

**Differences in microbial diversity, composition and function during
V(V) release and reduction in nitrate-V(V) co-contaminated water by
under liquid carbon sources**

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The following equations are used for the first-level dynamics calculation and the zero-level dynamics calculation¹.

Zero-order kinetic module:

$$C_t = C_0 - kt$$

First-order kinetic module:

$$C_t = C_0 e^{-kt}$$

where C_t and C_0 indicate the pollutants concentrations ($\text{mg N}\cdot\text{L}^{-1}$) in the t , and k is the kinetic constant.

References:

- 1 S. Sun, Y.-N. Hou, C. Huang, H. M. A. Sharif, J. Guo, N. Ren and A.-J. Wang, Acute responses of bio-denitrification to short-term clopyralid exposure: Kinetic analysis and biological mechanisms, *Chemical Engineering Journal*, 2023, **457**, 141145.

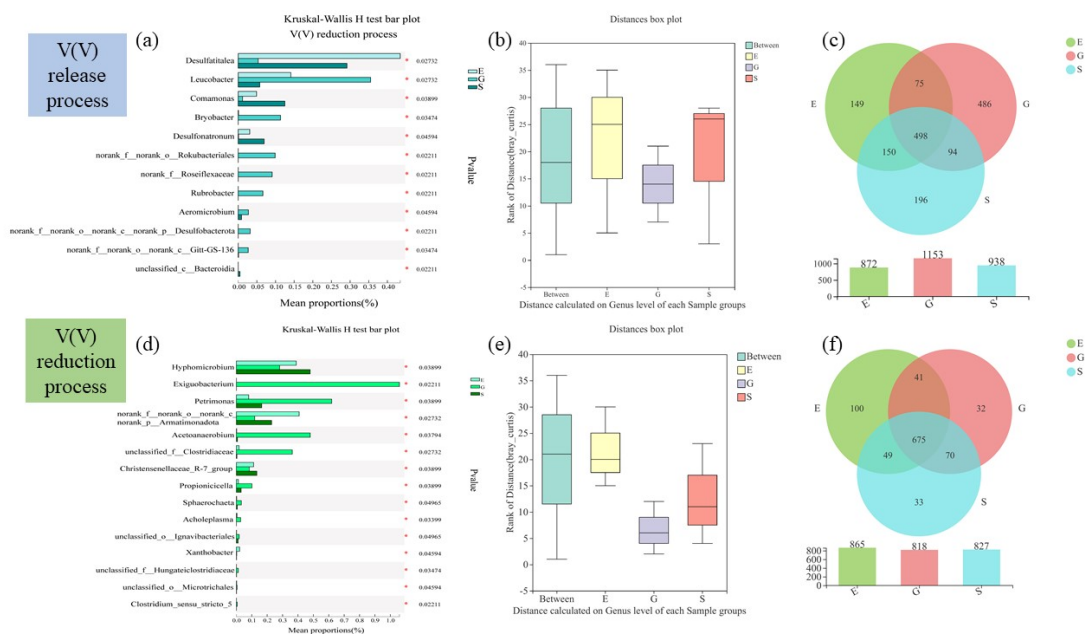
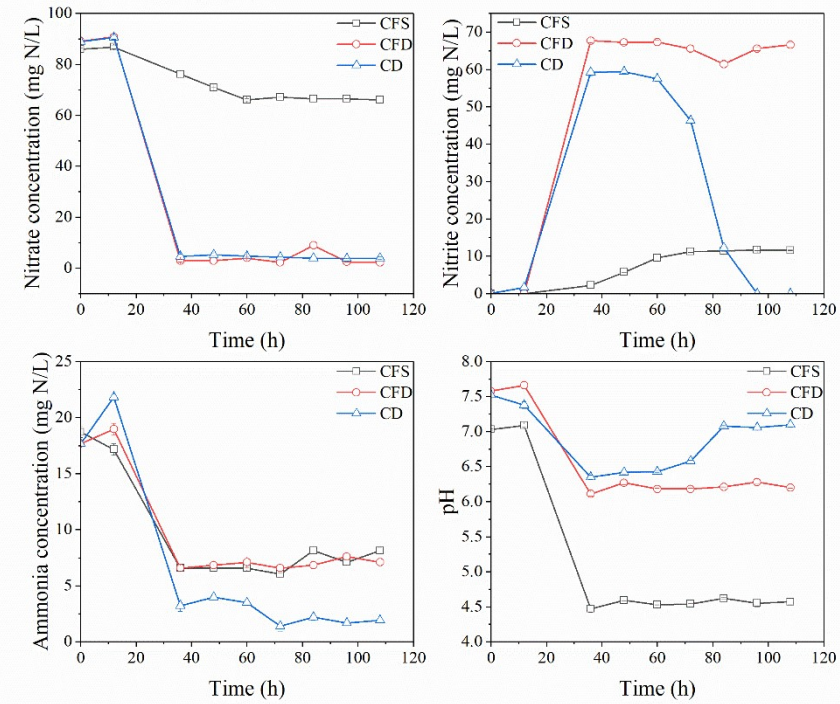


Fig. S1. Significant difference tests between groups (a) (d), Analysis of similarities (b) (e), the Venn plot (c) (f) based on different carbon source-mediated systems.

Single Nitrate system



Single V(V) system

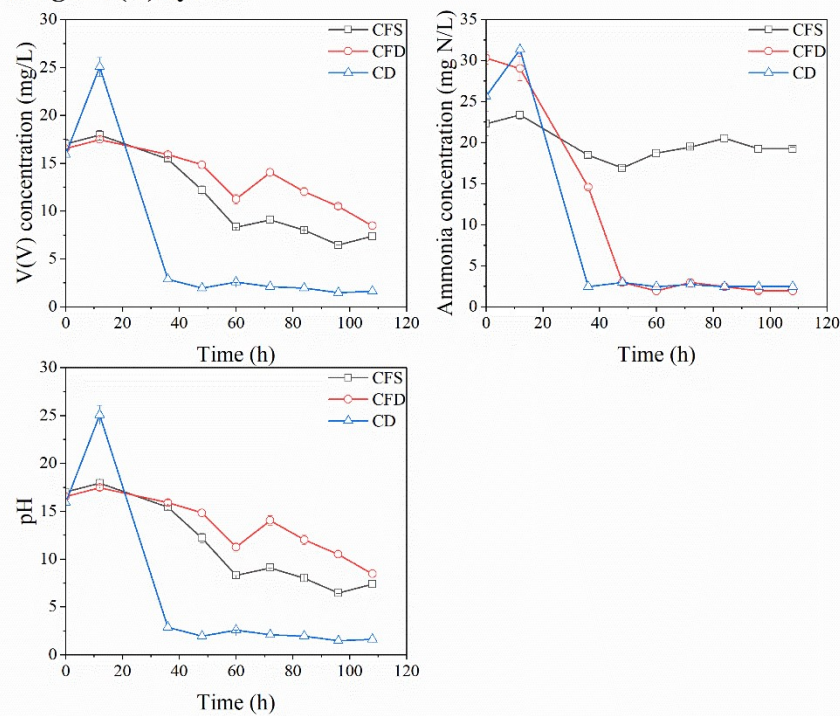
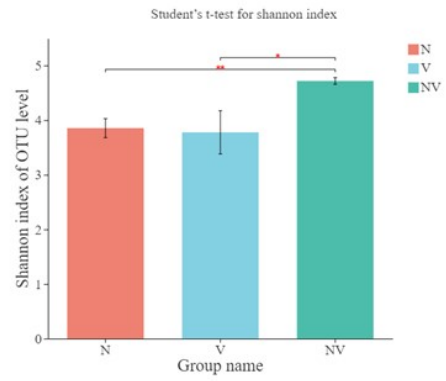
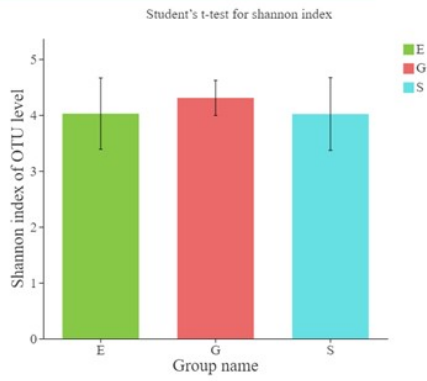


Fig. S2 the variation of nitrate-N, V(V), nitrite-N, Ammonia-N and pH concentration in all bio-reactors. (CFS stands for extracellular enzymes, CFE is related to intracellular enzymes, and CD corresponds to membrane-related enzymes.)

Vanadium release process



Vanadium reduction process

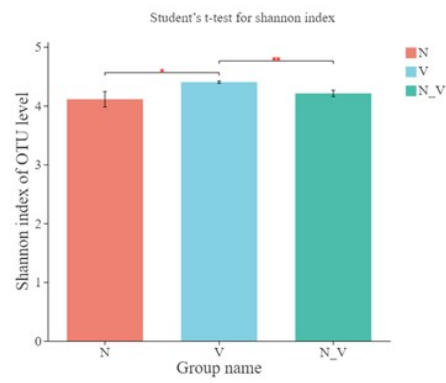
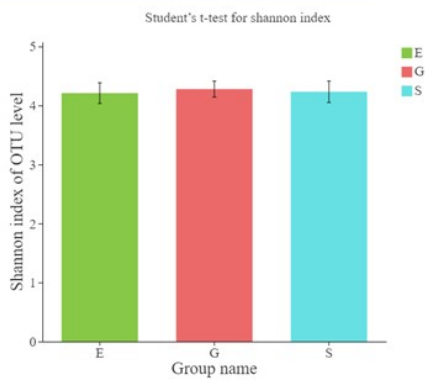


Fig. S3. Student's t-test for shannon index in V(V) release process and V(V) reduction process based on pollutants type and carbon source type.

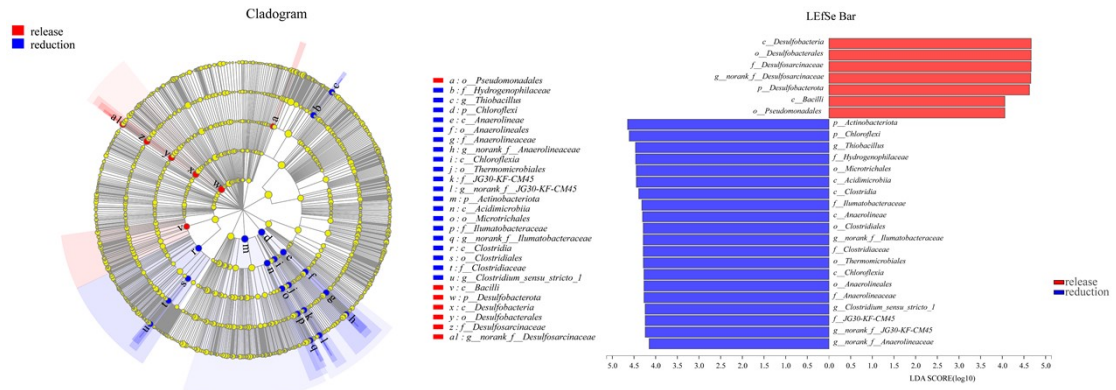


Fig. S4. Lefse multi-level species difference discriminant analysis (logarithmic LDA score = 2)

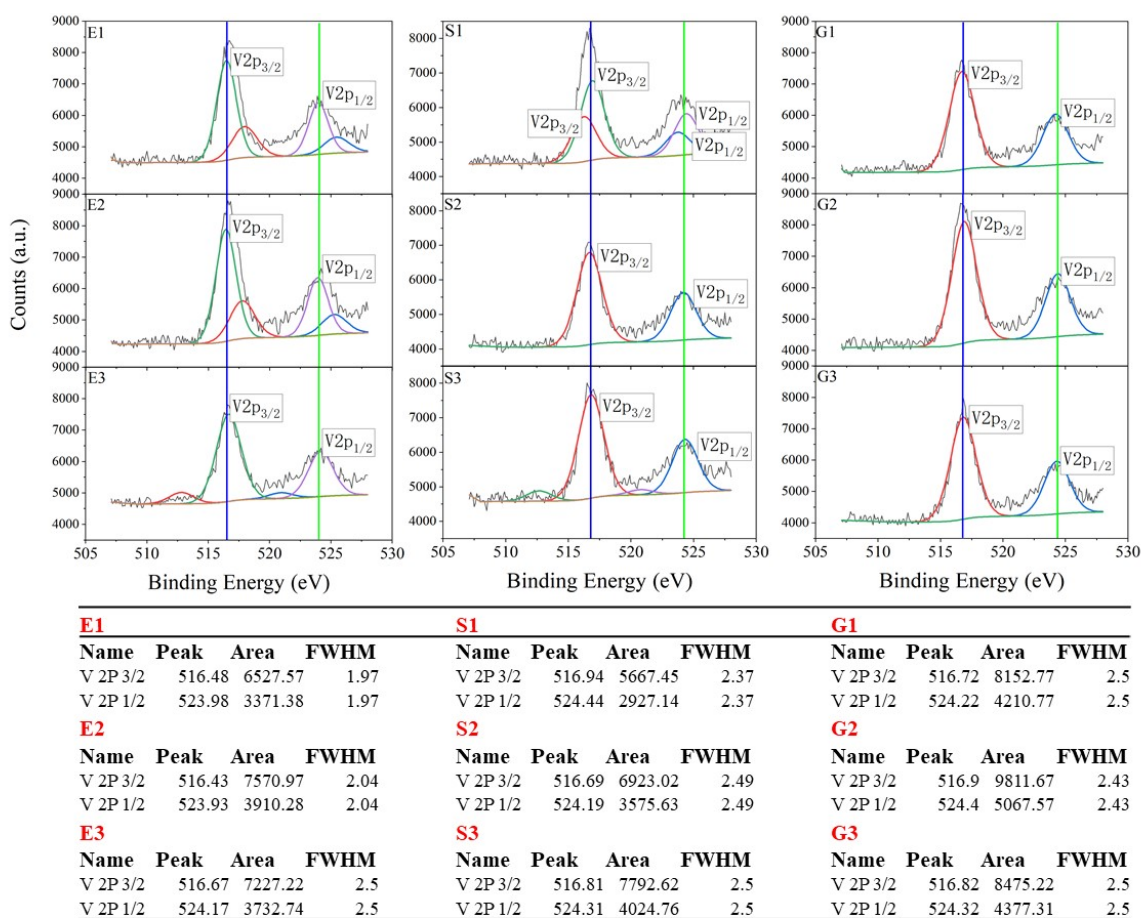


Fig. S5. XPS spectrum analysis based on different carbon source.

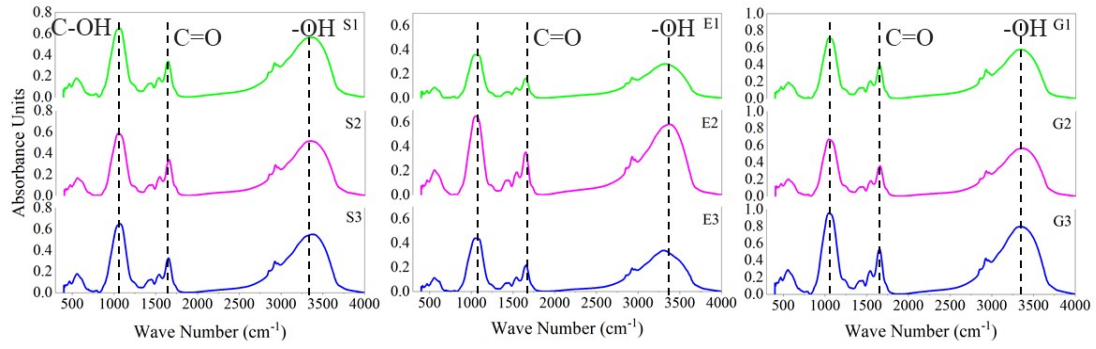


Fig. S6. FT-IR of sodium acetate (S), ethanol (E) and glucose (G) mediated bio-reactors

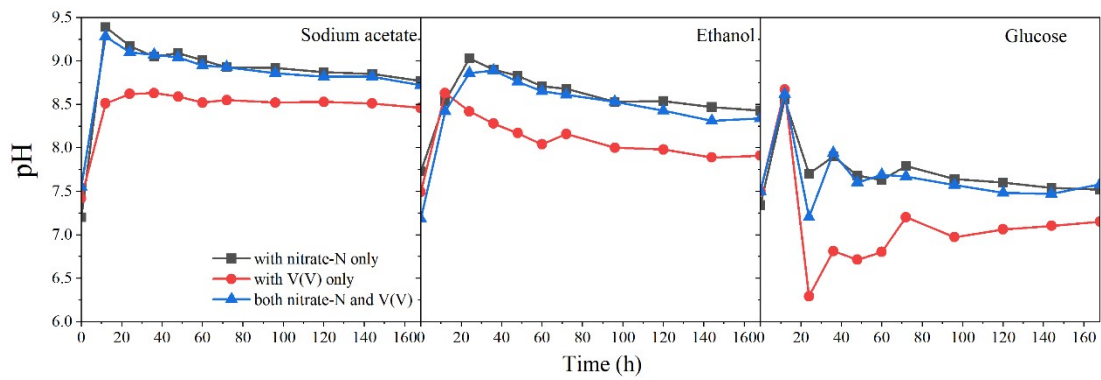


Fig. S7 Variation of pH in different liquid carbon source systems.

Table S1 The zero-order and first-order reaction kinetics of V(V) reduction by enzymes at different positions

Location	equation	k constant	R ²
CFS	$y = 0.0099x - 0.1187$	0.0099	0.9365
CFE	$y = 0.0059x - 0.1215$	0.0059	0.8477
CD	$y = 0.0187x + 0.6262$	0.0187	0.74

Table S2 the alpha-diverstiy index in V(V) release process (0) and V(V) reduction process (1)

Sample\Estimators	Sobs	Shannon	Simpson	Ace	chao
E1_0	590	3.840083	0.076838	638.0943	648.4531
E2_0	549	3.514768	0.094079	732.2761	738.8767
E3_0	431	4.701028	0.026802	436.9678	436
S1_0	628	3.70507	0.086232	800.4542	787.6111
S2_0	574	3.60744	0.102161	715.2031	707.5921
S3_0	587	4.766556	0.035208	590.4333	592.0556
G1_0	564	4.041508	0.060123	630.4566	642.0455
G2_0	581	4.230865	0.042862	606.5837	619.8864
G3_0	791	4.640305	0.038026	799.9812	802.0222
E1_1	583	4.026283	0.055903	633.8793	658.566
E2_1	709	4.388143	0.0289	884.6092	872.6538
E3_1	578	4.221963	0.034582	650.0658	676.2787
S1_1	660	4.038344	0.054939	831.1014	805
S2_1	731	4.405914	0.03302	854.5858	870.3596
S3_1	685	4.25978	0.035832	796.503	796.913
G1_1	668	4.257292	0.040299	813.5241	791.8462
G2_1	678	4.427622	0.031024	820.4065	825.0652
G3_1	675	4.155144	0.042225	816.6206	799.5566