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The Effect of Polarity of C_2 and C_3 Alcohols on the Extraction of Organic Insolubles of Crude Oil Residues

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Abstract: ***The precipitation of insoluble organic solids from a single phase bottom hole representation crude oil residue, Qua Iboe Light Mobile Nigeria, unlimited was studied. One C_2 and two C_3 organic polar solvents (ethanol, n-propanol and iso-propanol) were used to investigate the effect of polarity of the precipitating solvents. The insoluble organic solids precipitated from ethanol, n-propanol and iso-propanol were 73 %, 53.40 % and 24 % respectively. Based on the results obtained from % composition by weights of insoluble organic solids recovered, ethanol was observed to comparatively have higher insoluble organic solids precipitates (0.7300 g, 73 %) than its counterparts which are less polar solvents (0.5340 g, 53.40 % and 0.2400 g, 24 %). This is attributed to the fact that ethanol is more polar than its counterparts. Probably, this indicates that more polar solvents are better precipitating solvents of insoluble organic solids.***

Keywords: Organic solids, polarity, precipitation, composition

1. Introduction

Crude oil is petroleum that has not been refined. Petroleum mixture comprises of four main classes of compounds-Asphaltenes, Resins, Aromatic hydrocarbons (ARAS) and saturated hydrocarbons (SARA). Asphaltenes are the largest molecules found in crude oil with many aromatic rings usually connected or bonded to a linear or cyclic saturated hydrocarbon structures and polar functional groups [Nasir et al., 2015). . Asphaltenes have been characterized and defined as complex organic matter, containing carbon, oxygen, nitrogen, and sulfur (Gad, 2014; Ramirez-Corredores, 2017; Fernando *et al*., 2009). The black color of some crude oils and residuals is related to the presence of asphaltenes, which have not flocculated or precipitated (Saeid and Khosravi, 2019) Over the past decades, a number of investigators have researched the nature of organic insolubles and mechanisms of deposition. Because of the complexity of the nature of crude oil solids, a phenomenon of insolubles precipitation is not well understood. In addition, in view of the complexcity of the petroleum fluid, study and understanding of the insitu precipitation of insolubles seems to be challenging and timely. Such an understanding will help to design a more profitable route for petroleum production and transportation of products. The difficulty of dealing with insoluble deposits is proven to be proportional to the amount and nature of insolubles present in such systems. The insolubles give rise to variety of nuisances during crude oil production. Asphaltene, paraffin, scale, and other forms of deposition are known to cause significant problems in the production tubing on major oil fields around the world [Laurence, 2016]. The most serious precipitation problem is the creation of formation damage i. e partial or complete blockage of the inflow zone around the well, hence, loss of productivity.

Asphaltenes will precipitate when a quantity of an alkane solvent is added to the crude oil. Aromacity, polarity, solubility, surface tension, chain length, density of the solvents have been discovered to be responsible for the solubility of various compounds in crude oil (Sadeghbeigi, 2012; Stout and Wang, 2016; Buckley *et al*., 1998). The injection of hydrocarbon gases or carbon dioxide (CO_2) for Improved Oil Recovery (IOR) promotes asphaltene precipitation. Numerous field reports and laboratory studies on this phenomenon have been published (Kokal and Sayegh, 1995; Burke *et al*., 1990; Hirschberg *et al.*, 1984; Monger and Trujillo, 1991; Novosad and Costain, 1990;; Srivastava *et al.*, 1995; Thomas *et al.*, 1992; Srivastava *et al*., 1999; Turta *et al.*, 1997). This research is aimed at using ethanol, 1-propanol and 2-propanol for the precipitation of insoluble organic solids in crude oil sample, and to determine the percentage composition of the precipitates. Researchers like (Moghanloo *et al*., 2018; Branthaver and Huang, 2015) have used this technique in the past for the analysis of asphaltenes in crude oils and solvent extracts.

2. Materials and Methods

2.1 Materials

A single phase bottom hole representation crude oil was collected from Qua Iboe Light Mobile Nigeria, unlimited. All chemicals used in the experiments were in the analytical reagent grade and were purchased from Acros Organics and used without further purification.

2.2 Methods

30 ml of ethanol was accurately transferred into a 500 ml conical flask containing 1 g of the crude oil with regular whirling; the mixture was stirred for 2 hours and was allowed to equilibrate for 24 hours. It was centrifuged with a Generic 3500 RPM Centrifuge at 3500 ram per minute for 30 minutes and the insoluble organic solids recovered.

The ethanol-solubles (maltene) were filtered carefully and stored in a vial. The insoluble organic solids recovered were reprecipitated with another 10 ml of ethanol, stirred and filtered three times. The insolubles were dissolved with 150 ml of n-hexane. n-hexane was evaporated in an evaporating dish and the weight of the insoluble organic solids was recorded. The same precipitation procedure was used with 1 g of n-propanol and iso-propanol. The quantity of insoluble organic solids recovered was weighed and recorded as shown in Table 1.

3. Results

Amount (weights %) of insoluble organic solids recovered by precipitation: The amount of asphaltene (wt. %) recovered by precipitation with the three alcohols was calculated using the formula:

$$\text{Wt}\,\% = \frac{\text{weight of dry insoluble organic solids}}{\text{Weight of organic solid sample}}\ X\ 100\,\%$$

The Weight% of dried insoluble organic solids recovered after precipitation with ethanol, n-propanol and iso-propanol were 73%, 53.4 % and 24 % respectively. Similarly, the weights of the dry insoluble organic solids in grams for these samples were found to be 0.7300, 0.5340 and 0.2400 respectively. Comparison of amount recovered by precipitation from ethanol, n-propanol and iso-propanol (i. e. weights of insoluble organic solids):

4. Discussion

As shown in Table 1, the amount of insoluble organic solids recovered by precipitation is in the order of ethanol is greater than n-ropanol and iso-propanol. The result shows a decrease in the amount of precipitates with decrease in polarity of the precipitating solvents. Organic solids are relatively insoluble in C_2 and C_3 alcohols. The weight of the insoluble for ethanol was 73% while those for n-propanol and iso-propanol weighed 53.4 % and 24 % respectfully. This indicates that the organic solid-solvent interactions are weaker than the solvent-solvent interactions. These interactions get stronger as polarity of the alcohols decreases. Solubility depends on the relative stability of the solid and solvated states for a given compound. The organic solids are insoluble in polar solvents because the interactions with the solvents are weaker than the Coulomb interactions of the solvent molecules.

5. Conclusion

Based on the weights% composition of insoluble organic solids recovered, ethanol was observed to precipitate more asphaltene than n-propanol and isopropanol. Probably, this indicates that more polar solvents are better precipitating solvents of insoluble organic solids which are non polar. The results of this research could be used to augment exactness in modelling insoluble organic solids physical properties in solution and their nature in refinery processes. On the flip side, this could be helpful in designing and planning ways to solve production, transport and refinery problems associated with insoluble organic solids.

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Table 1: Percentage weights of insolubles from C_2 and C_3 solvents

S/N	Solvent	Polarity	Density gmol-1 at 20^oC	Insoluble organic solids recovered (%)	Insoluble organic solids recovered (g)
1.	Ethanol	0.654 (Reichardt and Welton, 2011)	0.7894 (Schroeder et al., 1982)	73	0.7300
2.	n-propanol	0.617 (Reichardt and Welton, 2011)	0.803 (Murov, 2020)	53.4	0.5340
3.	Iso-propanol	0.546 (Reichardt and Welton, 2011)	0.785 (Murov, 2020)	24	0.2400