STUDY OF BLEND OF PLANT SEED OILS AS POUR POINT DEPRESSANT IN NIGERIAN WAXY CRUDE OIL

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ABSTRACT

Finding solution to the problem of paraffin wax deposition in crude oil production facilities is of the major concerns in the oil industry. Chemical treatment had been most convenient and economical method for tackling this problem. This paper considered the study of blend of plant seed oils as pour point depressant in Nigerian waxy crude oil. Two waxy crude oil samples obtained from Niger Delta region of Nigeria were characterized to determine their pour point, American Petroleum Institute gravity (APIg), wax content and viscosity using standard methods. The impacts of the blend of Jatropha seed oil and castor seed oil on the pour points of the crude oil samples were determined using a portable Pour Point Tester PPT 45150 by PSL Systemtechnik. The results obtained showed that blend of castor seed oil with 40% Jatropha seed oil gave the highest depression of about 10^{O}C on the pout points of the crude oil samples at concentration of 0.1%v/v of additive with crude oil. Also, using copper strip test, the blend of the seed oils was found not to have corrosive effect on crude oil facilities. The appropriate blend of castor and Jatropha seed oils can be used as a pour point depressant in crude oil facilities.

***Keywords**: Blend of plant seed oil, pour point depressant, waxy crude oil*

1.0 INTRODUCTION

The risk of wax deposition is one of the most important challenges in the production of crude oils and handling of fuels (Misra *et al*, 1995; Lorge *et al*,. 1997; Garcia, 2001; Bello *et al*,. 2005; Fadairo *et al.*, 2010; Oseghale *et al.*, 2012, Akinyemi *et al.*, 2016a). Summarily, problems associated with wax deposition may result in production shutdown and hazardous conditions and will require extensive workovers, production losses, and possibly irreparable damage requiring equipment abandonment and replacement (Koshel and Kapoor, 1999; Adewusi, 1997; Kok and Saracoglu, 2000).

To reduce the operating cost during production of waxy crude oil and for lowering the energy consumption and ensuring safety and cost effectiveness in pipeline transportation of waxy crude, an extensive study of the rheological characteristics of crude oil is indispensible (Mahto and Singh, 2013). One of the most important rheological properties impacting on the flow behaviour of wax bearing crude oils is Pour point. Many of the problems associated with wax deposition in crude oil facilities can be effectively resolved by the appropriate application of pour point depressing chemicals (Akinyemi *et al.*, 2016b). Crude oil pour point depression is significant in eliminating paraffin wax deposition (Adewusi, 1997) and is crucial for assessment of flow behavior and storage of crude samples. This study is therefore designed to investigate the use of blend natural non-edible plant seed oils as pour point depressants for Nigeria waxy crude oil and compare their effectiveness with the impacts of the previously tested triethanolamine-xylene blend on the crude oil. The plant seeds oil considered in this study are from: *Jatropha* plant (*Jatropha curcas*), castor plant (*Ricinus communis*) and rubber plant (*Hevea brasiliensis*).

2.0 MATERIALS AND METHODS

The seed oils were extracted from seeds obtained from farm locations within the western region of Nigeria. The xylene and triethanolamine used were analytical grade products of BDH Chemical Ltd, Poole England. Two crude oil samples A and B, obtained through the Department of Petroleum Resources (DPR) from oil fields in Niger Delta region of Nigeria were used in the study. Solvent extraction was used to extract the oil from the seeds using a Soxhlet extractor with *n*-hexane (800 ml) as the solvent as described by Akinyemi *et al* (2016a) and fatty acid composition analysed using gas chromatography. Each crude oil sample was reconditioned by heating it to a temperature of about

60ºC for nearly 10hr, with hand-rocking occasionally during heating in the laboratory prior to experiments to erase any previous history that might exist in such sample. Reconditioning the samples ensured that all pre-crystallized wax got re-dissolved into the oil, thereby erasing any thermal and shear history and producing homogenous sample for testing. The specific gravity (S.G.) and API (American Petroleum Institute) gravity of the crude oil samples were determined using the ASTM D287 standard while the wax content was determined using precipitation method reported by Mahto and Singh (2013). Their pour points were determined by using the portable Pour Point Tester PPT 45150 by PSL SystemTechnik, which is a compact lab-instrument for measuring the pour point of oils and oil products. PPT 45150 which has the accuracy of ± 0.1ºC at high repeatability, measures according to the rotational method ASTM D5985 like the Herzog Pour Point Apparatus MC 850.

For each run of the experiment the pour points of samples were obtained by heating each sample to 35ºC and then poured into the hollow tubing connected to the internal cooling device. The pour points were identified based on the flow-temperature characteristics of the fluid. A sensing head for crude oil and inhibited crude oil determined the pour point temperature. The procedure was carried out on the pure crude oil samples as the reference point. To produce a binary blend of seed oil as chemical additive, the seed oil were blended in ratio 1:4, 1:3, 2:3, 1:1, 3:2 and 4:1 by volume in separate bottles. The blended mixtures were shaken together enough to ensure homogenous liquid was obtained for each binary mixture. Each chemical additive was added to crude oil sample at the concentrations of 0.1%v/v for subsequent tests of the additives on the pour points of the crude oil samples. The seed oils tested were rubber seed oil (RSO), jatropha seed oil (JSO) and castor seed oil (CSO). Impact of triethanolamine (TEA) blended with 90% xylene (being the percentage observed by previous researchers to be most effective on Nigerian waxy crude oil – Taiwo *et al.*, 2009, 2012) on the samples pour points was also tested for comparative purpose. Corrosive tendency of the blended seed oil on crude oil facilities was investigated using ASTM130 method with copper strip test apparatus.

3.0 RESULTS

The specific gravity of the extracted seed oils were found to be 0.91, 0.93 and 0.96 for CSO, RSO and JSO respectively. The results obtained showed that the specific gravity of sample A is 0.8777 and that of sample B is 0.8497while their APIº are 29.7º for A and 35º for B. Sample A has the higher wax content of 30.71% and higher viscosity of 18.67mPa.s at 40ºC. The pour point of sample B which is 10ºC, is however higher than that of A (Table 1). Thus, high API gravity does not necessary depict low pour point for a particular crude oil sample. This is in agreement with the findings of previous researchers (Miadonye and Puttagunta, 1998; Adewusi 1997; Koshel and Kapoor, 1999; Bello *et. al.*, 2005; Akinyemi *et al.*, 2016a). Both crude oil samples have low sulphur content. The results obtained from the copper strip test carried out on the plant seed oils blends showed that the colour of the copper strip was not altered after been dipped in the additive for 3hours (recorded as 1a in the result rating).

Table 1. Characteristic Properties of Crude oil Samples

Samples	S.G	APIg	Viscosity at 40ºC (mPa.s)	Wax content (%)	Sulphur content (wt%)	Pour point (ºC)
A	0.8777	29.7	18.67	30.71	0.11	7
B	0.8497	35.0	2.86	8.44	0.08	10

It was observed from Figure 1 that blending of the seed oils tend to improve the pour point depression ability for all the seed oils on sample A. The blend of CSO with little proportion of JSO (20% of JSO), increased its ability as a pour point depressant for sample A. Also, blend of CSO with little proportion of RSO caused a slight increase in its pour point depression ability. It was further observed that the mixture containing 40% and 50% of JSO in JSO/CSO blend gave similar and the highest pour point depression of sample A from 7 to -3ºC (pour point depression of 10ºC). The resultant effect of the combination of the interaction of oleic acid and ricinoleic acid in the mixture with the higher paraffin molecules in the crude oil sample may have been contributed to this.

From the results shown in Figure 2 it was observed that blending of the seed oils tend to improve the pour point depression ability for all the seed oils on sample B. The blend of CSO with little proportion of JSO (20% of

JSO), increased its ability as a pour point depressant for sample B. Also, blend of CSO with little proportion of RSO caused a slight increase in its pour point depression ability. It was further observed that the mixture containing 25%, 40% and 50% of JSO in JSO/CSO gave similar and the highest depression of the sample B pour point from 10 to 2.5ºC. This may have been due to the resultant effect of the combination of the interaction of oleic acid and ricinoleic acid in the mixture with the higher paraffin molecules in the crude oil sample.

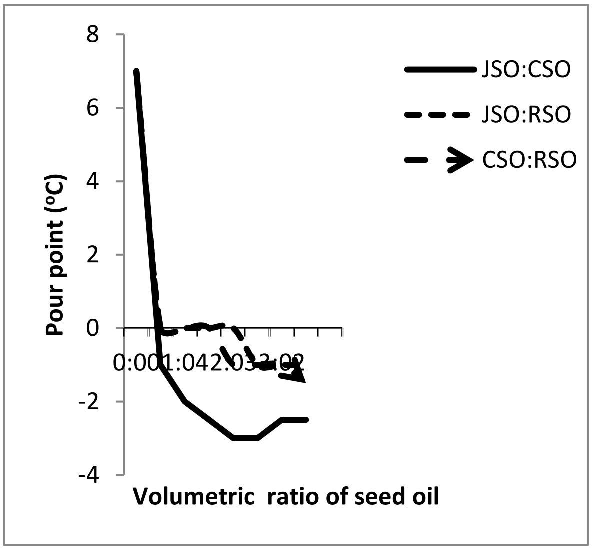

Figure 1. Effects of blends of seed oils on pour point of Sample A

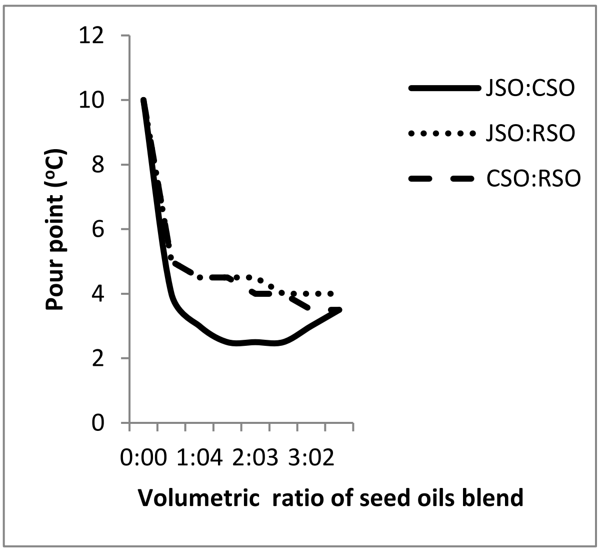

Figure 2 Effects of blends of seed oils on pour point of Sample B

The effects of addition of blend of xylene with TEA on pour points of samples A and B are shown in Figure 3.

The TEA-XY additive mixture contained 10% of TEA and 0.1% of the mixture was added to the crude oil samples tested. From the results obtained, addition of the blended xylene with TEA on both crude oil samples A and B depressed their pour points appreciably in agreement with the findings of the previous researchers (Taiwo *et al.*, 2009; 2012; Popoola *et al.*, 2015). However, comparing the performance of the TEA-XY with those of the plant seed oils blends, especially for sample A, all the plant seed oils blend performed better than the TEA-XY blend. CSO blended with 40% JSO performed better than TEA-XY as pour depressant in sample B while the TEA-XY performed better than CSO/RSO and JSO/RSO blends for the crude oil sample. The observed performance of the CSO/JSO blend was as a result of the synergy between the ricinoleic acid in CSO and oleic acid in the JSO in interacting with the higher paraffin molecules in the waxy crude oil.

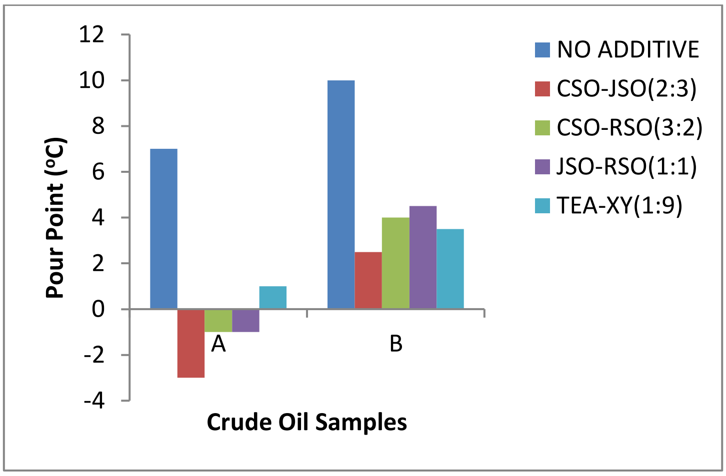

Figure 3. Comparison of effects of blend of seed oils and TEA-XY on pour points of crude oil samples

4.0 CONCLUSION

The impacts of blend plant seed oils and triethanolamine-xylene blend on the pour points of two waxy crude oil samples were investigated. The blended seed oils in binary formulations depressed the pour points of the crude oil samples appreciably better than the TEA-XY blend. 40% of JSO in CSO gave the optimum ratio of combination of plant seed oils blend with best performance on the waxy crude oil as our depressant. The JSO-CSO blend was able to depressed pour point of the waxy crude oil with about 10ºC. The blend of the seed oils will not give any corrosion problem the crude oil facilities based on the result obtained from the copper strip test. Thus, appropriate blend of CSO with JSO could be used as pour point depressant for waxy crude oil at low concentration of additives.

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