sup> | Good's Coverage |
|-----------------|---------------------------|-------------|-------------------|--------------------|----------------------|----------------------|-----------------|
| Original Sludge | 68,614                    | 891         | 1,004.18          | 985.92             | 0.949                | 6.339                | 0.997           |
| Inner Surface   | 82,006                    | 1085        | 1,229.86          | 1,182.53           | 0.986                | 7.472                | 0.998           |
| Bottom Surface  | 73,025                    | 954         | 1,053.99          | 1,047.44           | 0.948                | 7.252                | 0.997           |

a, b,d. Community richness. A higher number represented more richness.

c. Community richness. A higher number represented less richness.

e. Sampling depth