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Investigation of Enhanced Oil Recovery (EOR) Surfactants on Clay Mixed Sandstone Reservoirs for Adsorption

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Abstract

Adsorption of surfactants on sandstones leads to reduce in recovery efficiency of oil. This is caused mainly because of clay presence. Most of the water flooding projects has been stopped, when clay is present. Even surfactants are adsorbed due to clay. The aim of this research work is to reduce the adsorption of surfactants for different pH clay mixed sandstones. Three clay sandstones as crushed samples with different pH levels have been tested to observe the adsorption of Anionic surfactants Sodium Dodecyl Sulphonate (SDS) through bottle test. There was no significant adsorption found on pH 3 and above. Adsorption of SDS on pH 2 clay sandstone has reduced due to increase in alkalinity by application of Sodium Carbonate (Na_2CO_3).

Keywords: Adsorption, Clay Sandstone, Surfactants, SDS, Wettability

1. Introduction

In these days, chemical EOR challenges are developing and attracting researcher's interest. The major oil reserves were carbonates and sandstone reservoirs. Sandstones are the second dominant reservoirs next to carbonates worldwide[1]. Major concentration of chemical EOR research projects were conducted on sandstone reservoirs. The recovery of flooding method is related to residual oil saturation and mobility ratio.

Wettability is a property of adherence capacity, towards a matter. In sandstone reservoirs being naturally water wet, long term presence of oil can alter to oil or mixed wet. Recovering oil from oil wet reservoirs is not so easy. The most successful chemical to alter the properties of sandstone like wettability is anionic surfactants.

Sandstone is a reservoir where more concentration of minerals compared to carbonate plays an important role for wettability alteration. Silica is the main mineral in sandstone reservoir which posses negative charge at relevant pH as formation water. Clay minerals are the main sources for wettability alteration. Clay minerals are negatively charged and acts like cation exchangers. According to field examples BP has shown success by injecting low salinity water floods into clay contained sandstone reservoirs. Later low salinity flood has found to be successful in injecting into high salinity floods[2].

Clay is an important factor to be considered for loss of surfactant fluids inside reservoir[3]. Adsorption of surfactants will reduce the impact of wettability alteration. It is difficult to measure clay content completely inside reservoir.

The objective is to discover some EOR surfactants, which can alter wettability for clay mixed sandstone reservoirs.

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2. Methodology

2.1 pH of Clay in Sandstone

This is an important property to be considered for selecting the type of surfactant. Clay can posses negative charge to neutral to positive depending upon pH. OH group is ionised and attached to Al, Si, Fe edges of clay minerals. They posses three different charges like Clay-Al-OH_2+ very low in pH, Clay-Al-OH intermediate in ph and Clay-AL-O^- high in pH[4].

Most of the time the charge of kalonite will be negative but surface charge plays a major role in adsorption process. The selection of surfactants will depend on surface charge of the clay minerals[5]. Surfactant has to be chosen in such away the posses similar charge with surface of clay minerals[6].

2.2 Experiment by Bottle Test

Three sandstones of different pH clays have been taken. pH of each sandstone has measured in laboratory by crushing them into an aqueous dispersion l. Positive, neutral and negative charges at surface were chosen. Crushed aqueous clay sandstones have been taken in a bottle shown in Figure 1 Anionic surfactants SDS were prepared in five

Figure 1. Bottle test.

Table 1. Behavior of clay sandstones with different pH against SDS concentrations

SI.no	Concentration of SDS in ppm	Clay sandstone			
		pH 2 (+)	pH 3 (no charge)	pH 4 (-)	pH 2 0.5wt% Na_2CO_3
1	100	No flow at outlet	Separate phase	Separate phase	Separate phase
2	200	No flow at outlet	Separate phase	20.5ml	15ml
3	300	No flow at outlet	Separate phase	22ml	14.5ml
4	400	No flow at outlet	20ml	22ml	14ml
5	500	3ml	20.5ml	22ml	14ml

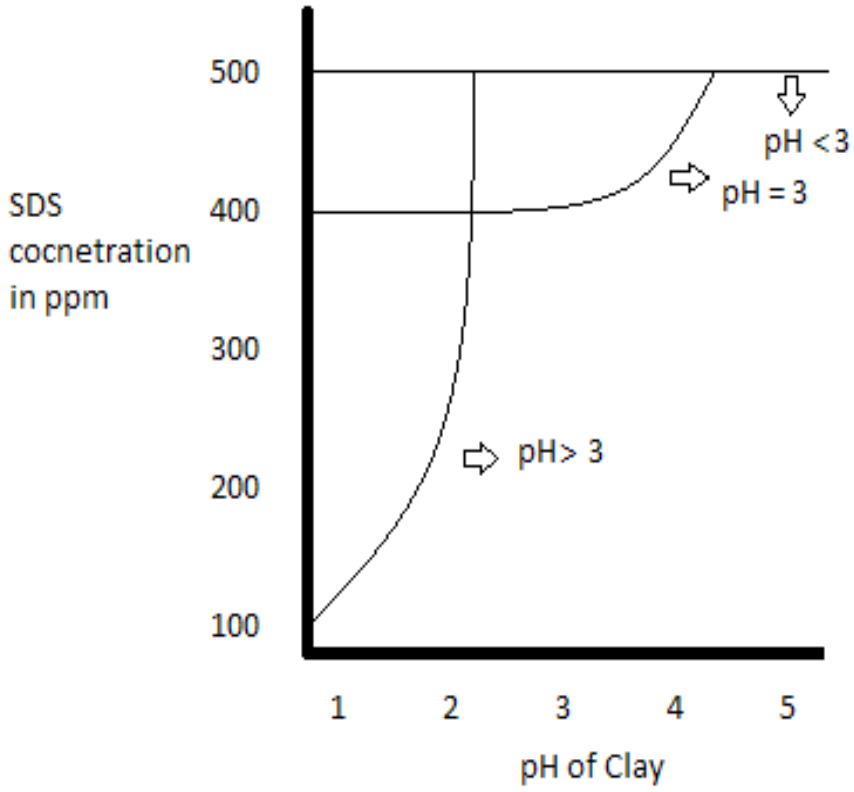

Figure 2. SDS concentration vs pH of clay.

concentrations with 0.5 wt % salinity. Each concentration was added and tested for flow inside the crushed medium.

- If the surfactants were absorbed then there will not be any outlet of fluids.
- If surfactants were not allowed we can see a separate phase above crushed medium.
- If surfactants were allowed to flow, we can see outlet after some time.

3. Results and Discussion

Five different concentrations of SDS were prepared and tested with different pH clay sandstones as shown in the Table 1.

SDS solution has been observed to flow inside the crushed medium from 200ppm onwards for pH 4 clay as shown in Figure 2. The flow has seen early because similarity in charges among surfactants and pH 4 clay that is negative. At neutral charge pH is 3 where the flow happened at 400 ppm of SDS solution. Up to that SDS has been in separate phase due to adsorption of some concentration into crushed medium results less outlet. pH 2 clay has shown completely no flow at outlet indicates total adsorption of SDS into clay by opposite charges. At 500ppm low outlet flow is because of gravity.

For clay sandstone of pH 2, 0.5wt% Na_2CO_3 in aqueous solution has been introduced before SDS flooding for making it alkaline. 200 ppm SDS is the best concentration to give outlet flow of 15ml. Outlet flow has increased due to increasing concentration of SDS with Na_2CO_3.

4. Conclusion

Adsorption of surfactants has been tested on three different types of clay sandstones having different pH levels. Clay sandstone pH<3 has shown high adsorption compared to pH=>3. This is because of opposite charge on clay surface against SDS. 0.5wt% of aqueous Na_2CO_3 was added to increase pH. Adsorption of SDS has been successfully reduced by increasing pH due to addition Na_2CO_3. Clay sandstone pH=>3 any anionic surfactants show no

adsorption. Adsorption of surfactants on Carbonate reservoirs can be reduced by altering pH.

In labs there are lots many core samples can be easily tested for results. But, in field there are other parameters to be considered. pH is not only the parameter to be considered for selecting type of surfactant to alter wettability. There are so many other impurities present in reservoir to be understood for selecting the type of surfactant either in carbonates or sandstones.

5. References

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