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A brief study on synthesis of surfactants and the mechanism of oil mobilization.

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Abstract: *Surfactants finds application in almost every industry of which the detergents, paints, dye-stuffs cosmetics, pharmaceuticals, pesticides, plastics, food, agriculture, asphalt, fuel etc are worth mentioning. Moreover surfactants play a vital role in the oil industry. An important and interesting aspect of the chemistry of surfactants which has not been systematically investigated hitherto, in the utilization of so prepared surfactants as emulsifiers with special reference to the study of interfacial tension, surface tension, viscosity, particle size and conductance and their use in the field of enhanced oil recovery .Oil\Water emulsions have been prepared by taking two immiscible liquids as internal and external phases using surface active agents. The present paper deals with the studies on the synthesis of surfactants. Three surfactants viz- RL-1, RL-2 and RL-3 have been synthesized by using cetyl palmate, acyl alcohol, vinyl acetate, cetyl behenate, cetyl stearate, benzene and benzoyl peroxide. From the analysis it is found that above prepared surfactants are ester copolymers*
Keywords:*. Surfactants; emulsifiers;interfacial tension;surface tension; viscosity.*

I. Introduction:

Surfactants finds application in almost every chemical industry of which the detergents, paints, dye-stuffs, cosmetics, pharmaceuticals, pesticides, fibers, plastics etc worth mentioning. Moreover surfactants play a vital role in the oil industry, for example enhanced oil recovery and tertiary oil recovery. A surfactants (surface active agent) in a substance that , when present in low concentration in a system has the property of absorbing into the surface or interfaces of the system and of altering to a marked degree the surface or interfacial free energies of those surface(or interfaces), the term interfaces refers to a boundary between any two immiscible phases.

Surface active agents in the most common form constituted of a hydrocarbon portion and polar or ionic portion. The hydrocarbon portion which can be linear or branched, interacts only very weakly with the water molecules in aqueous environment. Moreover the strong interactions between the water molecules arising from dispersion forces and hydrogen bonding act cooperatively to squeeze the hydrocarbon out of water , hence the chain is usually called hydrocarbolic. The polar or ionic portion of the molecules usually termed head group, however interact strongly with the water via dipole-dipole or ionic-dipole interactions and is solvated consequently, the head group is said to be hydrophilic.

General classification of surfactants:-

The classification usually used is that which puts surface active agents into various groups depending on the nature of the head group, i.e. anionic, cationic, non ionic and zwitter ionic.

(a) ANIONIC :- In this type of surfactants anionic group is a head group. E.g. Sodiumdodecyl sulphate($C_{12}H_{25}SO^{-}Na^{+}$)
(b) CATIONIC:- In this type of surfactant cationic group is a head group. e.g. Dodecyltrimethyl Ammonium Bromide($C_{12}H_{25}N^{+}MeBr$)
(c) NONIONIC :- Many of those based on polyoxy ethylene and a typical example is $C_{12}H_{25}(OCH_2CH_2)_6OH$ Dodecyl hexaoxyethylene glycol monoether. In these compounds the head group is larger than the hydrocarbon chain.
(d) ZWITTER IONIC :- In this type of compounds within head group, there are a number of important naturally occurring materials such as triglycrides lecithin etc. e.g. $R^{+}NH_2CH_2COO^{-}$(long chain amino acid)

II. Material & Methodology :

Surfactants In Enhanced Oil Recovery:-

Interfacial effects play an important part in any consideration of oil recovery because the oil and connate water are retained in a porous rock matrix of enormous solid\liquid and liquid\liquid interfacial areas(1). Oil can be recovered initially by primary production using the natural energy of the reservoir pressure and assist in oil displacement. Generally about 40% of the oil can be recovered economically up to the stage some 20-30%

of the residual oil will be trapped in pore space of the reservoir and is this oil, we seek to recover. Recovery of this oil can be improved by use of polymer surfactants, polymer blocking agents or foam flood.

Screening Tests For Surfactant Floods:-

A number of laboratory tests are generally carried out to assess the suitability of any surfactant system.

(a) Low interfacial tension measurement of specific oils with reservoir fluids
(b) Compatibility of the surfactant system with the reservoir fluid. This is particularly important, if the reservoir fluid is highly saline.
(c) Stability tests of the surfactants in the reservoir fluid at reservoir temperature.'
(d) Core/sand pack tests are carried out to determine oil recovery from residual oil saturation, which is oil remaining in place after water flooding.
(e) Phase- behaviour, the presence of liquid crystalline phase needs to be established because these could lead to undesirable pore blocking effects.

III. Result :

Mechanism Of Oil Mobilization:-

Low Surface Tension Flood:-

This relies on reducing the oil\water interfacial tension to very low levels ($10^{-3}mNm^{-1}$) so that oil ganglia trapped in a water wet pore by interfacial tension forces can be mobilized. The capillary pressure resistance to flow is proportional to the oil\water interfacial tension divided by the diameter of the constriction. Pore throat diameters, through which the oil ganglias must pass, are in the region of 10μ.

The ultra flow interfacial tension minimizes the work necessary to deform the interface of the oil ganglias as it moves through the neck of pores, with the use of suitable surfactant systems, a large number of oil ganglia can be mobilized. Fig 1-4 shows the propagation of oil ganglion/oil bank and its subsequent coalescence with additional oil ganglia. If ultra flow interfacial tension is not maintained at surfactant slug/oil bank interface, considerable oil would be lost due to entrapment process[2]. As shown in fig 5 that contact angle of oil drop or oil ganglia on rock surface depends on wettability of the rock. Hence the oil displacement by surfactant slug is influenced by the wettability of the rock surface.

Figure-6 shows the clear mechanism of ganglia movement. High surface charge density of oil ganglia leads to low interfacial tension. Low interfacial viscosity and strong electrical repulsion between oil droplets resulting easy passage of oil ganglia through narrow rock pores. While low surface charge density lead to high interfacial tension high interfacial viscosity and minimum electrical repulsion between oil droplets and sand particles resulting blocking of oil ganglia in the narrow neck of pores[3,4]

Mobilization could be achieved if the capillary number, the ratio of surface tension to viscous forces, could be reduced by a factor of 10^4 viscous forces can not be increased greatly because of the limited pressure resistance of the reservoir. Reduction of the interfacial tension to about $10^{-3}mNm^{-1}$ could produce the desired effect.

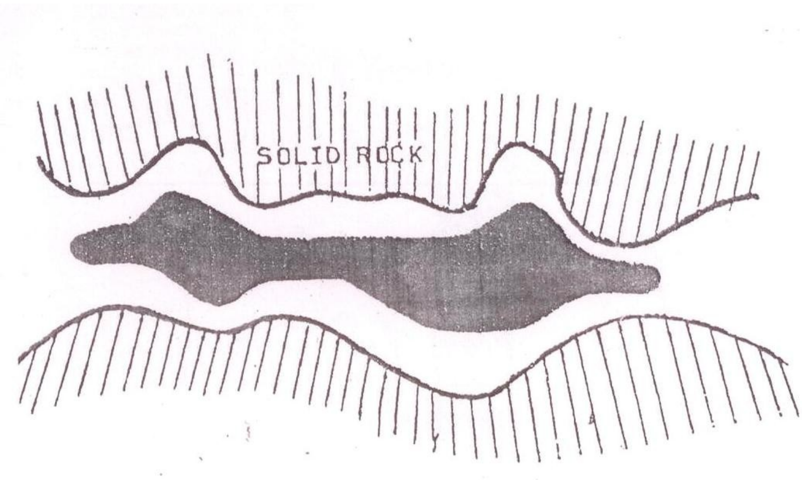

Figure-1 The effect of interfacial tension on the movement of oil ganglia through narrow neck of Rock Pores.

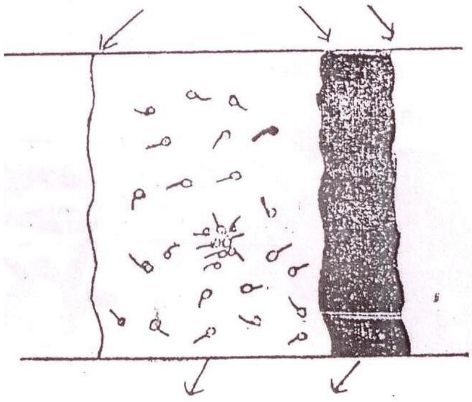

Figure-2 Displaced oil ganglia must coalesce to form a continuous oil bank

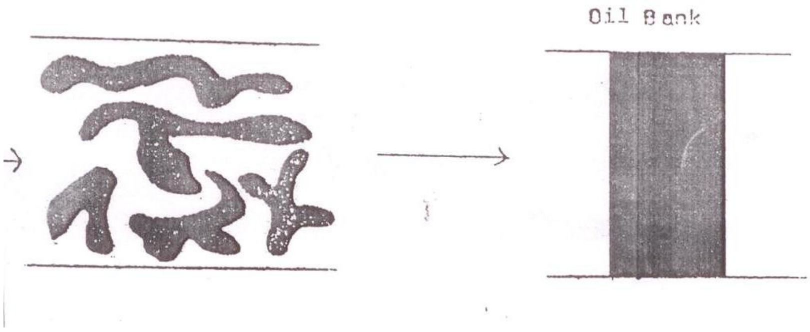

Figure-3 An efficient propagation of an oil bank through Porous media

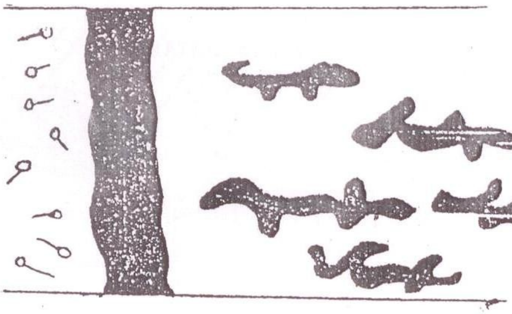

Figure-4 The flow of oil bank : surfactant slug and the polymer solution

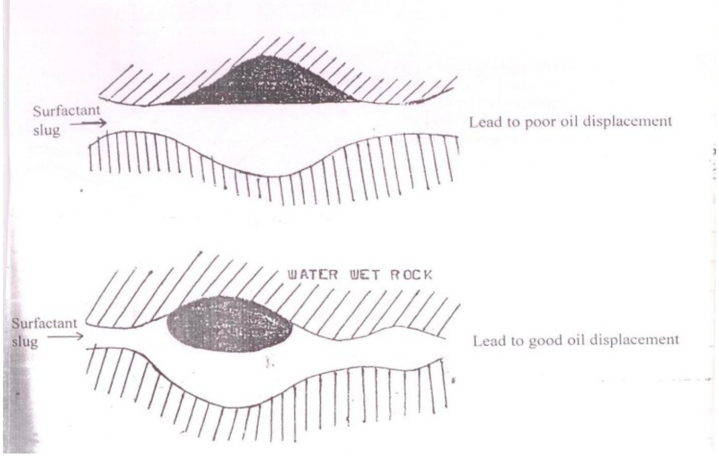

Figure-5 The effect of wittebility of rock surface on the contact angle of an oil drop in porous media

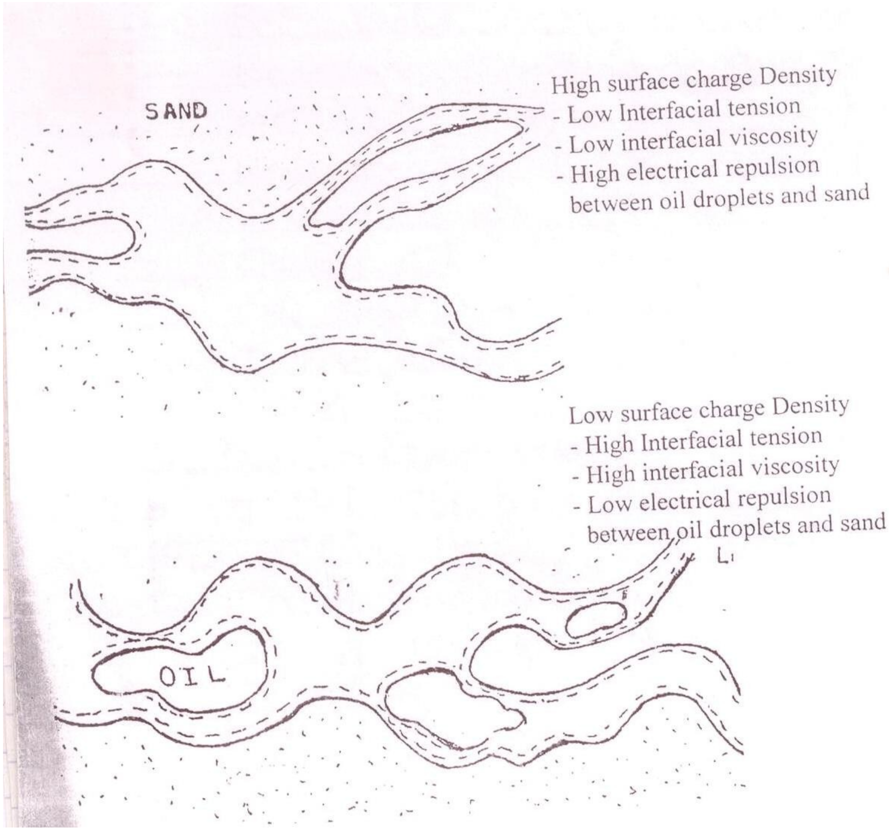

Figure-6 The effect of surface charge density of oil\brine interface on the oil displacement process

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