SUPPORTING INFORMATION FOR THE MANUSCRIPT

INVESTIGATION INTO THE FLOW ASSURANCE OF WAXY CRUDE OIL BY APPLICATION OF GRAPHENE-BASED NOVEL NANOCOMPOSITE POUR POINT DEPRESSANTS

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1. Characterization methods of crude oil

API gravity lies in the range 22.3-31.1° which implies that the crude oil is medium in nature. Results of the SARA analysis of the crude oil are as listed in the Table 2, reveals that saturates are in majority and aromatic and resin are in moderate quantity, while the crude oil contains very less asphaltene, indicating minimal chances of asphaltic deposition. Resin-asphaltene proportion is quite high, indicating that asphaltenes are well stabilized by resins in the crude oil and presents nominal chances of asphaltic deposition. The amount of saturates, aromatics, resins and asphaltenes (SARA) present in crude oil were determined based on the solubility of each component in particular organic solvents.

2. Characterization details of crude oil

Wax Appearance Temperature (WAT) of crude oil is determined by plotting the Arrhenius relation of viscosity with temperature as shown in Figure S1. At 323.12 K we can see a break from Arrhenius relation of viscosity and temperature indicating appearance of the WAT.



Figure S1. Determination of Wax appearance temperature of crude oil at constant shear rate 10 s⁻¹ using Non-Arrhenius Methodology in the temperature range (273 - 333 K)

3. UV visible spectroscopy

Graphite, GO, P(2-EHA) and P(2-EHA)-1% GO are initially mixed in Tetrahydrofuran (THF) and then sonicated for two minutes to get them properly dispersed before the measurements are performed with the UV-visible spectrophotometer. The UV-visible absorption spectra of the dispersed chemicals can be observed from Fig. S2 and the dispersion of samples in THF is exhibited in Fig. S3. Absorbance of the prepared solutions were measured over a wavelength range of 200-700 nm. Graphite exhibit a major absorption peak at 240 nm, which is attributed to the $\Pi \rightarrow \Pi^*$ transition of aromatic C=C bonds. Two major peaks are observed in absorption spectra of GO at 230 nm and 305 nm. The absorption peak at 230 nm is attributed to characteristic $\Pi \rightarrow \Pi^*$ transition of aromatic C=C bonds, while a small absorption peak at 305 nm corresponds to $n \rightarrow \Pi^*$ transition owing to the stretching mode of carbonyl groups in GO. In P(2-EHA), absorption peaks are recorded at 232 nm and 276 nm. In the nanocomposite P(2-EHA)-1% GO, the peak at 232 nm appearing due to $\Pi \rightarrow \Pi^*$ transition get redshifted to 234 nm. The absorption peaks at 233 nm and 276 nm in nanocomposite are attributed to the characteristics of P(2-EHA) in nanocomposite, while a new peak appearing at 314 nm in nanocomposite is a result of red shifting of the peak at 305 nm (present in GO), which is attributed to $n \rightarrow \Pi^*$ transition owing to the stretching mode of C=O bonds in GO. Thus, from the observations it can be concluded that UV visible spectroscopy helped to understand the formation of nanocomposite.



Figure S2. UV-visible spectroscopic plot of Graphite, GO, P(2-EHA) and P(2-EHA)-1% GO



Figure S3. Images of dissolution of Graphite, GO, P(2-EHA) and

P(2-EHA)-1% GO in THF solvent