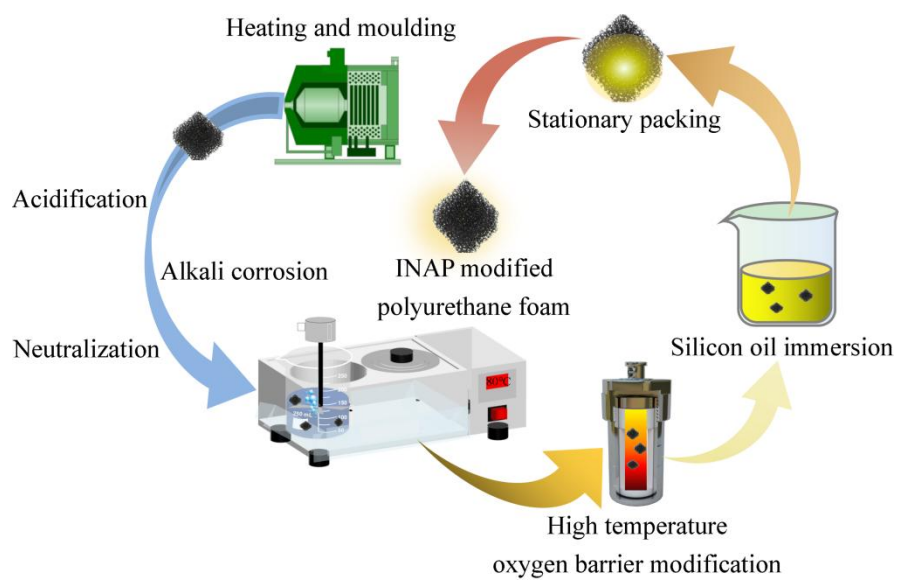


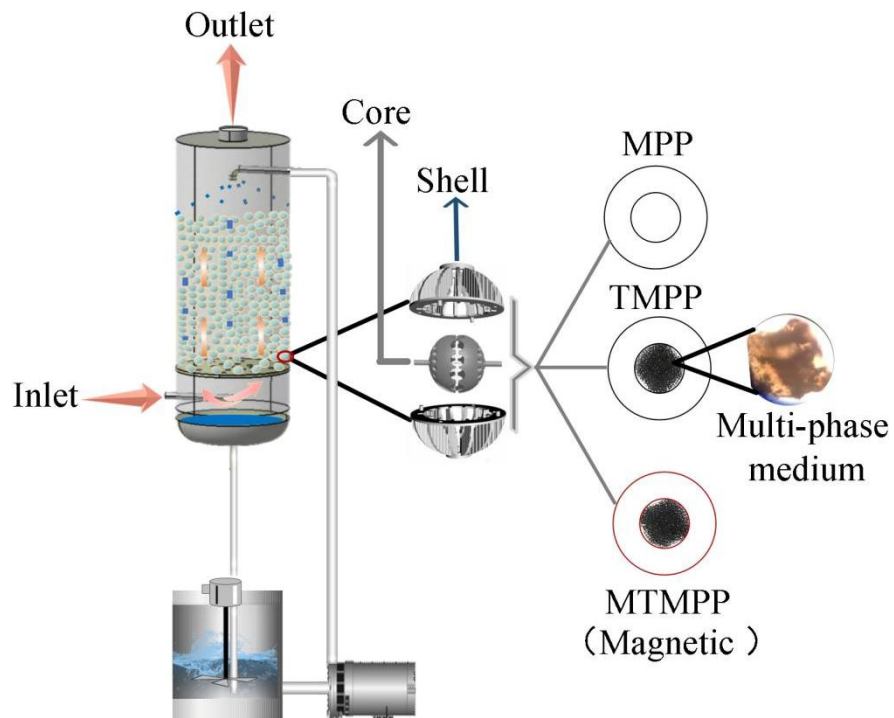
## Supplementary materials

### 1. Preparation of modified PU



**Fig. S1** The preparation technology of modified PU.

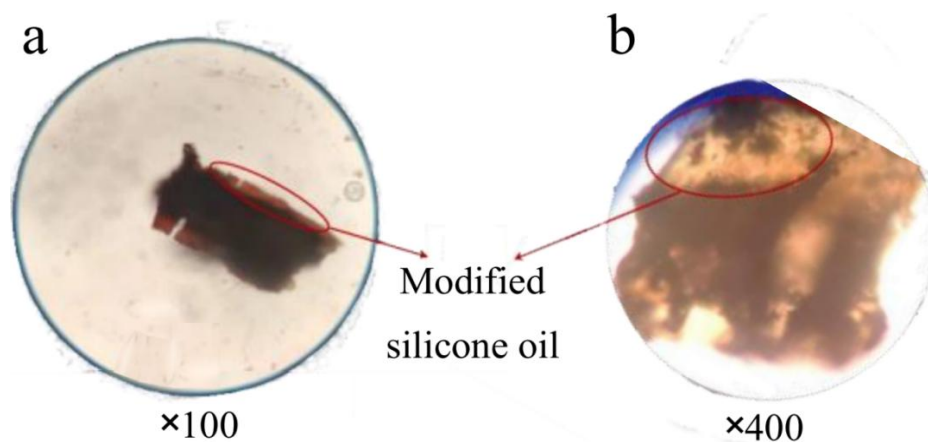
## 2. Craft of the laboratory-scale BTF system



**Fig. S2** Schematic of the BTF for CB treatment.

The bio-trickling filter was constructed as a column by steel with the inside diameter of 150 mm and the height of 570 mm.

3. The stability of silicone oil immobilized polyurethane foams



**Fig. S3** The surface morphology of silicone oil immobilized polyurethane foams (a. 0 d, b. 250 d).

4. The analysis of kinetic model in the BTF

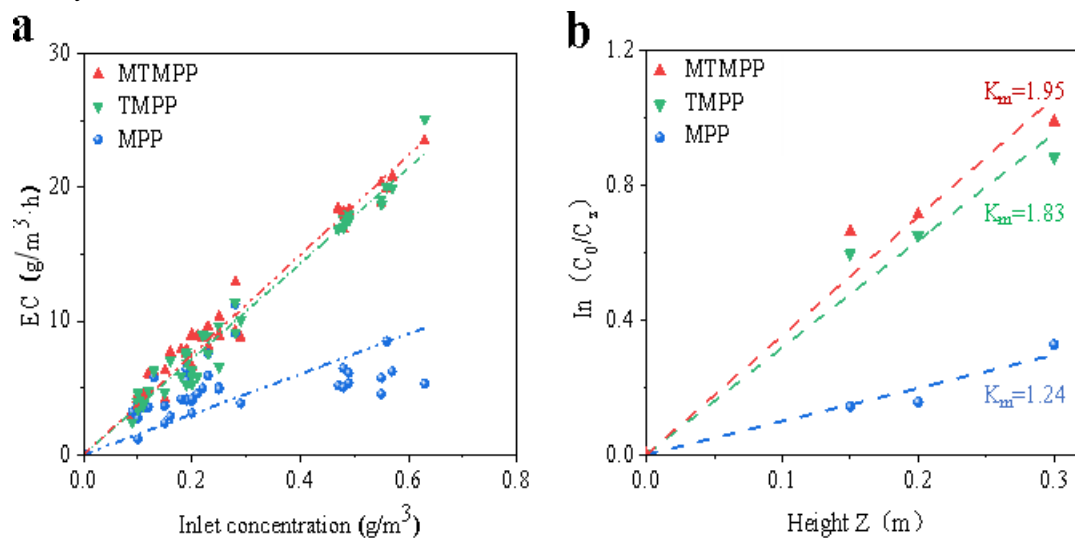
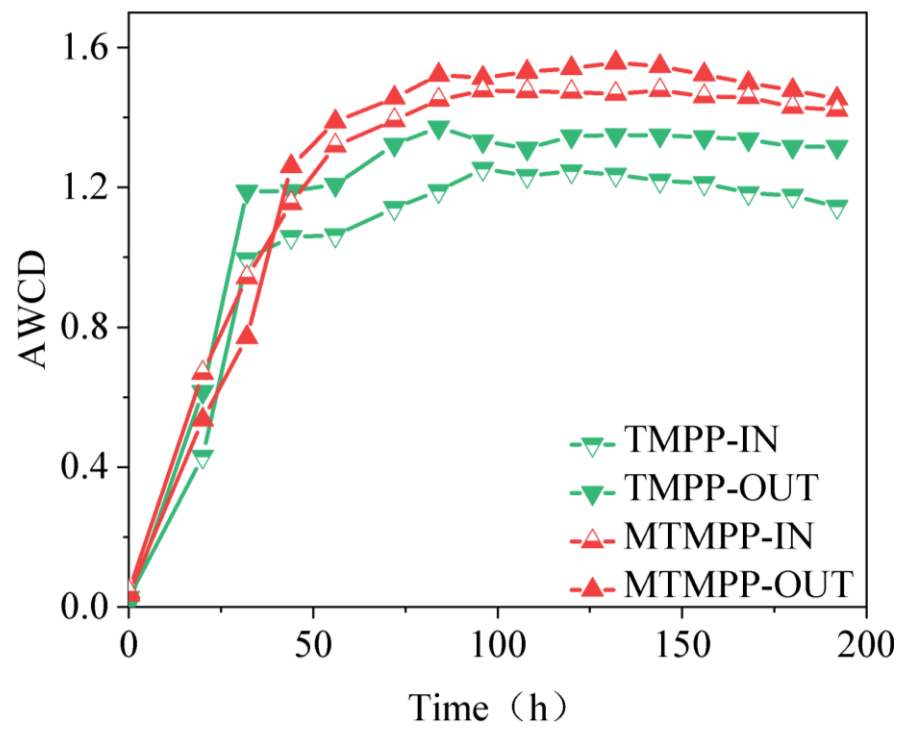


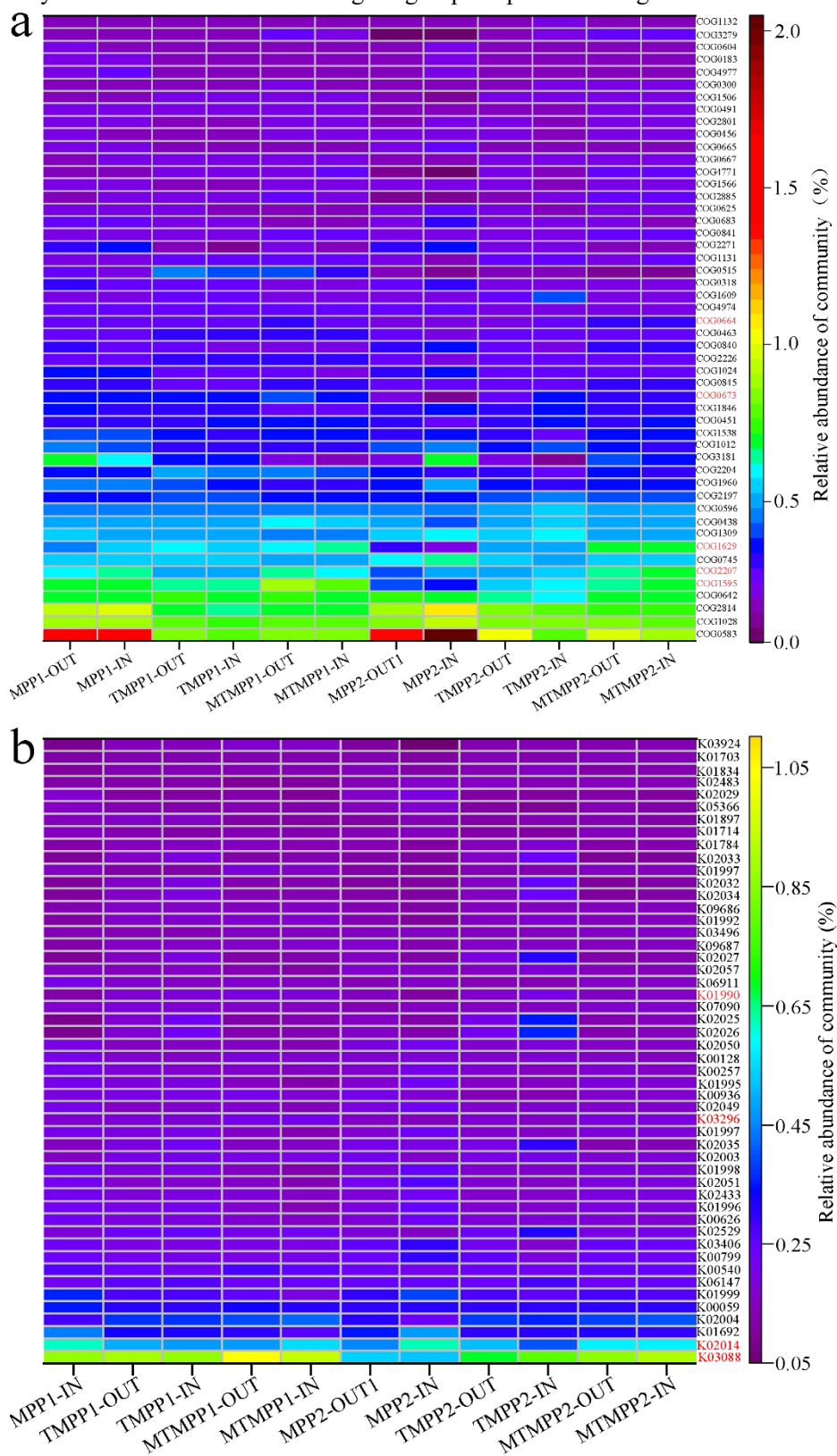
Fig. S4 Dynamic analysis:(a) Elimination capacity versus inlet concentration, (b) Dynamic mode.

5. The microbial metabolic activity



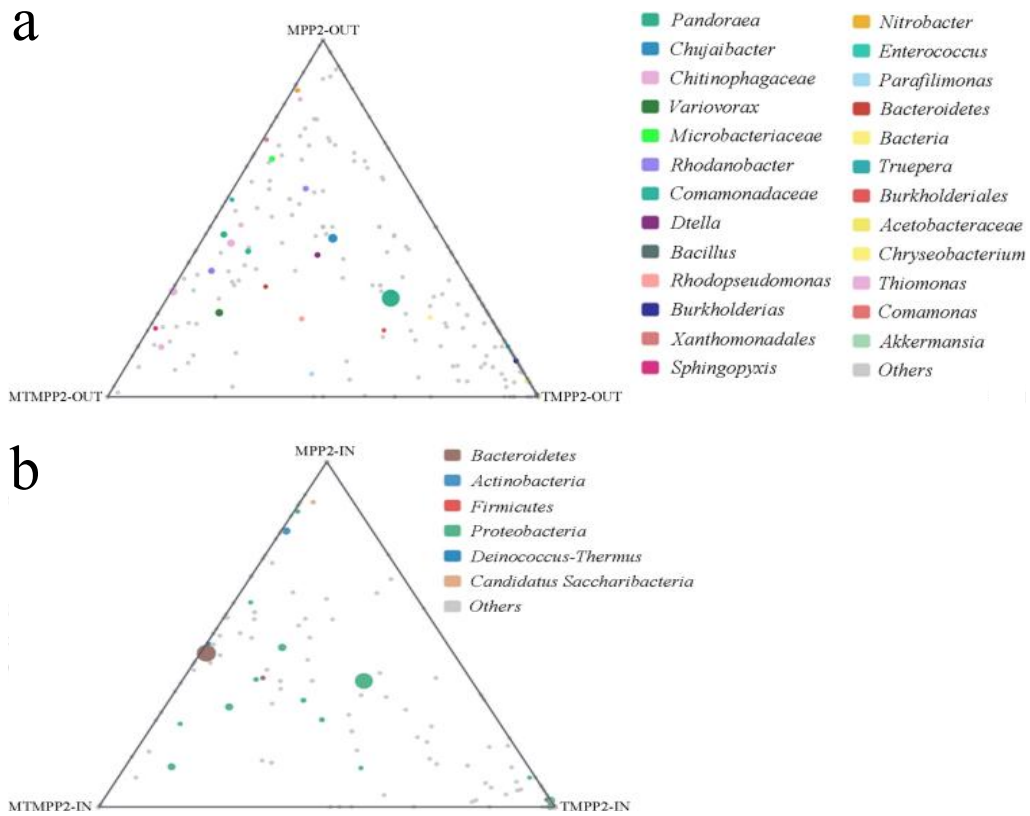
**Fig. S5** Development of AWCD of microbial samples from two bioreactors.

6. The analysis of main clusters of orthologous groups of proteins and gene



**Fig. S6** The relative abundance heatmap (a.COG, b.KO).

7. The correlation between the dominant genera in different BTFs



**Fig. S7** Ternary phase diagrams analysis for bioreactors (a. Genus level in the outer layer of late stage, b. Genus level in the inner layer of late stage).

Table S1 Composition of the mineral medium.

Ingredients	Concentration (g/L)	Specification	Manufacturer
$\text{Na}_2\text{HPO}_4 \cdot 12\text{H}_2\text{O}$	4.5	Analytical purity, AR	Shanghai Aladdin Reagent Company
$\text{KH}_2\text{PO}_4$	1	Analytical purity, AR	Shanghai Aladdin Reagent Company
$(\text{NH}_4)_2\text{SO}_4$	1.5	Analytical purity, AR	Shanghai Aladdin Reagent Company
$\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$	0.2	Analytical purity, AR	Shanghai Aladdin Reagent Company
$\text{CaCl}_2$	0.023	Analytical purity, AR	Sinopharm Group Chemical Reagent Company
$\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$	0.001	Analytical purity, AR	Shanghai Aladdin Test Company
$\text{MnSO}_4$	0.0001	Analytical purity, AR	Sinopharm Group Chemical Reagent Company
$\text{ZnSO}_4$	0.0001	Analytical purity, AR	Sinopharm Group Chemical Reagent Company
$\text{CoSO}_4 \cdot 6\text{H}_2\text{O}$	0.00002	Analytical purity, AR	Sinopharm Group Chemical Reagent Company
$\text{H}_3\text{BO}_3$	0.000014	Analytical purity, AR	Shanghai Aladdin Test Company
$\text{Na}_2\text{CO}_3 \cdot 2\text{H}_2\text{O}$	0.00002	Analytical purity, AR	Shanghai Aladdin Test Company

Table S2 Partition coefficients of chlorobenzene in the three phases.

Sample	Partition coefficient	R <sub>2</sub>
H <sub>2</sub> O	0.26	0.993
Immobilized polyurethane foams (0 d)	0.0014	0.991
Immobilized polyurethane foams (250 d)	0.0086	0.896

Table S3 Characteristics of the filler.

Filler	Polyurethane foam assembled in polyhedral hollow spheres	INAP-modified*	MF-modified**
MPP	√		
TMPP	√	√	
MTMPP	√	√	√

\* INAP was modified polyurethane foam fixed on the surface of polyurethane foam.

\*\* Polyhedral hollow spheres was magnetized.

Table S4 The Operational conditions of BTFs.

Stage	Period (days)	Inlet concentration (mg/m <sup>3</sup> )
I	1-50	100-150
II	51-60	100-150
III	61-70	200-300
IV	71-80	450-600
V	81-91	150-200

## Appendix S1

### Detail analytical methodology

#### CB concentration and CO<sub>2</sub> production determination

The concentration of CB was measured by the Agilent 6890 gas chromatography system with an HP-Innowax capillary column (30 m×0.32 mm×0.5 μm) and hydrogen flame ionization detector (FID). The temperatures of the inlet column (HP-Innowax), and hydrogen flame ionization detector temperatures set at 250°C, 200°C, and 280°C, respectively. Liquid CB concentration was calculated using the gas–liquid partition coefficient based on the gas concentration of CB according to our previous study.

Gas chromatography was performed using an Agilent 6890B system to measure CO<sub>2</sub> concentration. The analysis employed a 30 m × 0.32 mm × 20 μm HP-Plot Q capillary column. The thermal conductivity detector was set to temperatures of 100°C, 40°C, and 180°C, respectively. Helium served as the carrier gas, flowing at a 100 mL·min<sup>-1</sup> total flow rate, a 50:1 split ratio, and a 0.8 mL gas injection volume.

#### **Chloride ion and intermediate product determination**

Chloride concentration was measured using an ICS-2000 ion chromatography system. Aqueous samples were first filtered through a 0.45-μm membrane and then analyzed using an AS19 separation column (4.0 × 250 mm) with a sodium cation exchange. The conductivity detector was maintained at 35°C. Potassium hydroxide (KOH) was employed as the eluent with a concentration gradient ranging from 10 to 40 mmol·L<sup>-1</sup>, a flow rate of 1 mL·min<sup>-1</sup>, and an injection volume of 25 μL.