THE COMPONENT AND STABLE CARBON ISOTOPE ANALYSIS OF CASING GASES ON LOW PERMEABILITY RESERVOIR MEOR

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Introduction

MEOR (Microbial Enhanced Oil Recovery) has the characteristics of unique mechanism, simple operational process and reservoir and environment friendly, and it also has the advantage on flexibility to adjust microbial species and nutrient solution to suit difference reservoir conditions. In the process of oil displacement, microbial ecosystem can be regulated by injecting microbial activation water to serve the purpose of improving oil recovery efficiency. However, technical problems on when to inject, what is the best amount and concentration of microbial to inject, how to improve the microbial adaptability to reservoir environment and how to quickly evaluate oil displacement effect in the process of MEOR remain.

Casing gas samples were collected from two microbial activated water injection oil wells and three formation water injection oil wells in Bai-153 block of Changqing oil field in China for contrastive analysis on the characteristics of the compositional and stable carbon isotope. The objective is to monitor the reservoir microbial changes in real-time and to quickly evaluate the efficiency.

Results and discussion

The microbial react with hydrocarbons during oil displacement, resulting in changes in gas composition and stable carbon isotopes. Propane can be preferentially degraded by microbial comparing to other gaseous hydrocarbons [1], and n-alkanes (nC_4 and nC_5) are easier to be biodegraded than isomeric alkanes (iC_4 and iC_5) [2]. At the mean while, microbial prefer to utilize the components with lighter isotopes in gaseous hydrocarbons, resulting in relatively heavy stable carbon isotopes of methane, propane, iso-butane, and iso-pentane in gaseous hydrocarbons [4].

Comparison of the characteristics of casing gas components and stable carbon isotope of 2 microbial activated water injection oil wells and 3 formation water injection oil wells from Bai-153 block from Changqing oil field, indicated that the value of C_2/C_3, nC_4/C_3, iC_4/nC_4, iC_4/C_3 and iC_5/nC_5 from microbial activated water injection casing gas were relatively higher, and the stable carbon isotope of methane, propane, iso-butane and iso-pentane is relatively heavier (Table 1). It indicates that the composition and stable isotopes of the gaseous hydrocarbons from activated water changed obviously due to the effect of microbial.

In addition, the content of non-hydrocarbon gas (O_2 and N_2) in casing gas from microbial activated water injected well was significantly higher than the others as shown in Figure 1. It is speculated that some photosynthetic bacteria and nitrogen-fixing bacteria may exist in the activated water.

Therefore, the efficiency and stages of MEOR can be characterized by hydrocarbon composition and stable carbon isotope change in casing gases.

Table 1 *Correlation table of hydrocarbon composition and stable carbon isotope of casing gas from microbial activated water injection well and formation water injection well*
MAWICG: Casing gas from the well of microbial activated water injection; FWICG: Casing gas from the well of formation water injection

Ratio	C_2/C_3	nC_4/C_3	iC_4/nC_4	iC_4/C_3	iC_5/nC_5	$\delta^{13}C_1$(‰)	$\delta^{13}C_3$(‰)	$\delta^{13}iC_5$(‰)	$\delta^{13}iC_5$(‰)
MAWICG	1.15	0.29	0.41	0.12	0.18	-50.1	-33.9	-33.5	-30.5
FWICG	0.85	0.17	0.35	0.08	0.14	-51.2	-34.2	-34.6	-31

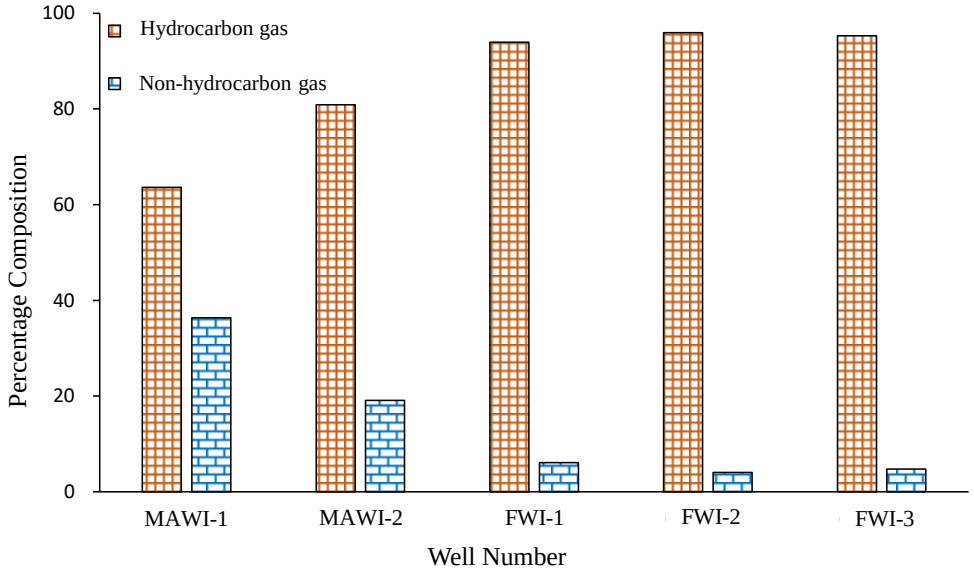

Figure 1 *Hydrocarbon and non-hydrocarbon characteristics of casing gas*
MAWI-1, MAWI-2: Casing gas from the well of microbial activated water injection; FWI-1, FWI-2 and FWI-3: Casing gas from the well of formation water injection; Hydrocarbon: C_1-C_5; Non-hydrocarbon: O_2 and N_2

Conclusion

In the process of microbial enhanced oil recovery in low permeability reservoir, the composition and stable carbon isotope ratio of gaseous hydrocarbons can be affected by the biochemical interaction between microbial and hydrocarbons in reservoir. The characteristics of components and stable carbon isotope of casing gases which can be easily collected can be used to monitor microbial activities in reservoir, adjust the amount, concentration of microbial of injection, and to quickly evaluate the efficiency of MEOR. This evaluation method is proposed for the first time as we know.

References

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