DOI: 10.21276/sb.2016.2.6.17

Scholars Bulletin
(A Multidisciplinary Journal)
An Official Publication of "Scholars Middle East Publishers",
Dubai, United Arab Emirates
Website: http://scholarsbulletin.com/

ISSN 2412-9771 (Print)
ISSN 2412-897X (Online)

Endogenous Microbial Flooding Evaluation

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Abstract: Microbial enhanced oil recovery technology is the use of microbial activity itself and its metabolites, acting on the fluid reservoir and the reservoir, so as to achieve the purpose of enhanced oil recovery techniques. Compared with other oil recovery technology, microbial enhanced oil recovery technology process is simple, wide application, clean, good economic returns, therefore, continue to arouse the attention of experts, but also caused microbial academia, industry, oil, petroleum geology industry and other related subjects of interest and concern. This paper analyzes the endogenous microbial EOR technology mechanism, in terms of using the devices, methods, analysis shows the effect of microbial oil displacement situation I sea area. Porous media endogenous microbial growth and stability of different growth media activation effect was compared. After water flooding through to the limit, further on endogenous microbial enhanced oil recovery.

Keywords: Microbial flooding; Laboratory study; Viscosity; Evaluation.

INTRODUCTION

Microbial enhanced oil recovery technology is rapidly developing an enhanced oil recovery technology at home and abroad, Century 21 is a high-tech biotechnology [1]. Following the US Department of Energy has listed it as thermal recovery, miscible flooding, the fourth category EOR chemical flooding after. The main mechanism of microbial enhanced oil are: microbes can significantly reduce the interfacial tension between the oil layer, changing the oil displacement efficiency; reduce the viscosity of crude oil, improve oil flow ratio; selective pore of reservoir demeanor, flooding sweep efficiency improvement to improve oil recovery [2].

In recent years, the oil industry through the use of endogenous microbial reservoir flooding method, which is suitable for long-term water flooding in through the rear of the reservoir and the blocks are used, the use of any original reservoir microbial enhanced oil recovery. Select the appropriate reservoir for specific blocks, a reservoir of endogenous microorganisms, by analyzing the nature of the liquid reservoir block to determine endogenous microbial activators, and injected into the formation. Because the application is not applied bacteria, but the direct use of the formation of the Central Plains and some microbes, so no strain screening, bacteria production, transport bacteria, while the endogenous bacteria avoid the adaptability of microbes formation. Than traditional microbial enhanced oil recovery technology to reduce costs and improve efficiency [3].

MATERIALS AND METHODS

Materials

150mL conical flask, 50mL graduated cylinder, autoclave, HZS-H water bath oscillator, CS501 3C a water bath, DV-ll + Pro Brookfield viscosity agent, DCA 322 a contact angle analyzer, PB3002 an electronic balance, corn sugar , potassium nitrate (analytical grade), money dihydrogen phosphate (AR), I sea area of crude oil, sea water injection zone I, deionized water, adjusting the pH with acid solution.

Experimental equipment

20cm * 2.5cm fill sand advection model LB-10 pumps, piston intermediate container, incubators, precision pressure gauges, gas flow meter, graduated cylinder, stopwatch, range 10mL graduated test tube and so on.

Experimental Procedure

I Sea region injecting water, sea I dewatering dead oil, optimization activation system, 0.9% sterile saline, deionized water, high-pressure nitrogen.

1) with a certain proportion of quartz sand filling model, measured at room temperature nitrogen permeability Kg;

2) vacuum, water saturation, porosity calculation, the measured water permeability Kw;

3) 58 ^{o}C incubator placed ld, lmL / min pump speed unsaturated oils to irreducible water saturation Swc, incubator aging 3d;

4) 58^{o}C incubator to 0.5mL / min water pump speed to drive the moisture content (fw) 98%;

5) for subsequent experiments.

ACTIVATION IN POROUS MEDIA EVALUATION

Core <# 1>: injection 2PV total number of bacteria.

Core <#2>:injection 2PV optimization system activated nitrogen flooding a daily basis, driven out lmL detect liquid water, with nitrogen displacement, driven out lmL liquid detection of total bacteria count in Table 1 a day.

Porous Media activating effect

Table 1: Basic parameters of the model

Core number	L*ϕ, cm	$K_g, \mu m^2$	$K_w, \mu m^2$	Swc, %	ϕ, %
1#	20*2.5	0.557	0.435	17.54	42.83
2#	20*2.5	0.576	0.449	17.21	41.68

As can be seen from Figure 1, the optimization system activation in the core activation of endogenous microbes delay 6d, logarithmic phase length 5d, about the culture around 10d into the stable growth of microorganisms.

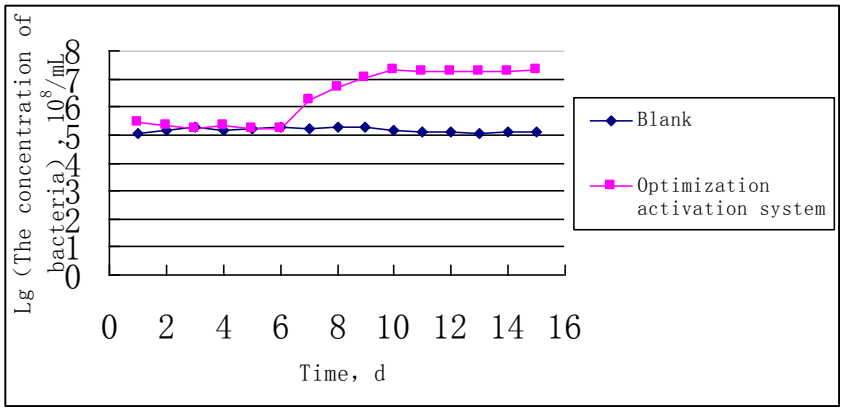

Fig-1: Porous media source for microbial growth curve

Different growth medium activating effect of contrast

As can be seen from Figure 2, the same concentration of the best activation system in a different medium, the effect of activating internal source of microorganisms there are obvious differences. Shake the bottle to activate the endogenous microbial delay period is very short (less than ld), within the range of the sampling frequency can-not be detected [4], and in the core there are significant delays of up to 6d, so shake flasks endogenous bacteria activated starting speed significantly greater than the startup speed rock core; shake flasks logarithmic phase length about 3d, and cores logarithmic growth phase is about 4d, so activate speed flasks endogenous microbes also significantly greater than the rock activation of the speed of the hearts; after activation of endogenous microbes, the highest concentration of bacteria in shake flasks and cores highest concentration of bacteria belong to the same order of magnitude, indicating the degree of activation of endogenous microorganisms in shake flasks and degree of activation of cores or less.

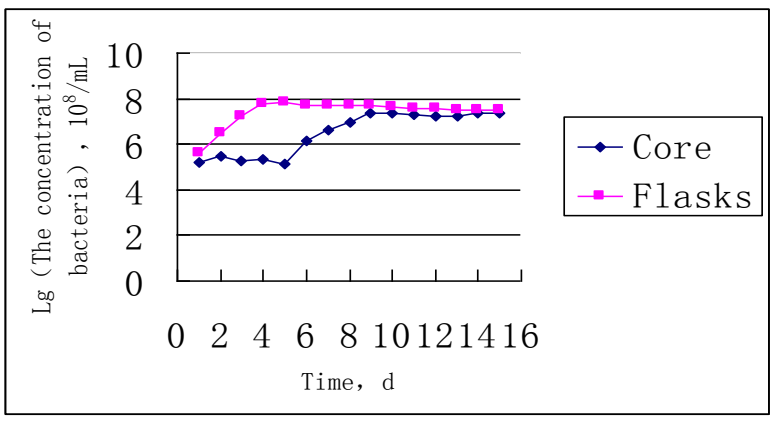

Fig-2: Different growth media endogenous microbial growth curve

The main reason is that: 1) the different degree of dilution activator. As to the cores activator injection, it will be the leading edge of the formation water continuously diluted, resulting in reducing the effective concentration of nutrients; and flasks activator will not be diluted, to ensure the effective concentration of nutrients [5]. Thus, the activation rate flasks endogenous bacteria is significantly greater than the speed of activation of cores. 2) different oxygen content. Flask non-sealed system, with the shake flask through the air into the bottle and seal can be dissolved to shake the Activator to ensure that the activators have a certain amount of dissolved oxygen, so that aerobic and facultative anaerobes can quickly activate a large number; and the core is a closed system, there is only that part of the oxygen injected activators, one begins to dissolve, with the activation of endogenous microorganisms oxygen, the oxygen content decreased, limiting the aerobic and facultative anaerobes activation. Therefore, limiting oxygen also led to activation of endogenous microbes speed cores is significantly less than the speed of activation shake flasks. 3) the relationship between different microorganisms in contact with crude oil. Shake flasks endogenous microbes and crude oil only at the contact surface of the contact, limited contact area, with crude oil as part of the role of the carbon source is limited; and core large surface area, wide distribution of crude oil, and crude oil activator large contact area, Endogenous microorganisms may come in contact with crude oil as a carbon source, to ensure an adequate supply of nutrients. So either shake flasks or bacteria activated after cores endogenous microbial concentration less.

EOR EVALUATION

Core <#3>: injection 1PV optimization system is activated a culture 10d, water drive to the continuous aqueous 98% or more;

Core <#4>: injection 1PV water, 10d after subsequent water flooding to the continuous aqueous 98% or more (see Table 2).

NOTE: Each stage of flooding pressure - before the first end to the previous stage injection pressure Ps, record the pressure P, water production, oil production in the flooding process and calculate recovery (Re), moisture content.

Table 2: basic parameters of the model

Core number	L*ϕ, cm	$K_g, \mu m^2$	$K_w, \mu m^2$	Swc, %	ϕ, %
3#	20*2.5	0.517	0.422	10.67	40.48
4#	20*2.5	0.556	0.439	12.84	38.37

As can be seen from Figure 3, the water flood to limit water (98%), based on the injection system for optimal activation of endogenous microbial enhanced oil recovery can be further increased 9.13%, indicating that endogenous microorganisms are activated, the metabolism conducive to flooding substances played a role in increasing oil production [6].

As it can be seen from Figure 4, the injection system for optimal activation of endogenous microbial flooding better able to reduce the water. IPV subsequent injection system optimized culture 10d after activation; activated when injected into the optimization system 0.4PV, water began to fall from 98.05% down to 92.83%, indicating that the optimization system itself will activate a certain role flooding water flooding [7], water content significantly decreased from 98.04% down to 84.82%, indicating that endogenous microorganisms are activated, reduce the water played a role.

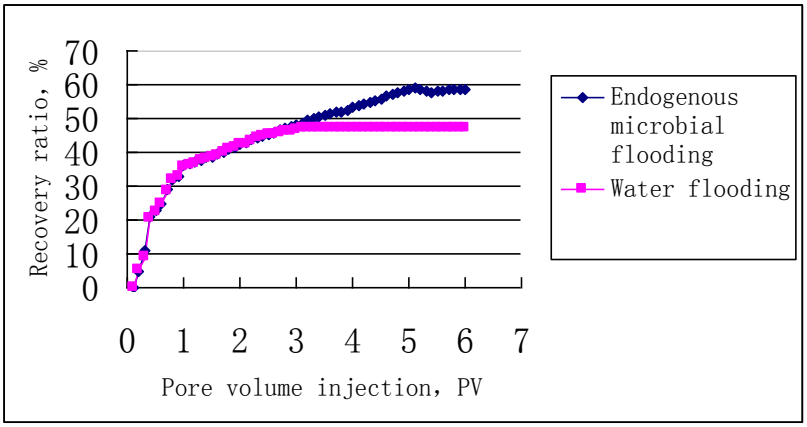

Fig-3: Recovery-injected pore volume curve

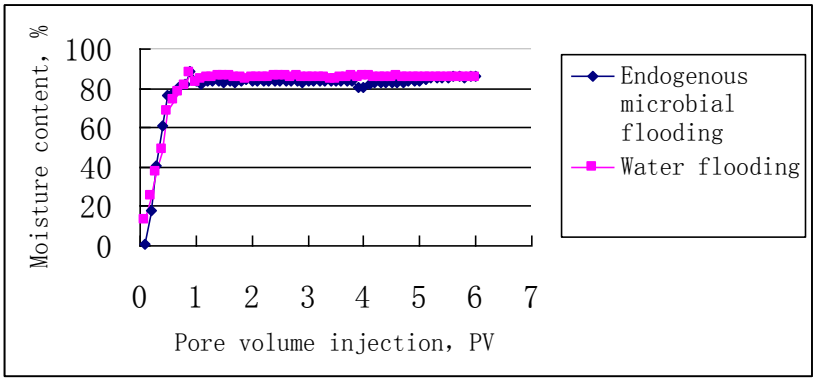

Fig-4: Moisture content-injected pore volume curve

As can be seen from Figure 5, the injection system to optimize the activation process pressure rises, the water rises to the driving end of 0.04MPa 0.046MPa, which is slightly greater than the viscosity due to activation caused by the viscosity of the injected water. Subsequent water flooding during the first increased pressure decrease [8], which is due to the growth and metabolism of endogenous microorganisms prompted oil, water redistribution start waterflood residual oil into the flow passage, and produce biogas, insoluble metabolites selective plugging of formations, resulting in increased displacement pressure; with residual oil recovery, and gradually formed a smooth flow path of water injection pressure decreases, the pressure for a reduction significantly greater than the reduction in the pressure of water flooding [9]. From this, optimized injection system activation of endogenous formation has certain microbial plugging effect.

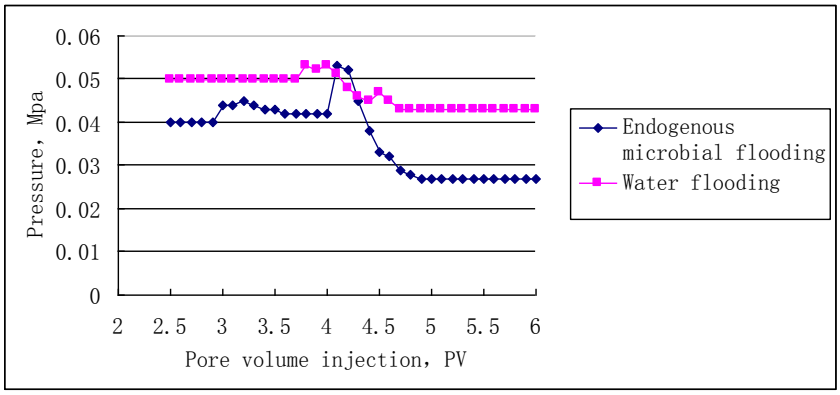

Fig-5: Pressure-injected pore volume

CONCLUSION

1. Adoption of the endogenous microbe oil displacement effect of experimental analysis, optimization activation system in the core of delay activation of endogenous microbes 6d, logarithmic phase length 5d, about the culture around 10d into the stable growth of microorganisms.

2. The same concentration of the best activation system in a different medium, the effect of activating internal source of microorganisms there are obvious differences.

3. In the water flood to limit water (98%), based on the injection system for optimal activation of endogenous microbial enhanced oil recovery can be further increased 9.13%, indicating that endogenous microorganisms are activated, the metabolism in favor of flooding substance, played a role in increasing oil production..

4. The injection system activation optimization process pressure rises, the water flooding at the end of 0.04MPa raised to 0.046MPa, which is slightly greater than the viscosity due to activation caused by the viscosity of the injected water.

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