Appendix

Fig. S1. Samples from a closed landfill in Jilin Province, China, using a monitoring well (photo was taken in 2020.12)

The HOM experimental group with the highest oxygen concentration exhibited the peak CO2 concentration. When the gas generation rate reached its maximum, the CO2 concentration was measured at 19.2%. When oxygen decreases, the utilization of organic nitrogen by microorganisms exhibits a certain degree of decline. Degradation test results indicate that the concentrations of N_2O and NH_3 gases decrease with increasing oxygen concentration. Elevated oxygen levels may inhibit the activity of most nitrifying and denitrifying bacteria, resulting in a rapid decline in N_2O emission rates. Additionally, as oxygen concentration increases, the emission flux of NH_3 decreases, along with the total nitrogen content. This occurred because under high-oxygen conditions, the efficiency

of microbial decomposition and transformation of organic nitrogen improves, thereby enhancing nitrogen removal.

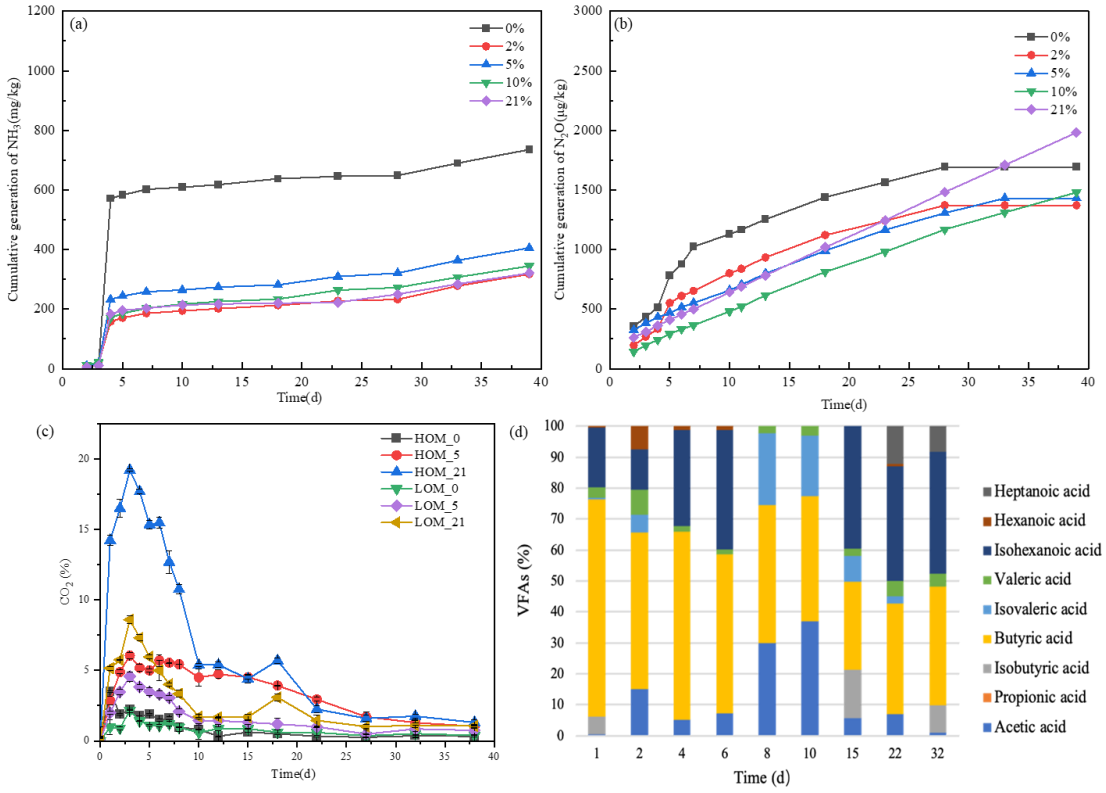

Fig. S2. The variation of gas and VFAs concentrations in the waste degradation over time (a)NH_3; (b)N_2O; (c)CO_2; (d)VFAs

Table S1. The initial nature of waste

Group	Waste Density (kg/m³)	Moisture Content (%)	Volatile Solids (VS, %)	Total Carbon (Dry Basis, %)	Total Nitrogen (Dry Basis, %)
HOM	476 ~ 500	60	50.9	29.11	1.32
LOM	470 ~ 507	57	32.4	27.01	1.55

Table S2. Microbial genera and environmental factors analyzed by the mantel test

Genus	LOM_0	LOM_2	LOM_5	LOM_10	LOM_21	HOM_0	HOM_2	HOM_5	HOM_10	HOM_21
Acinetobacter	301	16395	14452	17817	5941	5	95	15	1322	9593
Lactobacillus	71	0	0	2	0	12045	20849	1058	659	9
Weissella	398	93	6	0	4	559	457	13212	5494	32
Bacillus	4192	472	407	160	355	421	4842	10880	7206	1898
Pediococcus	42	0	0	0	0	18975	2495	4235	531	12
Flavobacterium	43	987	2062	718	1805	0	0	0	0	16303
unclassified_f__Rhizobiaceae	8	54	329	1058	3067	7	5	0	2	33
Lactococcus	159	12	3	4	4	10	3	175	3614	104
Pantoea	0	6	12	100	203	23	7	0	0	10
Devosia	5	0	17	325	3724	0	0	0	0	0
O2	0	2	5	10	21	0	2	5	10	21
pH	7.25	7.55	7.46	7.57	7.42	5.85	6.27	6.88	6.91	7.08
Water	66.41	55.26	56.33	57.53	58.32	61.54	59.05	56.85	62.82	60.61
CO2	1.41	2.56	3.83	5.37	7.31	1.79	3.45	3.45	5.18	17.68
VFAs	4558	1460	1080	1384	1033	8639	7480	7314	6799	2293

Table S3. Top 10 log2FC in High_O_2 and Low_O_2.

Module_ID	**Module_Category**	**High_O_2**	**Low_O_2**	**log2FC**
M00156	Cytochrome c oxidase, cbb3-type	0.00193	0.00062	2.037
M00044	Tyrosine degradation, tyrosine => homogentisate	0.00216	0.00071	2.013
M00038	Tryptophan metabolism, tryptophan => kynurenine => 2-aminomuconate	0.00197	0.00067	1.956
M00741	Propanoyl-CoA metabolism, propanoyl-CoA => succinyl-CoA	0.00305	0.00125	1.690
M00575	Pertussis pathogenicity signature, T1SS	0.00116	0.00059	1.387
M00697	Multidrug resistance, efflux pump MdtEF-TolC	0.00116	0.00060	1.354
M00144	NADH:quinone oxidoreductase, prokaryotes	0.01636	0.00883	1.296
M00866	KDO2-lipid A biosynthesis, Raetz pathway, non-LpxL-LpxM type	0.00962	0.00521	1.292
M00718	Multidrug resistance, efflux pump MexAB-OprM	0.00359	0.00195	1.291
M00546	Purine degradation, xanthine => urea	0.00182	0.00099	1.288

Table S4. The KMO and Bartlett test results of PCA analysis

KMO and Bartlett test			
HOM		LOM	
KMO Measure of Sampling Adequacy	0.738	KMO Measure of Sampling Adequacy	0.653
Approximate Chi-Square	208.58	Approximate Chi-Square	187.31
p-value	<0.01	p-value	<0.01