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Heavy organics precipitation: Effect of different volume ratios of low molecular weight N-Alkane in ternary mixtures at a fixed total volume

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Abstract
Heavy organic precipitates were generated from crude oil residue using different volume ratios of ternary n-alkanes mixtures: C_5:C_6:C_7, C_5:C_6:C_8, C_5:C_7:C_8 and C_6:C_7:C_8. The ratios; 1:2:3, 1:3:2, 2:1:3, 2:3:1, 3:1:2 are 3:2:1 was considered. At a fixed total volume of 15mls/g oil, C_5:C_6:C_7 had maximum HOS yield at 3:2:1 ratio, (5.7% wt), and minimum at 1:2:3 ratio (4.1% wt). C_5:C_6:C_8 had maximum HOS yield at 2:3:1 ratio (4.9% wt) and minimum value is at the ratio 3:1:2 (2.9% wt). C_5:C_7:C_8 had maximum HOS yield at 2:3:1 ratio (4.2% wt) and minimum value is at the ratio 1:2:3 (3.1% wt). C_6:C_7:C_8 had maximum HOS yield at 2:3:1 ratio (3.4% wt) and minimum value is at the ratio 1:2:3 (2.5% wt). At 45mls/g, C_5:C_6:C_7 had the highest HOS value at the ratio 3:2:1 (2.1%wt) and minimum at 2:1:3 (1.4% wt). C_5:C_6:C_8 had the highest HOS value at the ratio 2:3:1 (1.2%wt) and minimum at 2:1:3 (0.8% wt). C_5:C_7:C_8 had maximum HOS yield at 3:2:1 ratio (1.2% wt) and minimum value is at the ratio 1:2:3 (0.6% wt). C_6:C_7:C_8 had maximum HOS yield at 3:1:2 ratio (1.1% wt) and minimum value is at the ratio 2:1:3 (0.8% wt). And at 75mls/g C_5:C_6:C_7 had the maximum HOS yield at 3:2:1 (1.2% wt) and minimum at 2:1:3 (1.0% wt). C_5:C_6:C_8 had the maximum HOS yield at 3:2:1 (1.3% wt) and minimum at 2:1:3 (0.6% wt). C_5:C_7:C_8 had maximum HOS yield at 2:3:1 ratio (0.7% wt) and minimum value is at the ratio 1:2:3 (0.5% wt). C_6:C_7:C_8 had maximum HOS yield at 2:3:1 ratio (0.7% wt) and minimum value is at the ratio 1:3:2 (0.6% wt). Analysis of variance shows that yields at varying volume ratios at different fixed total volume for same combination are significant since P-value here (0.0001) <5%. The results have shown that varying volume ratios affects HOS yield differently.

Keywords: Heavy Organic Solids (HOS), Ternary mixtures, Precipitates, Crude oil, N-alkanes

1. Introduction
Crude oil is a naturally occurring flammable liquid consisting of a complex mixture of hydrocarbons and heteroatomic organic compounds of various molecular weights. It is found in geologic formations beneath the earth's surface [1]. Maqbool (2011) stated that in the refinery operations the processing of asphaltenic oil results in storage capacity loss, equipment fouling and catalyst deactivation as a result precipitation and deposition [2].
Buenrostro-Gonzalez *et al.* (2004) in their work on 'Precipitation of asphaltene from Crude Oils: Experiments and Theory' stated that the effect of pressure and composition of the surrounding fluid on the precipitation of asphaltene is mainly taken to be more than that of temperature when it comes to asphaltene stability [3].
Work has been channeled recently towards heavy organic solids precipitation from petroleum with the use of single n-alkanes in the laboratory hoping that the data gotten would provide a better knowledge and comprehension of the heavy organic precipitation issue. However this has not yielded answers useful in the forecasting of the readiness of petroleum to precipitate heavy organics.
More also field samples were found to be richer in n-heptane components than the laboratory produced asphaltenes using single individual solvents [4, 5]. And no explanation was offered for this observation.
This ternary study is believed to yield results from which models could be drawn for predicting asphaltene precipitation. This will add to existing data that will help in solving the problem of precipitation in the field.

2. Materials and Methods

Nigerian crude oil sample (Bonny Light) was sourced at the Nigerian National Petroleum Corporation (NNPC) Port Harcourt, Nigeria, from the Research and Development Division. The crude sample was distilled to a constant volume at a steady temperature of 260 ^{0}C.

The heavy organics precipitation was done by methods same with those effected by Buenrostro-Gonzalez *et al.* (2004) and Kokal *et al.* (1992) [3, 6] and ASTM/IP (modified) procedures. Different volume ratios of; 1:2:3, 1:3:2, 2:1:3, 2:3:1, 3:1:2 and 3:2:1 of the individual n-alkanes for each of the ternary solvent (C_5:C_6:C_7, C_5:C_7:C_8, C_5:C_6:C_8, & C_6:C_7:C_8) mixtures respectively, at a fixed volume (15ml, 45ml & 75ml), were poured into about one gram of crude oil each in a conical flask of 50ml. The mixture was agitated half an hour with the mechanical shaker. After allowing the mixture stand for 48hours, filtration was done with the help of a vacuum pump through a membrane filter of 0.45µm. The conical flask and filter membrane were washed by adding little quantities of the corresponding ternary mixtures of n-alkane solvents to remove any leftover oil. The filter membrane which has the precipitate dried with the help of an oven and weighed finally to get the heavy organic solid precipitate weight.

The percentage weights of the heavy organic solids at each corresponding mixture were calculated thus:

$$\text{Wt \%} = \frac{\text{Wt (in mg) of HO precipitate X100}}{\text{Wt (in mg) of Residue 1}}$$

2.1 Heavy Organics Precipitated by Varying Volume Ratio of the Ternary Mixtures: C_5:C_6:C_7, C_5:C_7:C_8, C_5:C_6:C_8, & C_6:C_7:C_8.

(A) At 15mls/g Oil Total Volume

Table 1: Precipitated heavy organic solids by varying volume ratio of C_5:C_6:C_7 ternary mixture

Test (s/n)	Solvent ratio C_5:C_6:C_7	volumes ratio(m/s) C_5:C_6:C_7	Wt(g) of Crude oil residue	Wt(g) of HO ppt	Wt% of HO ppt
1	1 : 2 : 3	2.5 : 5 : 7.5	1.0013	0.0415	4.1446
2	1 : 3 : 2	2.5 : 5 : 7.5	1.0008	0.4550	4.5464
3	2 : 1 : 3	5 : 2.5 : 7.5	1.0189	0.0530	5.2017
4	2 : 3 : 1	5 : 2.5 : 7.5	1.0122	0.0522	5.1571
5	3 : 1 : 2	7.5 : 2.5 : 5	1.0028	0.0525	5.2353
6	3 : 2 : 1	7.5 : 2.5 : 5	1.0238	0.0584	5.7042

Table 2: Precipitated heavy organic solids by varying volume ratio of C_5:C_7:C_8 ternary mixture

Test (s/n)	Solvent ratio C_5:C_7:C_8	Volume ratio(mls) C_5:C_7:C_8	Wt(g) of Crude oil residue	Wt(g) of HO ppt	Wt% of HO ppt
1	1 : 2 : 3	2.5 : 5 : 7.5	1.0141	0.0314	3.0963
2	1 : 3 : 2	2.5 : 7.5 : 5	1.0009	0.0317	3.1671
3	2 : 1 : 3	5 : 2.5 : 7.5	1.0171	0.0354	3.4805
4	2 : 3 : 1	5 : 7.5 : 2.5	1.0292	0.0436	4.2363
5	3 : 1 : 2	7.5 : 2.5 : 5	1.0089	0.0346	3.4295
6	3 : 2 : 1	7.5 : 5 : 2.5	1.0064	0.0320	3.1797

Table 3: Precipitated heavy organic solids by varying volume ratio of C_5:C_6:C_8 ternary mixture

Test (s/n)	Solvent ratio C_5:C_6:C_8	Volume ratio(m/s) C_5:C_6:C_8	Wt(g) of Crude oil residue	Wt(g) of HO ppt	Wt% of HO ppt
1	1 : 2 : 3	2.5 : 5 : 7.5	1.0046	0.0319	3.1754
2	1 : 3 : 2	2.5 : 7.5 : 5	1.0202	0.0421	4.1266
3	2 : 1 : 3	5 : 2.5 : 7.5	1.0128	0.0417	4.1173
4	2 : 3 : 1	5 : 7.5 : 2.5	1.0082	0.0493	4.8899
5	3 : 1 : 2	7.5 : 2.5 : 5	1.0040	0.0295	2.9382
6	3 : 2 : 1	7.5 : 5 : 2.5	1.0114	0.0425	4.2021

Table 4: Precipitated heavy organic solid by varying volume ratio of C_6:C_7:C_8 ternary mixture

Test (s/n)	Solvent ratio C_6:C_7:C_8	Volume ratio(mls) C_6:C_7:C_8	Wt(g) of Crude oil residue	Wt(g) of HO ppt	Wt% of HO ppt
1	1 : 2 : 3	2.5 : 5 : 7.5	1.0205	0.0258	2.5282
2	1 : 3 : 2	2.5 : 7.5 : 5	1.0148	0.0310	3.0548
3	2 : 1 : 3	5 : 2.5 : 7.5	1.0297	0.0286	2.7775
4	2 : 3 : 1	5 : 7.5 : 2.5	1.0264	0.0350	3.4100
5	3 : 1 : 2	7.5 : 2.5 : 5	1.0145	0.0269	2.6516
6	3 : 2 : 1	7.5 : 5 : 2.5	1.0021	0.0310	3.0935

(B) At 45mls/g Oil Total Volume.

Table 5: Precipitated heavy organic solid by varying volume ratio of C_5:C_6:C_7 ternary mixture

Test (s/n)	Solvent ratio C_5:C_6:C_7	Volume ratio(n/s) C_5:C_6:C_7	Wt(g) of Crude oil residue	Wt(g) of HO ppt	Wt% of HO ppt
1	1 : 2 : 3	7.5 : 15 : 22.5	1.0384	0.0204	1.9646
2	1 : 3 : 2	7.5 : 22.5 : 15	1.0065	0.0147	1.4605
3	2 : 1 : 3	15 : 7.5 : 22.5	1.0352	0.0142	1.3717
4	2 : 3 : 1	15 : 22.5 : 7.5	1.0570	0.0151	1.4286
5	3 : 1 : 2	22.5 : 7.5 : 15	1.0587	0.0161	1.5207
6	3 : 2 : 1	22.5 : 15 : 7.5	1.0260	0.0211	2.0565

Table 6: Precipitated heavy organic solid by varied volume ratios of C_5:C_7:C_8 ternary mixtures

Test (s/n)	Solvent ratio C_5:C_7:C_8	Volume ratio(mls) C_5:C_7:C_8	Wt(g) of Crude oil residue	Wt(g) of HO ppt	Wt% of HO ppt
1	1 : 2 : 3	7.5 : 15 : 22.5	1.0188	0.0060	0.5889
2	1 : 3 : 2	7.5 : 22.5 : 15	1.0159	0.0092	0.9056
3	2 : 1 : 3	15 : 7.5 : 22.5	1.0368	0.0093	0.8970
4	2 : 3 : 1	15 : 22.5 : 7.5	1.0272	0.0016	1.0319
5	3 : 1 : 2	22.5 : 7.5 : 15	1.0265	0.0111	1.0813
6	3 : 2 : 1	22.5 : 15 : 7.5	1.0068	0.0122	1.2118

Table 7: Precipitated heavy organic solid by varied volume ratios of C_5:C_6:C_8ternary mixture

Test (s/n)	Solvent ratio C_5:C_6:C_8	Volume ratio(m/s) C_5:C_6:C_8	Wt(g) of Crude oil residue	Wt(g) of HO ppt	Wt% of HO ppt
1	1 : 2 : 3	7.5 : 15 : 22.5	1.0052	0.0091	0.9053
2	1 : 3 : 2	7.5 : 22.5 : 15	1.0154	0.0102	1.0045
3	2 : 1 : 3	15 : 7.5 : 22.5	1.0198	0.0084	0.8237
4	2 : 3 : 1	15 : 22.5 : 7.5	1.0053	0.0120	1.1937
5	3 : 1 : 2	22.5 : 7.5 : 15	1.0004	0.0090	0.8996
6	3 : 2 : 1	22.5 : 15 : 7.5	1.0255	0.0119	1.1604

Table 8: Precipitated heavy organic solid by varied volume ratios of C_6:C_7:C_8ternary mixture

Test (s/n)	Solvent ratio C_6:C_7:C_8	Volume ratio(m/s) C_6:C_7:C_8	Wt(g) of Crude oil residue	Wt(g) of HO ppt	Wt% of HO ppt
1	1 : 2 : 3	7.5 : 15 : 22.5	1.0074	0.0090	0.8934
2	1 : 3 : 2	7.5 : 22.5 : 15	1.0265	0.0105	1.0229
3	2 : 1 : 3	15 : 7.5 : 22.5	1.0246	0.0081	0.7906
4	2 : 3 : 1	15 : 22.5 : 7.5	1.0056	0.0080	0.7955
5	3 : 1 : 2	22.5 : 7.5 : 15	1.0086	0.0112	1.1105
6	3 : 2 : 1	22.5 : 15 : 7.5	1.0102	0.0089	0.8810

(C) At 75mls/g Oil Total Volume

Table 9: Precipitated heavy organic solid by varying volume ratios of C_5:C_6:C_7 ternary mixture

Test (s/n)	Solvent ratio C_5:C_6:C_7	Volume ratio(m/s) C_5:C_6:C_7	Wt(g) of Crude oil residue	Wt(g) of HO ppt	Wt% of HO ppt
1	1 : 2 : 3	12.5 : 25 : 37.5	1.0251	0.0112	1.0926
2	1 : 3 : 2	12.5 : 37.5 : 25	1.0255	0.0115	1.1214
3	2 : 1 : 3	25 : 12.5 : 37.5	1.0143	0.0104	1.0253
4	2 : 3 : 1	25 : 37.5 : 12.5	1.0015	0.0111	1.1083
5	3 : 1 : 2	37.5 : 12.5 : 25	1.0115	0.0105	1.0381
6	3 : 2 : 1	37.5 : 25 : 12.5	1.0230	0.0120	1.1730

Table 10: Precipitated heavy organic solid by varied volume ratios of C_5:C_7:C_8 ternary mixture

Test (s/n)	Solvent ratio C_5: C_7:C_8	Volume ratio(mls) C_5:C_7:C_8	Wt(g) of Crude oil residue	Wt(g) of HO ppt	Wt% of HO ppt
1	1 : 2 : 3	12.5 : 25 : 37.5	1.0108	0.0049	0.4848
2	1 : 3 : 2	12.5 : 37.5 : 25	1.0149	0.0052	0.5124
3	2 : 1 : 3	25 : 12.5 : 37.5	1.0164	0.0056	0.5510
4	2 : 3 : 1	25 : 37.5 : 12.5	1.0126	0.0074	0.7308
5	3 : 1 : 2	37.5 : 12.5 : 25	1.0153	0.0062	0.6107
6	3 : 2 : 1	37.5 : 25 : 12.5	1.0300	0.0063	0.6117

Table 11: Precipitated heavy organic solid by varied volume ratios of C_5:C_6:C_8 ternary mixture

Test (s/n)	Solvent ratio C_5:C_6:C_8	Volume ratio(mls) C_5:C_6:C_8	Wt(g) of Crude oil residue	Wt(g) of HO ppt	Wt% of HO ppt
1	1 : 2 : 3	12.5 : 25 : 37.5	1.0142	0.0071	0.7001
2	1 : 3 : 2	12.5 : 37.5 : 25	1.0027	0.0078	0.7779
3	2 : 1 : 3	25 : 12.5 : 37.5	1.0197	0.0064	0.6276
4	2 : 3 : 1	25 : 37.5 : 12.5	1.0243	0.0076	0.7420
5	3 : 1 : 2	37.5 : 12.5 : 25	1.0313	0.0075	0.7272
6	3 : 1 : 2	37.5 : 25 : 12.5	1.0295	0.0130	1.2627

Table 12: Precipitated heavy organic solid by varied volume ratios of C_6:C_7:C_8 ternary mixture

Test (s/n)	Solvent ratio C_6:C_7:C_8	Volume ratio(m/s) C_6:C_7:C_8	Wt(g) of Crude oil residue	Wt(g) of HO ppt	Wt% of HO ppt
1	1 : 2 : 3	12.5 : 25 : 37.5	1. 0200	0.0065	0.6373
2	1 : 3 : 2	12.5 : 37.5 : 25	1.0138	0.0061	0.6017
3	2 : 1 : 3	25 : 12.5 : 37.5	1.0074	0.0065	0.6452
4	2 : 3 : 1	25 : 37.5 : 12.5	1.0006	0.0070	0.6996
5	3 : 1 : 2	37.5 : 12.5 : 25	1.0313	0.0068	0.6594
6	3 : 2 : 1	37.5 : 25 : 12.5	1.0222	0.0071	0.6946

3. Results and Discussion

Experimental results of total yield of precipitate for varying volume ratios of individual n-alkanes for different combinations at a fixed total volume of solvents/g oil are presented on tables 1 - 12, and their curves given in figures 1 – 12.

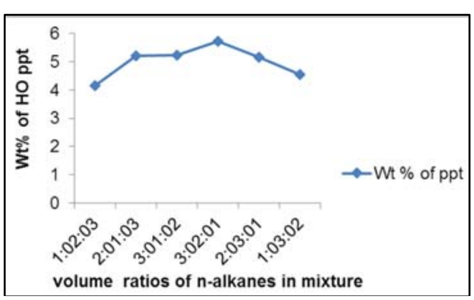

Fig 1: Weight % of Heavy organics precipitate vs varied volume ratios of C_5:C_6:C_7 ternary mixtures at 15mls total solvent per g of oil.

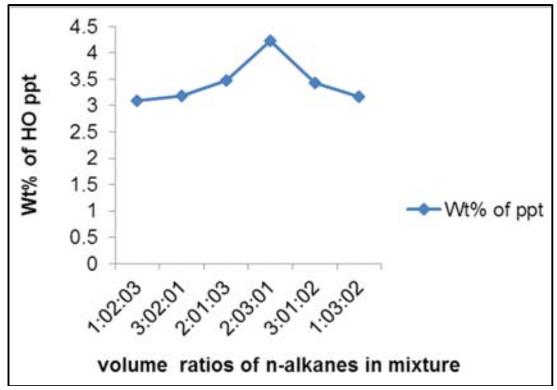

Fig 2: Weight % of Heavy organics precipitate vs varied volume ratios of C_5:C_7:C_8 ternary mixtures at 15mls total solvent per g of oil

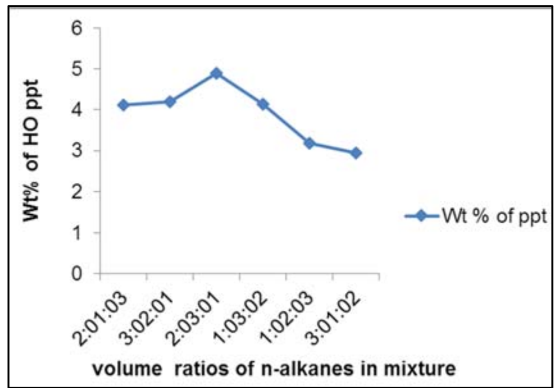

Fig 3: Weight % of Heavy organic precipitate vs varied volume ratios of C_5:C_6:C_8 ternary mixtures at 15mls total solvent per g of oil.

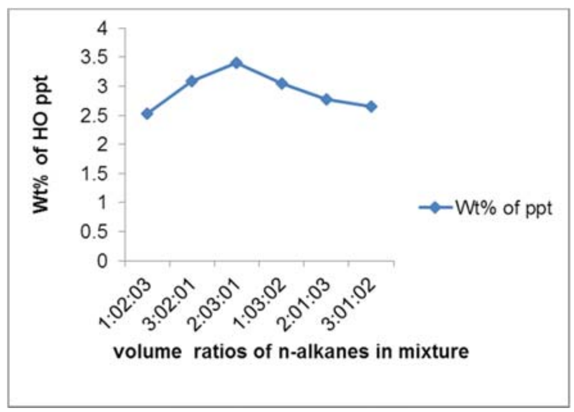

Fig 4: Weight % of Heavy organics precipitate vs varied volume ratios of C_6:C_7:C_8 ternary mixtures at 15mls total solvent per g of oil

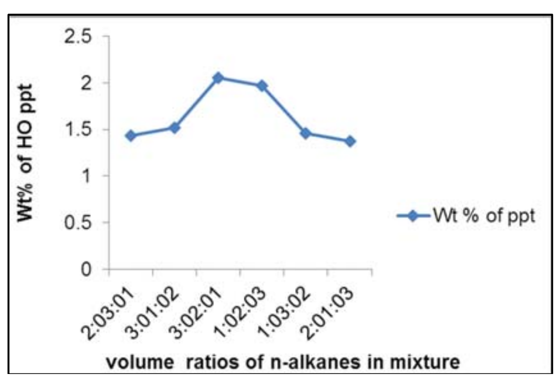

Fig 5: Weight % of Heavy organics precipitate vs varied volume ratios of C_5:C_6:C_7 ternary mixtures at 45mls total solvent per g of oil.

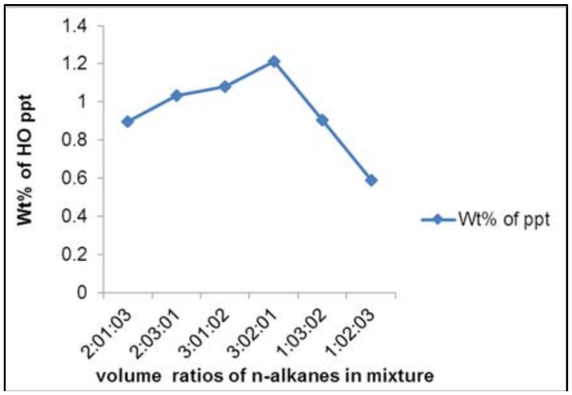

Fig 6: Weight % of Heavy organics precipitate vs varied volume ratios of C_5:C_7:C_8 ternary mixtures at 45mls total solvent per g of oil

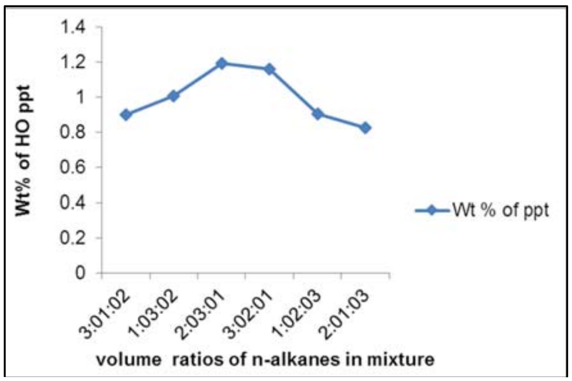

Fig 7: Weight % of Heavy organics precipitate vs varied volume ratios of C_5:C_6:C_8 ternary mixtures at 45mls total solvent per g of oil.

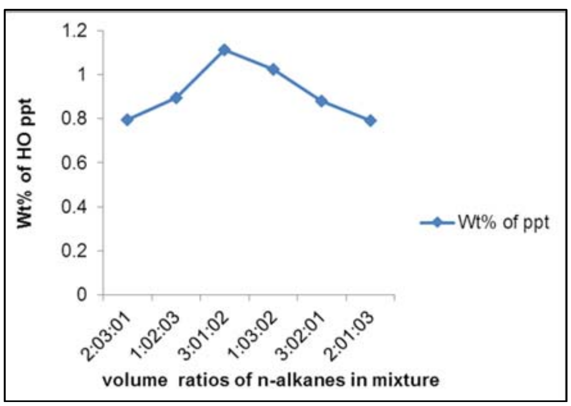

Fig 8: Weight % of Heavy organics precipitate vs varied volume ratios of C_6:C_7:C_8 ternary mixtures at 45mls total solvent per g of oil

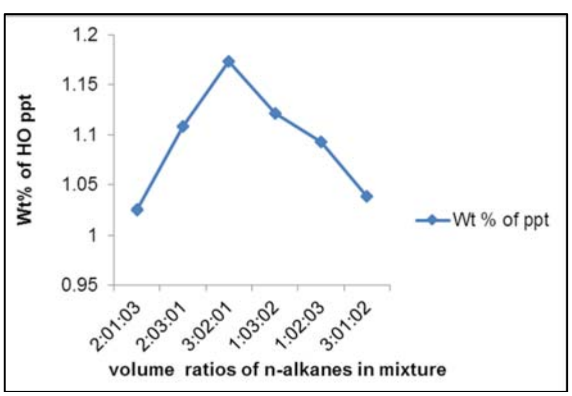

Fig 9: Weight % of Heavy organics precipitate vs varied volume ratios of C_5:C_6:C_7 ternary mixtures at 75mls total solvent per g of oil

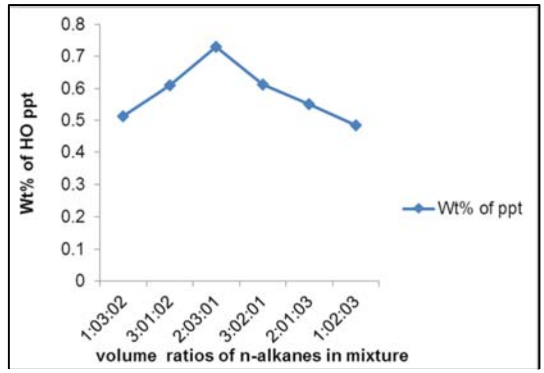

Fig 10: Weight % of Heavy organics precipitate vs varied volume ratios of C_5:C_7:C_8 ternary mixtures at 75mls total solvent per g of oil

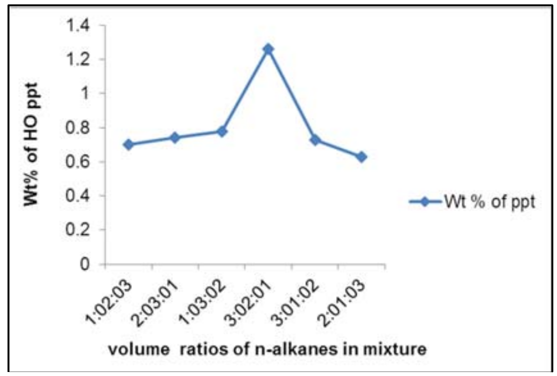

Fig 11: Weight % of Heavy organics precipitate vs varied volume ratios of C_5:C_6:C_8 ternary mixtures at 75mls total solvent per g of oil.

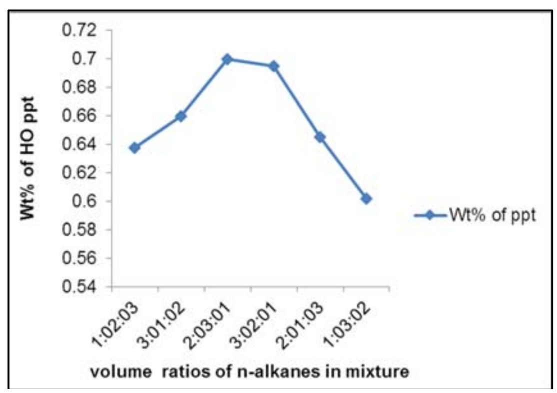

Fig 12: Weight % of Heavy organics precipitate vs varied volume ratios of C_6:C_7:C_8 ternary mixtures at 75mls total solvent per g of oil.

The curves, fig 1 - 12, involve total yield of HOS precipitate for varying volume ratios of same combination in fixed total volume of n-alkane solvent per g of oil.

The ratios; 1:2:3, 1:3:2, 2:1:3, 2:3:1, 3:1:2, 3:2:1 was considered. The HOS precipitate wt% changed in each ternary mixture as the ratio of the selected mixture was changed for a fixed total volume of the precipitant.

The curve in fig 1-4 represent HOS yield at a fixed total volume of 15mls for the different ternary mixtures. For the C_5:C_6:C_7 curve, maximum HOS yield was observed at 3:2:1 ratio, (5.7% wt), and minimum at 1:2:3 ratio, (4.1% wt). C_5:C_6:C_8 had maximum HOS yield at 2:3:1 ratio (4.9% wt) and minimum value is at the ratio 3:1:2 (2.9% wt). C_5:C_7:C_8 had maximum HOS yield at 2:3:1 ratio (4.2% wt) and minimum value is at the ratio 1:2:3 (3.1% wt). C_6:C_7:C_8 had maximum HOS yield at 2:3:1 ratio (3.4% wt) and minimum value is at the ratio 1:2:3 (2.5% wt). Ratios for the highest value for the 15mls fixed total volume and the other fixed total volumes (45mls & 75mls) could be attributed to effect of the contribution of lower carbon number on solubility of HOS. A common feature from single solvent precipitations shows that as the number of n-alkane carbon atom of the solvent increases, amount of precipitated heavy organic solid material decreases [3].

For a fixed total volume of 45mls fig 5 - 8, C_5:C_6:C_7 had the highest HOS value at the ratio 3:2:1 (2.1%wt) and minimum at 2:1:3 (1.4% wt). C_5:C_6:C_8 had the highest HOS value at the ratio 2:3:1 (1.2%wt) and minimum at 2:1:3 (0.8% wt). C_5:C_7:C_8 had maximum HOS yield at 3:2:1 ratio (1.2% wt) and minimum value is at the ratio 1:2:3 (0.6% wt). C_6:C_7:C_8 had maximum HOS yield at 3:1:2 ratio (1.1% wt) and minimum value is at the ratio 2:1:3 (0.8% wt).

Udourioh *et al.* (2014) in their binary work on heavy organics precipitation for varied ratio of C_6:C_7 mixture at 30mls solvent (total)/g oil, fig 13, showed that the quantity of precipitate increases sharply as the quantity of nC_6 in C_6:C_7 ratio increases/tends to 100% and drops sharply as the quantity of nC_7 in C_6:C_7 ratio increases/tends to 100% [7]. Hence the results observed in the ternary mixtures for any of the fixed total volume. As the ratio of the lowest carbon atom in the mixture rises, the quantity of precipitate increases and vice versa.

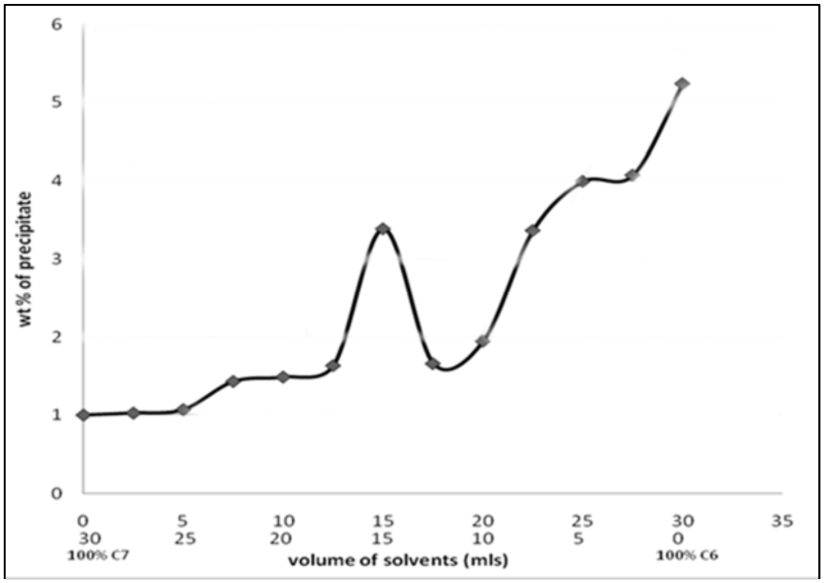

Fig 13: Wt % of HOS precipitate vs varied mixture ratio of C_6:C_7 mixture for 30mls solvent (total)/g oil [7].

Fixed total volume of 75mls, fig 9 - 12, C_5:C_6:C_7 had the maximum HOS yield at 3:2:1 (1.2% wt) and minimum at 2:1:3 (1.0% wt). C_5:C_6:C_8 had the maximum HOS yield at 3:2:1 (1.3% wt) and minimum at 2:1:3 (0.6% wt). C_5:C_7:C_8 had maximum HOS yield at 2:3:1 ratio (0.7% wt) and minimum value is at the ratio 1:2:3 (0.5% wt). C_6:C_7:C_8 had maximum HOS yield at 2:3:1 ratio (0.7% wt) and minimum value is at the ratio 1:3:2 (0.6% wt).

Other observations can be made from the work; for all the fixed total volumes C_5:C_6:C_7 mixture had its maximum yield at the 3:2:1. For the 15mls fixed total volume, all the different combinations had the ratio one corresponding to their highest carbon number for their maximum HOS yields which makes sense. For the 45mls fixed total volume, all the different combinations had the ratio three corresponding to their highest carbon number for their minimum HOS yields which also makes sense. The C_5:C_7:C_8 mixture, at all the fixed total volumes, minimum yields were at the 1:2:3 ratios. For the C_5:C_6:C_8 combination, at 15mls and 45mls fixed total volumes, fig. 3 & 7, maximum yields were at the 2:3:1 ratio i.e. 4.9% wt, and 1.2% wt respectively. But at 75mls fixed total volume, fig 11, maximum yield is at 3:1:2 (1.3% wt). This is what one could have expected because of C_5 carbon atom with maximum ratio of 3, but wasn't observed in the case of 15mls and 45mls fixed total volumes. One could say here that lower fixed total volumes here produce maximum at 2:3:1 ratio while higher fixed total volumes yield maximum at 3:2:1 – volume affect.

It was observed generally that different volume ratios for a particular combination and for a fixed total volume yield different HOS quantities. Hence it can be deduced here that varying volume ratios for a particular combination at any fixed total volume affects HOS yield differently. The reason for this can be attributed to the P_iX_i factor (where P is the assumed precipitation factor & X is the volume ratio). Since P_i for each n-alkane is different, therefore for different X_i ($V_i/\sum V_i$ or V_i/V_T), contribution will be a product of P_iX_i. $\sum P_iX_i$ = contribution of each n-alkane type into the HO precipitate.

4. Conclusion

A significant finding here is that n-alkane volume ratios affect the HO yield for any given (a) combination and (b) any total volume of mixture. The susceptibility of crude to precipitate HOS in significant quantity to give a problem in the field will be a function of volume ratio of individual n-alkanes present in the crude.

5. References

1. Hyne NJ. Non-technical Guide to Petroleum Geology, Exploration, Drilling and Production. Penwell. 2001, 4.
2. Maqbool T. Understanding the kinetics of aphaltene precipitation from crude oils. Pro Quest Dissertations and Theses. 2011.
3. Buenrostro-Gonzalez E, Lira-Galeana C, Gil-Villegas A, Wu J. Asphaltene Precipitation in Crude Oils: Theory and Experiments, AIChE J. 2004; 50:2552.

4. Chapman WG, Creek J, Hirasaki GJ, Gonzalez DL. Modeling of Asphaltene Precipitation Due to Changes in Composition Using the Perturbed Chain Statistical Associating Fluid Theory Equation of State. Energy and Fuels. 2007; (21):1231-1242.
5. Njiofor VO. Precipitation of Heavy Organics from a Crude oil Residue using Binary Mixtures of n-alkane solvents. M.Sc Thesis (unpublished). 2012.
6. Kokal SL, Najman J, Sayegh SG, George AE. "Measurement and Correlation of Asphaltene Precipitation from Heavy Oils by Gas Injection. J Can Petrol Technol. 1992; 31:24.
7. Udourioh GA, Ibezim-Ezeani MI, Ofodile SE. Comparative investigation of heavy organics precipitation from crude oil using binary mixtures and single N-alkane organic solvents''. Journal of Petroleum and Gas Exploration Research (ISSN 2276-6510) 2014; 4(4):53-59.