Supplementary Materials

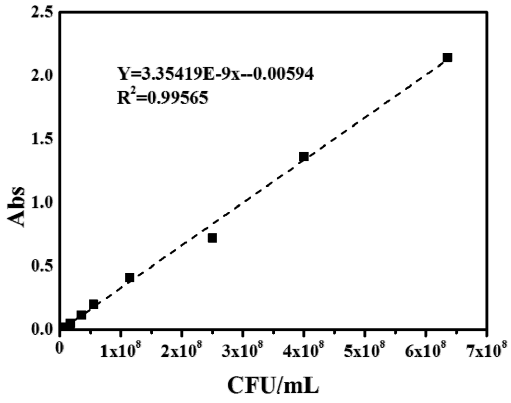

Fig. S1. Calibration curve of biomass of petroleum hydrocarbon degrading bacteria

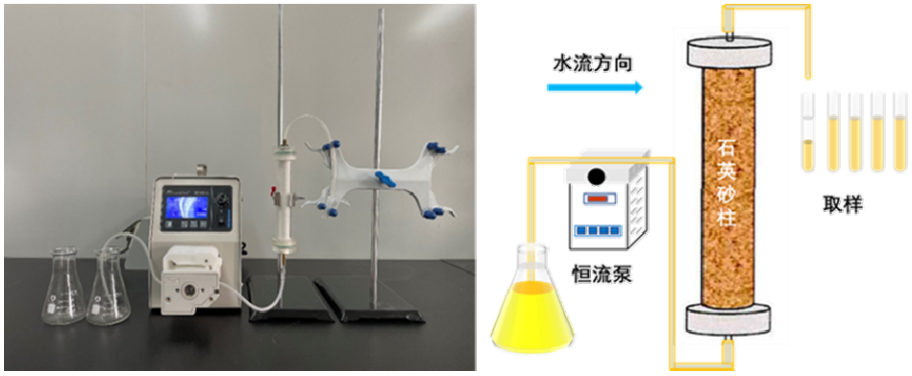

Fig. S2. Diagram of transport experimental device

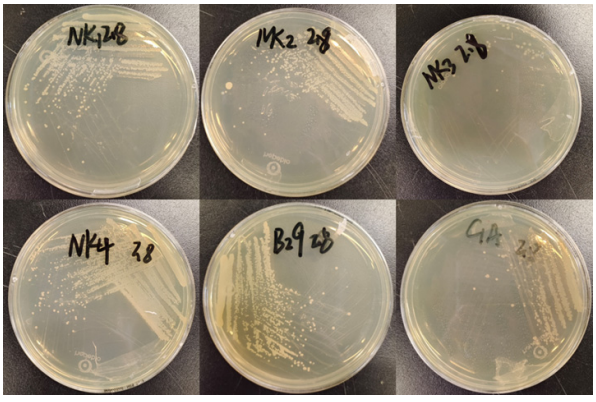

Fig. S3. Solid medium morphology of 6 degrading bacteria

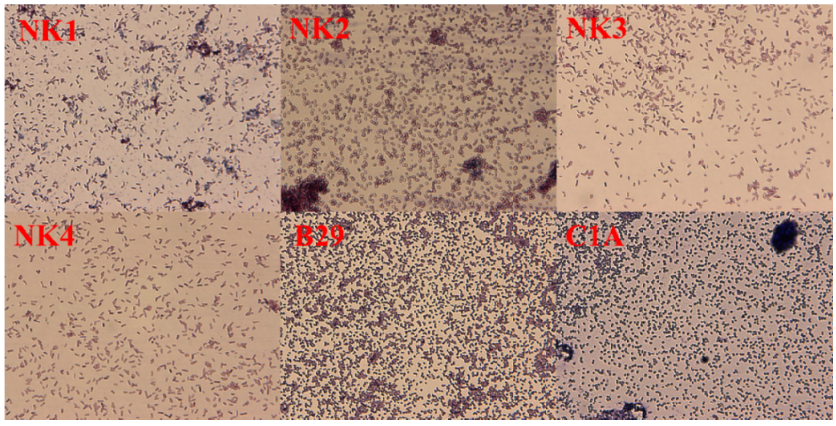

Fig. S4. Gram-stained picture of degrading bacteria

Table S1. Basic parameters of experimental column

Sand type	Particle size (mm)	Quality (g)	Bulk density (g/cm^3)	Porosity	Pore volume (mL)
Coarse sand	0.5~1.0	80.50	1.71	0.434	20.38
Medium sand	0.25~0.5	81.18	1.72	0.427	20.12
Fine sand	0.125~0.25	81.79	1.74	0.412	19.44

Table S2. Colony morphology and Gram staining results of six strains

ID	Characterization	Morphological description	Gram stain
NK1	*Acinetobacter venetianus*	The colony is round, with neat edges, raised, white, and smooth, moist surfaces	G$^-$
NK2	*Pseudomonas aeruginosa*	The colony is round, with neat edges and a raised center, white, moist, and translucent	G$^-$
NK3	*Acinetobacter venetianus*	The colony is yellowish, opaque, with a smooth surface and regular edges	G$^-$
NK4	*Pseudomonas guguanensis*	Round bulge, smooth surface, viscous texture, milky white, translucent	G$^-$
B29	*Alcaligenes faecalis*	Light yellow, translucent, slightly shiny, round, no fluidity	G$^-$
C1A	*Pseudomonas aeruginosa*	Orange yellow, round opaque, rough surface, dry	G$^-$

Table S3. Antagonistic relationship of different colonies

	NK1	NK2	NK3	NK4	B29	C1A
NK1		+	+	−	+	−
NK2	+		+	−	−	−
NK3	+	+		−	−	−
NK4	−	−	−		−	−
B29	+	−	−	−		−
C1A	−	−	−	−	−	

Note: "−" ndicate there is no antagonistic effect between each other; "+" indicate there is antagonistic effect between the strains.

Table S4. Relative content of degradation product components

Carbon segment	1d	3d	7d	11d	15d	21d
C10-C16 (%)	79.18	79.25	51.44	14.05	4.71	0
C17-C22 (%)	20.82	20.75	48.56	85.95	95.29	100.00

Table S5. Zeta potential of mixed bacteria

Ionic strength (mM)	Compound bacteria (mV)
1	-27.7±0.9
50	-16.4±0.4
100	-10.5±0.7