Microbial Degradation Impact on Biomarker Parameters under the Addition of Biosurfactant

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Introduction

Biodegradation of crude oil is a focus in petroleum geochemistry, because it could influence oil viscous, density and acidity. Selective biodegradation would influence biomarkers which characterize maturity and depositional environment and parameters of identification of PAHs pollution source. Therefore, some parameters are being questioned and it is with less explored. Under the background of these, it has significance for researches to grasp the change of characteristic compounds in molecular markers or biomarkers.

As well known, biosurfactant is an amphoteric compound produced by microorganism and could accelerate biodegradation process. The objective of this study is to investigate the impact of surface aerobic biodegradation on molecular marker parameters under the addition of biosurfactant in heavy oil.

Laboratory biodegradation experiments were carried out in 150mL sterilized MSM medium supplemented with 2% (v/v) heavy oil which used as sole carbon source. Each medium was inoculated with strain BC1 and added following biosurfactant (mg/L): 0, 10, 20, 50, 100 and 200. Cultures were grown at 30℃ with shaking at 160 rpm for 45 days. After the degradation, hydrocarbon groups were carried out with a GC-MS.

Results

With increasing the concentration of biosurfactant, Pr/nC17 and Ph/nC18 has a significant trend of increase and Pr/Ph varies from 0.24to 0.27. TARFA shows a rising trend from 3.033 to 6.051. The low molecular weight hydrocarbons (<n-C20, LMWH) become more abundant than the higher molecular weight hydrocarbon (>n-C25, HMWH). Results show LMWH/HMWH ratios vary from 0.29-0.91. However, some parameters CPI-related present a decrease, such as CPI change from 1.345 to 0.834, Overall CPI change from 1.18to 0.80, Low CPI change from 1.13 to 0.76, High CPI change 1.25 to 0.89. Dicyclic sesquiterpenoids parameters also vary with the concentration of biosurfactant. The ratio of 44889-PMDHN/44899-PMDH reduces from 0.65 to 0.41. 8β(H)-homodrimane/8β(H)-drimane ratios present values increase from 0.82 to 1.80, whereas the relative content of diadrimane decrease from 0.58 to 0.42.

Hopane and sterane parameters show a lightly change with biodegradation, such as Ts/Ts+Tm） changes from 0.26 to 0.29, C_{31}αβ22S/ (22S+22R) changes from 0.54 to 0.55, C_{29}ααα 20S/ （20S+20R） changes from 0.36 to 0.39 and C_{29}ββ/ (ββ+αα) varies from 0.19 to 0.22, they changes slightly and may change much bigger when biodegradation degree increase. In addition, C_{35} homohopane index (C_{35}/ (C_{31}-C_{35})) vary from 4.01% to 5.13% with a lightly increase. Gammacerane/ C_{30} hopane and moretane/ C_{30} hopane is relatively stable.

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MPI-1 index is used to identify maturity of oil and the organic matter. The values of MPI1 and MPI3 change from 0.80 to 0.41 and from 0.88 to 0.46, and have the trend to decrease. In addition, the value of 1,7/ (1,7+2,6-DMP) lies between 0.69 and 0.89 have the trend to increase. Furthermore, Some PAHs molecular biomarker parameters for source apportionment are also changed, such as An/(An+Ph)change from 0.03 to 0.02, Fl/(Fl+Py) change from 0.12 to 0.11, DBT/P change from0.06 to 0.02 and C_1DBT/C_1P change from 0.07 to 0.04. It could be clearly see that most of them show a lightly decrease trend with the increasing biodegradation. But there are some parameters presents slow increase trend, BaA/ (BaA+Chr) change from 0.20 to 0.23, IP/ (IP+B (g,h,i)P change from 0.10 to 0.11.

Table1. Selected biomarker parameters in samples

Biomarker Parameters	The concentration of biosurfactant(mg/L)	oil	0	10	20	50	100	200
n-alkanes	CPI	1.345	1.352	1.351	1.392	1.170	0.878	0.832
	(16)C ratio	28.44	30.03	41.09	34.39	3.940	31.04	33.84
dicyclic sesquiterpenoids	8β(H)-homodrimane /8β(H)-drimane	0.829	1.093	1.183	1.369	1.317	1.499	1.801
	diadrimane /8β(H)-drimane	0.584	0.578	0.504	0.531	0.508	0.537	0.430
sterane	C_{29}20S/(20S+20R)	0.359	0.347	0.354	0.349	0.348	0.354	0.350
	C_{29}ββ/(ββ+aa)	0.206	0.181	0.184	0.185	0.183	0.186	0.183
hopanoid	Ts/(Ts+Tm)	0.256	0.263	0.270	0.260	0.257	0.260	0.264
	22S/(22S+22R)	0.545	0.549	0.539	0.544	0.545	0.551	0.544
PAHs	MPI1	0.799	0.805	0.703	0.406	0.777	0.558	0.596
	An/178	0.033	0.031	0.002	0.053	0.025	0.029	0.025
	DBT/P	0.058	0.058	0.058	0.030	0.030	0.042	0.013
	C_1DBT/C_1P	0.072	0.073	0.088	0.079	0.038	0.055	0.029

The column of oil is the biomarker parameters before degradation, the other columns are the values after microbial degradation with different concentration of biosurfactant.

Conclusions

Biosurfactant is able to accelerate biodegradation process of petroleum and biomarker parameters change bigger when microbial degradation with biosurfactant.

Some biomarker parameters which have low molecular weight and easy to degrade may be influenced and changed markedly by biodegradation. However, some parameters with high molecular weight to be hardly-degraded did not change significantly, but whether these parameters could be applied in serious degrade situations remain to be confirmed.

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