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Optimizing Recovery through EOR Surfactants on Matured Fields

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Abstract: In this paper, Process and mechanism of chemical EOR mainly related to surfactants for effective recovery were stated. This work has been taken considering a sample from a field of Lower Cretaceous having specific gravity of 22.3 API. Concentration was kept on IFT reduction, which plays a major role for additional oil recovery after water flooding. Aqueous Surfactants have been prepared based on properties of crude oil, brine and reservoir. Oil recovery have been observed on adsorption basis.

I. INTRODUCTION

Most of the Indian fields are matured and the production has crossed its peak level during water flooding and right now it is at declined state [1]. Research and development programs on EOR related to Indian matured fields are required. Mostly all matured fields in India are owned by ONGC. Due to complex nature of fields, ONGC is attracting for more joint ventures but results were few.

One of the most demanding and promising methods in EOR is the application of chemicals to extract additional oil, keeping the environmental concerns and health of the reservoirs[2]. Though laboratory results promise high, while applying in the field, the results are not satisfactory at present. The selection of chemicals best suited in different types of reservoirs understanding each reservoir characteristics like adsorption, wettability and other factors are important factors [3].

The potential ability of chemical EOR, to produce additional oil is effective, as well as expensive. In last five years, the importance of chemical flooding in EOR process is proliferating because of its ability to produce more oil than any other EOR method[4] .

The IFT decreases sharply as surfactant concentration increases until the (CMC) Critical micelle concentration is reached. Beyond the CMC, little change in IFT occurs [5].

II. METHODS AND MECHANISMS

A. Adsorption

Interfacial Tension is the tension created at interface, where two immiscible fluids are in contact and plays a major role in oil recovery process. For sandstone reservoirs, surfactants can reduce IFT between hydrophobic and hydrophilic phases and for carbonate and tight reservoirs it alters the wettability [6].

Adsorption of surfactants onto the surface is a major problem in EOR process. The surfactants can reduce IFT unless they were in contact with Oil. In Oil wet reservoirs, residual oil will be left behind water flooding [7]. Nonionic surfactants can stimulate or opens the blockage of capillary pores. Which will indeed enhance the contact and permeability.

Critical micelle concentration (CMC) is a characteristic of surfactant, where Micelles start to form at a particular concentration fig(1) . This indicates complete separation of all phases and ultralow IFT have been achieved. IFT will have an effect on surfactant concentration fig(2) [8] .

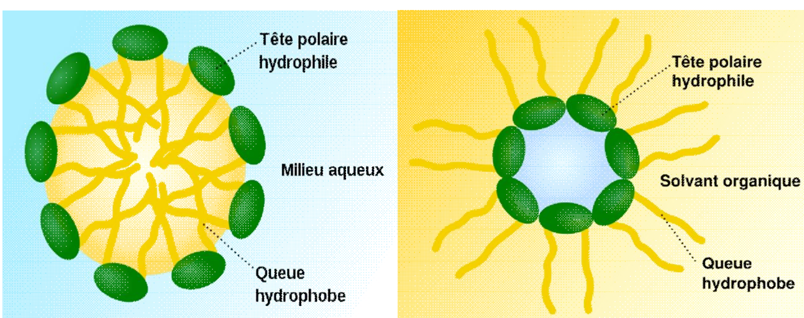

Fig.1 micelle alignment in polar and organic phases

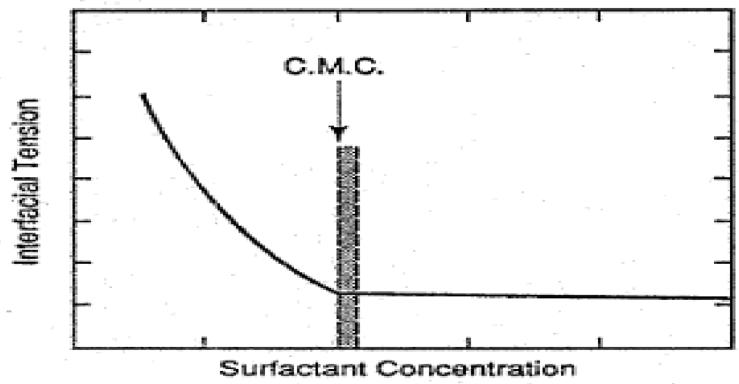

Fig.2 IFT vs Surfactant concentration

III. RESULTS

The IFT between aqueous surfactant solution and a hydrocarbon phase is a function of salinity, temperature, surfactant concentration and cosurfactant. Considering all parameters, a Micro emulsion system which posses ultralow IFT (about 10^{-3} dynes/cm) with aqueous and hydrocarbon phase was prepared by changing the concentration of Brine and alkali.

conductivity mS/cm	surf.conc ppm
10	100
15	200
20	300
25	400
30	500
33	600
35	700
36	800
37	900

Table 1 SDS Conductivity

A. Preparation of SDS Stock Solution

SDS surfactant from vendor is 36% active. 1gm in 100 ml distill water, which gives 36wt% of SDS. 1 wt% SDS that is 2.7ml was dissolved in 100ml of Distill water, which gives 10,000ppm. Then, 1ml will give 100ppm.

25 ml of an approximately 0.04 M aqueous stock solution of SDS was prepared for conductivity measurement. The process has been conducted on the basis of finding a specific concentration for ultralow IFT as shown in Fig.3. A test tube of 25 ml distill water with 1.0 ml or 100ppm of the SDS stock solution was kept into the conductance cell. The conductivities have been observed by adding 1.0 ml upto 900ppm shown in Table 1.

B. Preparation of EO Solution

For EO, Optimum Concentration for core flooding has been determined by emulsion tests. Five Emulsions varying concentrations of surfactants with constant brine and Oil were prepared. Clear Middle layer at 1000ppm have been observed as shown in Table 2. 1000ppm of EO was chosen for core analysis.

C. Core Analysis

Core flooding operation has been conducted on 3 categories. In first, adsorption of SDS has been observed and in second how much EO has reduced the SDS adsorption. Third, recovery of oil by injecting both types of surfactants simultaneously.

Initially Berea Core (3×3 cm^2 Area) was dried in a vacuum oven at 90^0C for 24 hours. It has porosity of 0.23, permeability of 55md. They were then saturated under vacuum with degassed brine, oil flooded upto connate water saturation, and then water flooded to residual oil saturation usually in the range of 30 to 35% of Pore Volume (PV). Pore volume (PV) is determined by injecting water continuously into the core in a vacuum condition. How much water it has been adsorbed will be considered as pore volume. Injection rate was kept constant throughout the experiment (q=5ml/h), the core was saturated with injection water TDS (60g/).

EO		
ppm	Brine Wt %.	Appearance
0	0.5	2 phases
500	0.5	2 phases
1000 ppm	0.5	3 phases clear
2000	0.5	3 phases cloudy
3000	0.5	2 phases

Table.2 Emulsion Test for Microemulsion

5 PV of SDS(750ppm aqueous) have been injected into core followed by water (60g/L). Surfactants have observed at outlet after injecting 3.2 PV. The adsorption of SDS onto the core has been calculated as 2.2. Core was saturated by water and followed by EO of 5 PV have been injected. With water (60g/l) injection surfactants were recovered. Then SDS was injected with 5 PV. Break through has observed to be 2.0 PV. Adsorption of SDS has observed to be 1.0 PV.
Finally, core was saturated by oil followed by water injection. After water injection, EO and SDS were injected simultaneously. Oil has been recovered as 38% with 1.5PV of SDS adsorption.

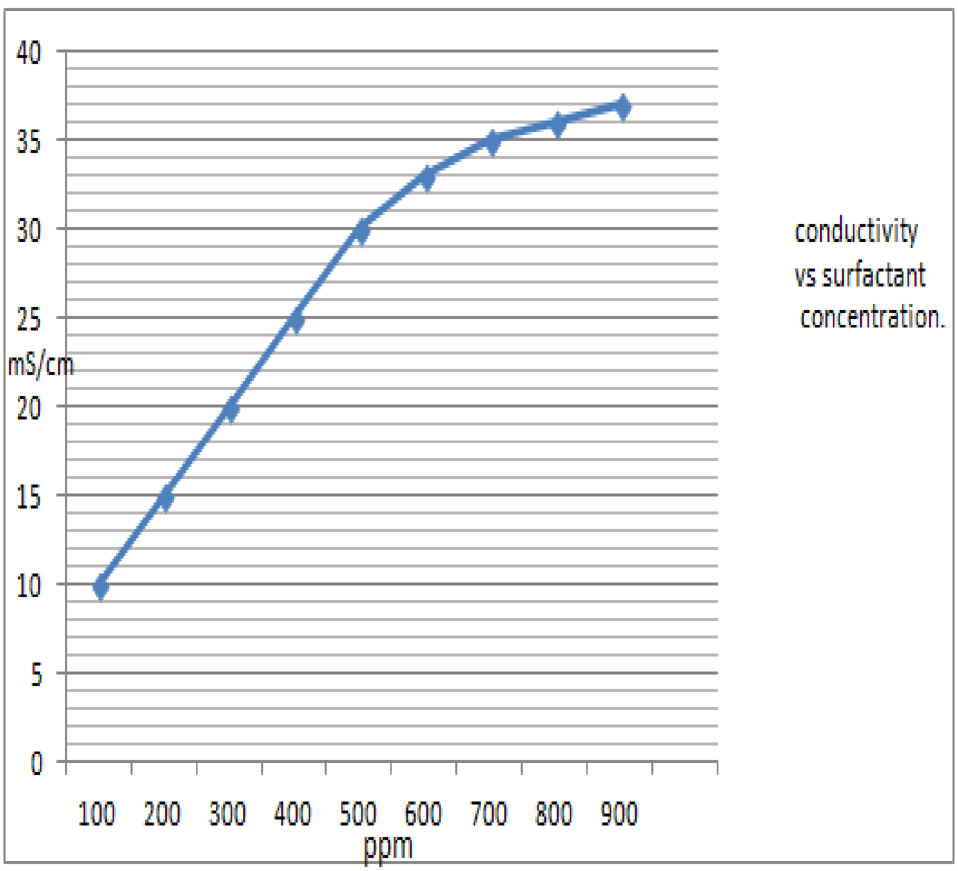

Fig.3 Conductivity for CMC

As per the Fig.3 specific concentration for ultralow IFT were found to be at 750ppm. Nine emulsions have been prepared in 25ml tubes, where Oil is 12.5ml, remaining based on the concentrations of brine and alkali shown in Table 3.

SDS ppm in 12.5ml	NaCl wt%	Na_2CO_3 wt%	Appearance in layers
750	0.0	0.0	1
750	0.5	0.0	2
750	1.0	0.0	2
750	0.0	0.5	2
750	0.0	1.0	2
750	0.5	0.5	2
750	1.0	0.5	3 microemulsion
750	0.5	1.0	2
750	0.5	1.0	2

Table 3 SDS Emulsions with brine and alkali

IV. CONCLUSIONS

Chemical processes have been shown to be effective in recovering unswept oil by improving the mobility ratio (polymer flooding), or by reducing residual oil saturation (micellar or surfactant polymer flooding (SP), alkaline/surfactant/polymer (ASP). R&D on surfactants to develop and to optimize recovery in low quality reservoirs must be developed.

The production rates of the 100 largest oilfields in the world are all declining from plateau production. Behind water the challenge is to develop Chemical EOR methods that ensure an economical tail end production from these fields.

Nonionic Surfactants have been found in numerous applications in oil fields. Their properties to alter surface characteristics, stability at high salinity and temperatures made them more attractive for research. They exhibit good viscoelastic property which has great scope in chemical EOR. They enhance permeability and blocks to improve contact with fluids. Research has to be conducted on limestone and dolomite reservoirs.

Oil recovery can be optimized by Reducing IFT. Ultralow IFT can be achieved by selecting proper surfactant concentration. Surfactants have been shown to be effective in recovering unswept oil by reducing residual oil saturation. The application of EO and SDS as IOR process will enhance oil recovery with low adsorption.

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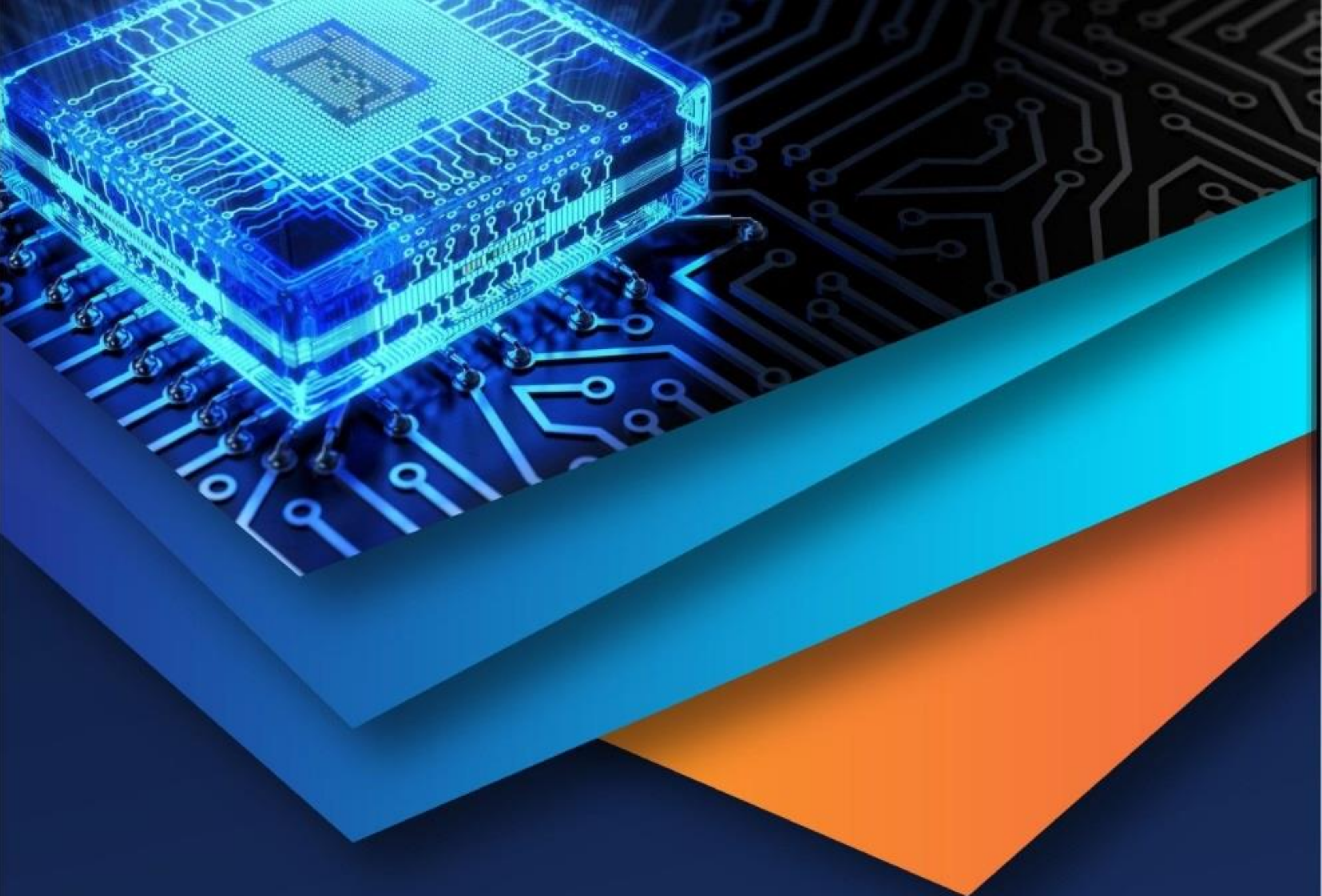

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