

Study on the effect of different chemical additives on the rheological behaviour of highly viscous crude oils of Ankлав field, Western Onshore

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ABSTRACT

The Ankлав field of Cambay Asset is encountering flow related problems due to the highly viscous nature of the produced crude oils. To mitigate this problem, three crude oil samples of wells Ankлав-A, Ankлав-B and Ankлав-C of the Cambay Asset were selected for the studies to identify a suitable chemical treatment for the individual wells.

The oils are of medium gravity with relatively high pour point (39°C-42°C). High asphaltene content (7.31% to 12.24%) may be the factor responsible for the viscous nature of the crude oils.

Twenty chemical formulations prepared in the lab (chemical additives procured from different vendors) were evaluated to identify the most suitable chemical formulation to enhance the flow. The chemical formulations effectively act as flow behaviour improvers, pour point depressants, inhibitors of the wax precipitation process and are even capable to remove & disperse wax already deposited in the production tubing and surface pipelines.

The three identified chemicals, Aquat ER 482, EC 5353A, and IGPPD 12048SK, reduced the viscosity of treated crude oil up to 93% to 96% and depressed the pour point to 27°C - 30°C. The chemicals could exhibit paraffin inhibition efficiency in the range of 58% to 72% and wax dispersion effect from 48% to 61%.

INTRODUCTION

Crude oil accounts for large percentage of global energy consumption. The solid deposition in pipelines during production, transportation and storage of crude oil is the most common problem being faced globally by the downstream and upstream oil companies all over the world. The

depositions may lead to plugging of flow lines, loss of hydrocarbon production and increase in production costs (Misra et al., 1995)

The crude oil being produced from Ankлав field of Cambay Asset has poor flow characteristics due to its highly viscous nature (Gupta et al., 2015). The main factor contributing to the viscous nature of the oil seems to be the high asphaltene content (Chanda et Al., 1998) in the Ankлав crude oil.

Anклав field is located on the eastern rising flank of Tarapur depression in Cambay-Tarapur tectonic block of Cambay Basin between Kathana and Padra fields. The field consists of multiple fault closures and covers an area of 1.9 sq. km. The Paleogene sequence in the area is represented by Trap, Olpad, Cambay, Kalol and Tarapur formations. EP-I sand within Tarapur Formation has been found to be hydrocarbon bearing. Total production from the field is about 150 m³/day and the producing wells are on SRP mode.

Three crude oil samples of wells Ankлав-A, Ankлав-B & Ankлав-C were studied for flow assurance of crude oils

Experimental details

The crude oil samples were analyzed for physico-chemical characterization, rheological analysis to see the effect of various chemical formulations on the viscosity of crude oils with the change in temperature and wax dispersion & inhibition studies.

To observe the effect of chemical additives, crude oil is treated with different doses of chemical formulation prepared in xylene. The solution is refluxed for one and a half hour keeping the flat bottom flask in a water bath at 60°C-70°C. For

carrying out the required studies, two instruments were utilized viz., Rheometer MCR- 301 and Cold finger Apparatus.

RESULTS AND DISCUSSION

Physico chemical characterization

The water content in the Anklav-A, Anklav-B, Anklav-C crude oil is 1%, 4.8% and 1% and pour point is 39°C, 42°C and 39°C respectively. All the three crude oils of Anklav-A, Anklav-B and Anklav-C have medium API gravity of 28.24, 26.90 and 26.78 respectively, very high viscosity ranging from 78200 to 86500 cP at 20°C, and high asphaltene content of 12.24 wt%, 9.9wt% and 7.31wt%, respectively. (Table 1)

Rheological properties of neat and treated crude oils

The viscosity of neat crude oil of wells Anklav-A, Anklav-B and Anklav-C is 28 cP, 53 cP and 110 cP at

55°C and 78220 cP, 82450 cP and 86500 cP at 20°C respectively. For identifying the suitable chemicals for reducing the viscosity and the pour point of the crude oils, rheological studies were carried out with twenty chemical formulations in the temperature range 55°C to 20°C. Three chemicals Aquat ER 482, EC 5353A and IGPPD 12048SK were found to be effective in decreasing the viscosity and were also able to depress the pour point significantly for all the three crude oils.

The three identified chemicals, viz. Aquat ER 482, EC 5353A and IGPPD 12048SK, at different doses, reduced the viscosity of studied oils by 87% to 97% at 20°C and depressed the pour point to 27°C, except the chemical IGPPD 12048SK in 2500 ppm dose was able to reduce the pour point of Anklav-C crude oil up to 30°C (Table 2).

Variation of viscosity with temperature of neat crude oil of Anklav-A, Anklav-B and Anklav-C are shown in the figures 1, 2 & 3 respectively.

Table 1: Physico-chemical parameters of Anklav-A, Anklav-B and Anklav-C crude oils

Sl. No.	Property	Unit	Results		
			Anklav-A	Anklav-B	Anklav-C
1	Water Content	%(v/v)	1	4.8	1
2	Density at 15°C	g/cc	0.88	0.89	0.894
3	API gravity	degrees	28.24	26.9	26.78
4	Pour Point	°C	39	42	39
5	Asphaltene	wt%	12.24	9.9	7.31
6	Resin	wt%	7.58	12.9	11.84
7	Wax	wt%	7.87	4.6	4.53

Table 2: Effect of identified chemicals on the viscosity and pour point of crude oil

Chemical with 10 % Xylene	Anklav-A Crude oil Neat oil viscosity at 20°C is 78220cP Pour point = 39 °C				Anklav-B crude oil Neat oil viscosity at 20°C is 82450 cP Pour point = 42 °C				Anklav-C crude oil Neat oil viscosity at 20°C is 86500 cP Pour point= 39 °C			
	Dose (ppm)	Pour point (°C)	Viscosity (cP) after treatment at 20°C	(%) Reduction at 20°C	Dose (ppm)	Pour point (°C)	Viscosity (cP) after treatment at 20°C	(%) Reduction at 20°C %	Dose (ppm)	Pour point (°C)	Viscosity (cP) after treatment at 20°C	(%) Reduction at 20°C %
Aquat ER 482	3000	27	3465	96	3000	27	3043	96	2000	27	5005	94.2
EC 5353A	2000	27	2410	97	2000	27	5520	93	3000	27	5450	94.0
IGPPD 12048SK	3000	27	4600	94	2500	27	10850	87	2500	30	5273	93.7

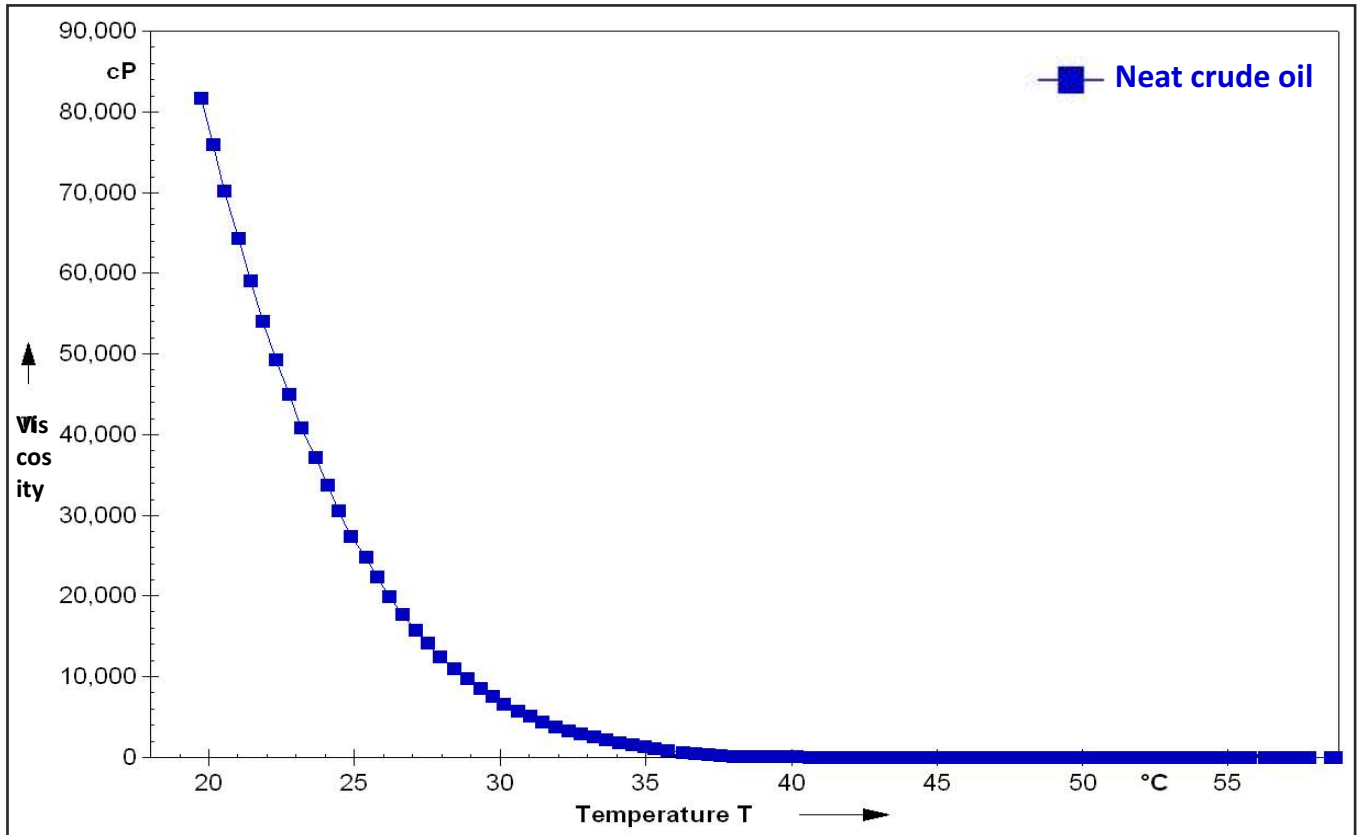


Fig.1: Variation of viscosity with temperature of neat crude oil of Anklav-A

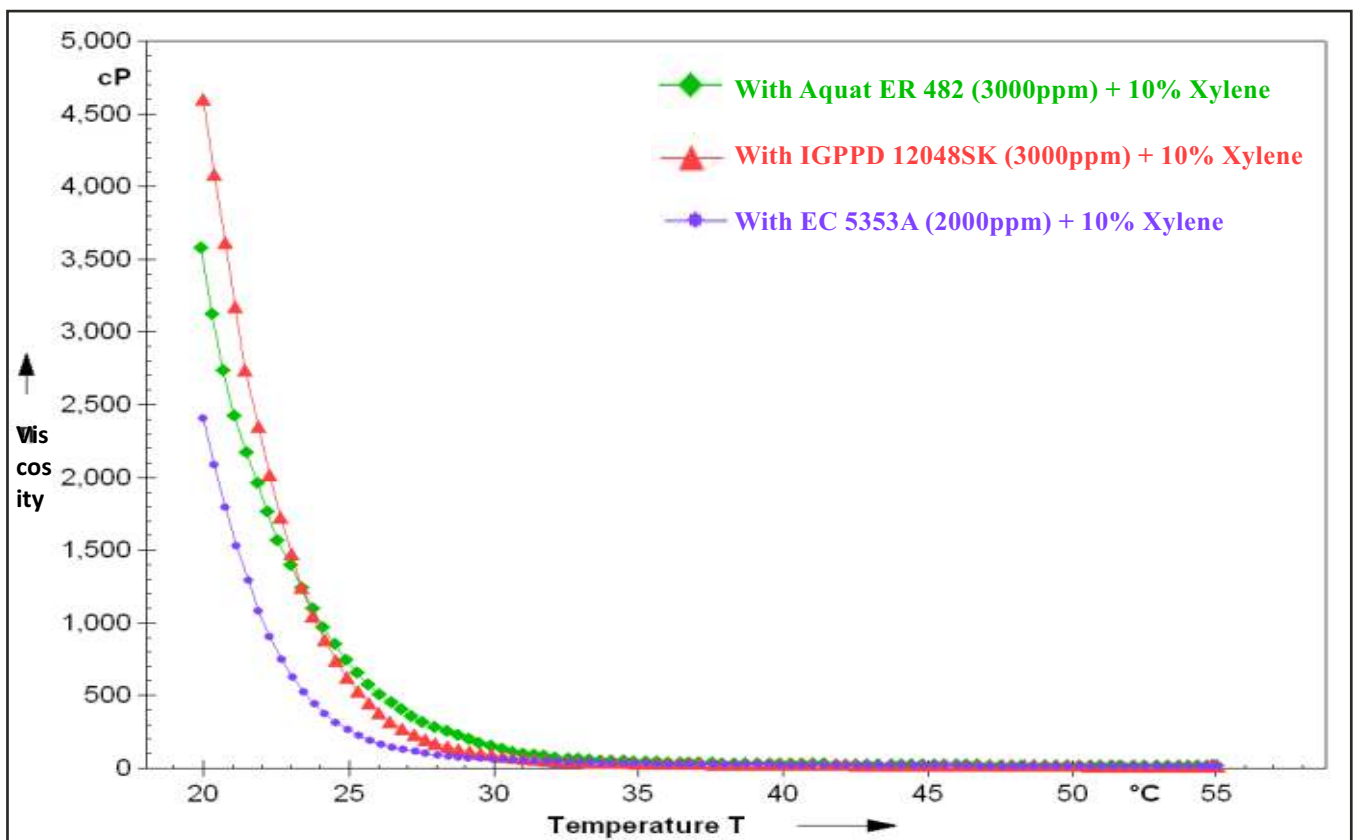


Fig.1a: Effect of different chemical additives on the viscosity the crude oil of Anklav-A at different temperatures

Effect of different chemical additives on the viscosity of crude oils of Anklav-A, Anklav-B and Anklav-C at different temperatures are shown in Fig.1a, 2a and 3a respectively.

Wax dispersion & inhibition studies of crude oils

Wax deposition can be a serious problem in crude oil carrying pipelines operating in low temperature

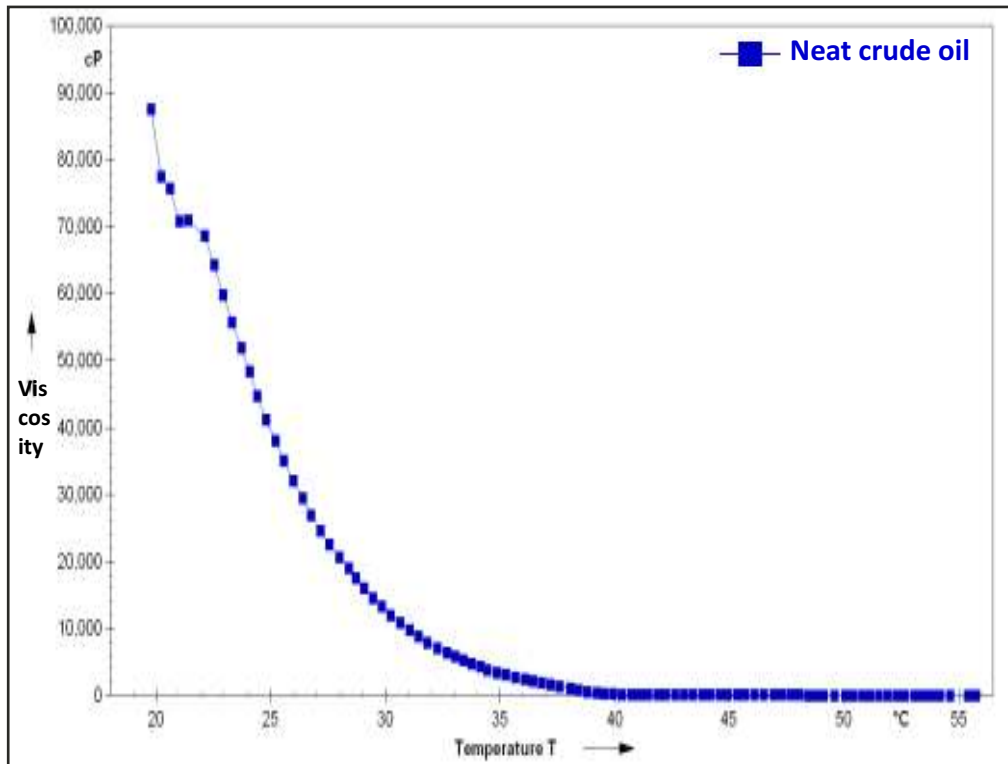


Fig. 2: Variation of viscosity with temperature of neat crude oil of Anklav-B

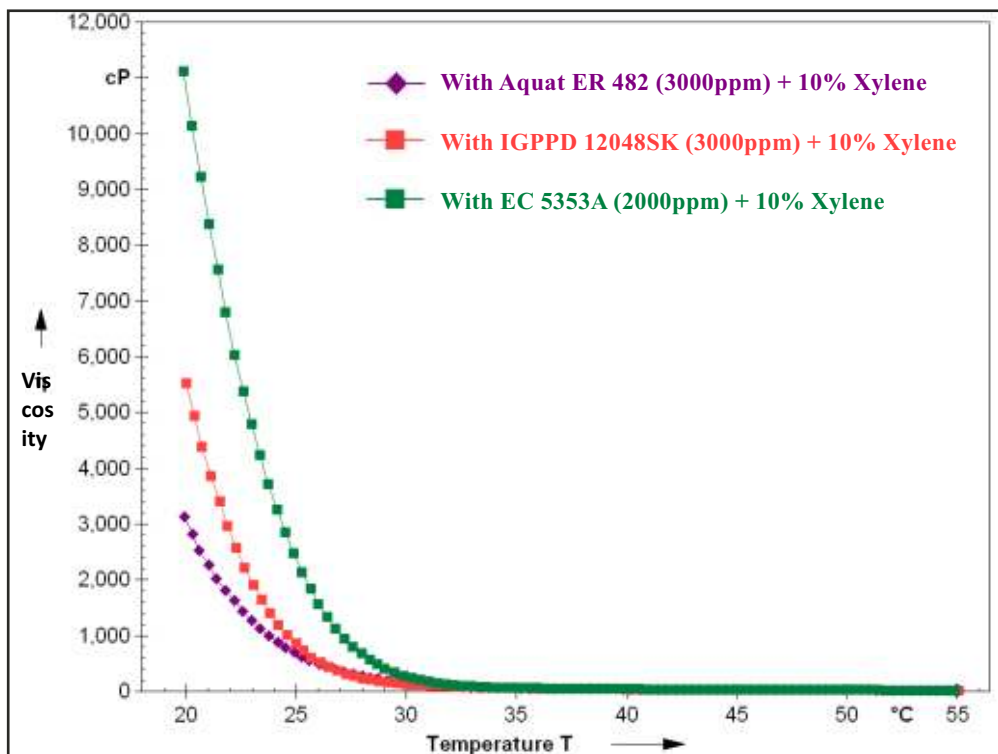


Fig. 2a: Effect of different chemical additives on the viscosity the crude oil of Anklav-B at different temperatures

environments (Todi et al., 2006). Wax dispersion & inhibition studies were carried out on the three crude oils of Ankлав field using eight chemical additives chosen on the basis of their performance

in rheological studies. The dose optimization of the three identified chemical additives viz. Aquat ER 482, EC 5353A and IGPPD 12048SK was carried out in three different doses of 2000 ppm, 2500 ppm

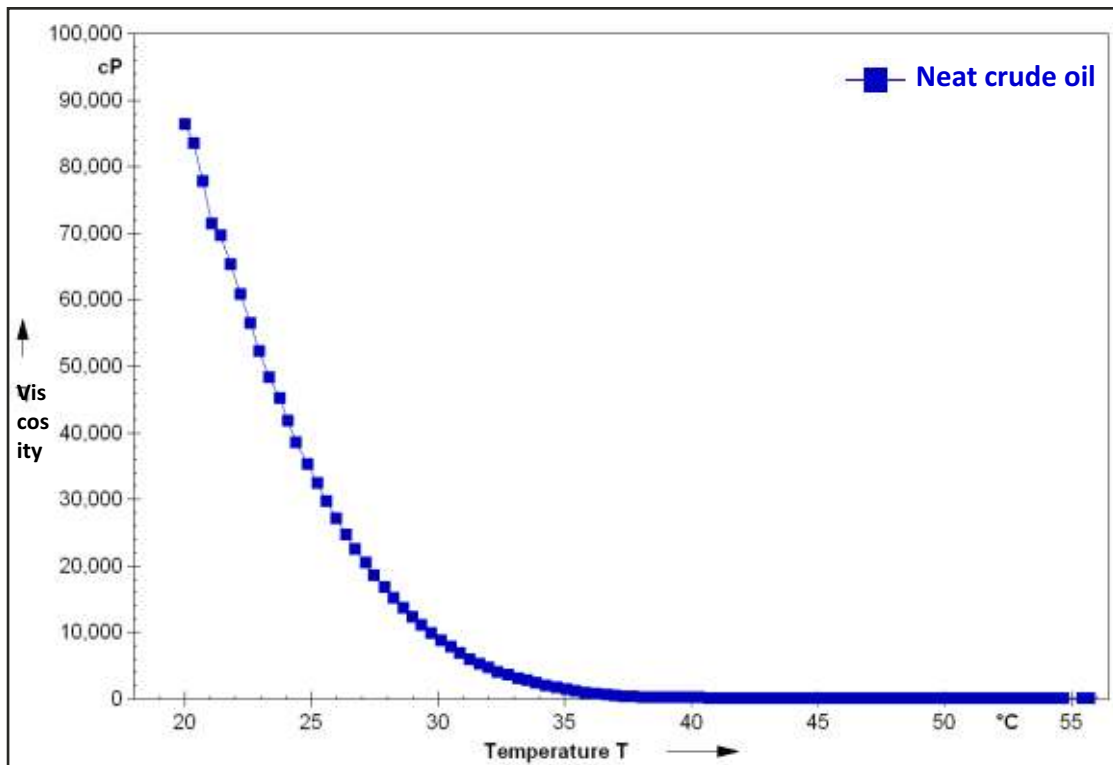


Fig. 3: Variation of viscosity with temperature of neat crude oil of Ankлав-C

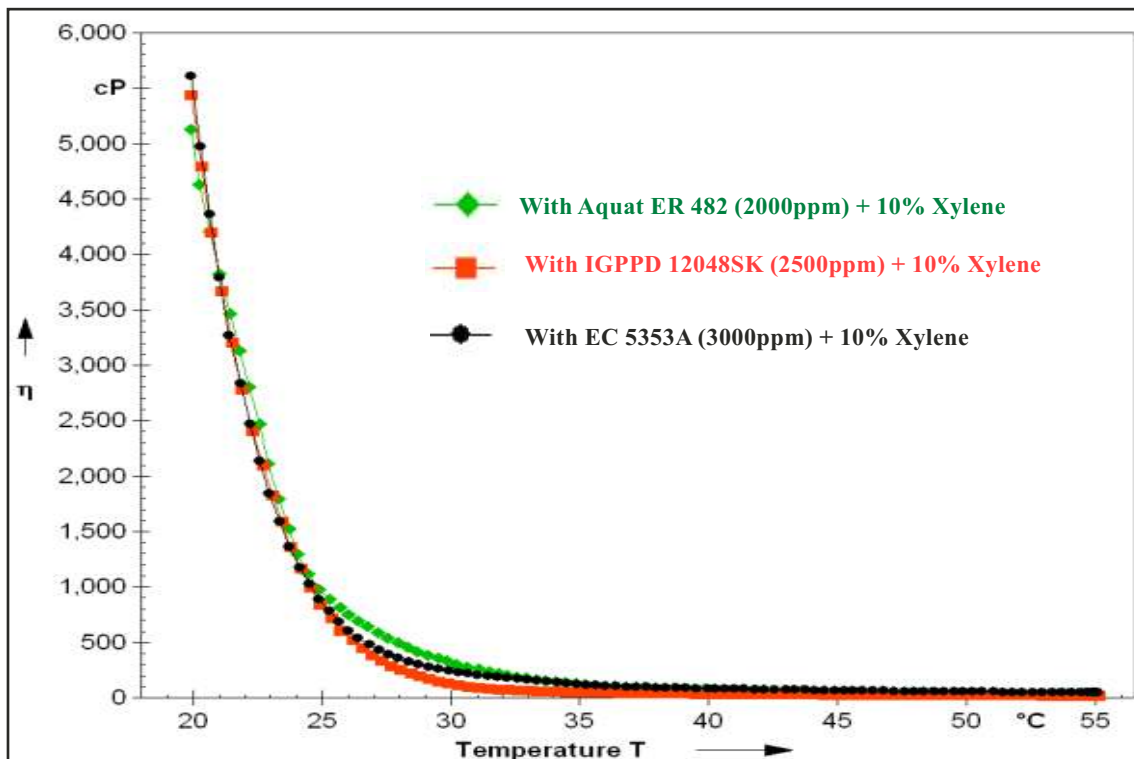


Fig. 3a: Effect of different chemical additives on the viscosity the crude oil of Ankлав-C at different temperatures

and 3000 ppm. Chemical additive mixed with 10% xylene (10% of volume of crude oil taken) is added to crude oil for analysis.

Wax inhibition and wax dispersion efficiency of the three identified chemical additives Aquat ER 482,

EC 5353A and IGPPD 12048SK varies from 52% - 72% and 39% - 61% respectively for the three crude oils (Table 3). Bar diagram showing wax inhibition & dispersion effect of chemical additives on crude oils of Anklav-A, Anklav-B and Anklav-C are given in Fig.4, 5 & 6 respectively.

Table 3: Dispersion & inhibition efficiency of identified chemical additives on Anklav-A, Anklav-B and Anklav-C crude oil

Sl. No.	Chemical additive mixed with 10% xylene	Dose (ppm)	Anklav-A		Anklav-B		Anklav-C	
			Dispersion %	Inhibition %	Dispersion %	Inhibition %	Dispersion %	Inhibition %
1	Aquat ER 482	2000	46	56	44	56	61	72
		2500	48	57	50	62	58	69
		3000	58	70	54	68	54	67
2	IGPPD 12048SK	2000	47	59	56	67	42	53
		2500	50	60	49	59	44	54
		3000	60	68	52	61	48	59
3	EC 5353A	2000	51	62	45	54	48	60
		2500	48	59	48	58	51	63
		3000	39	52	46	55	47	58

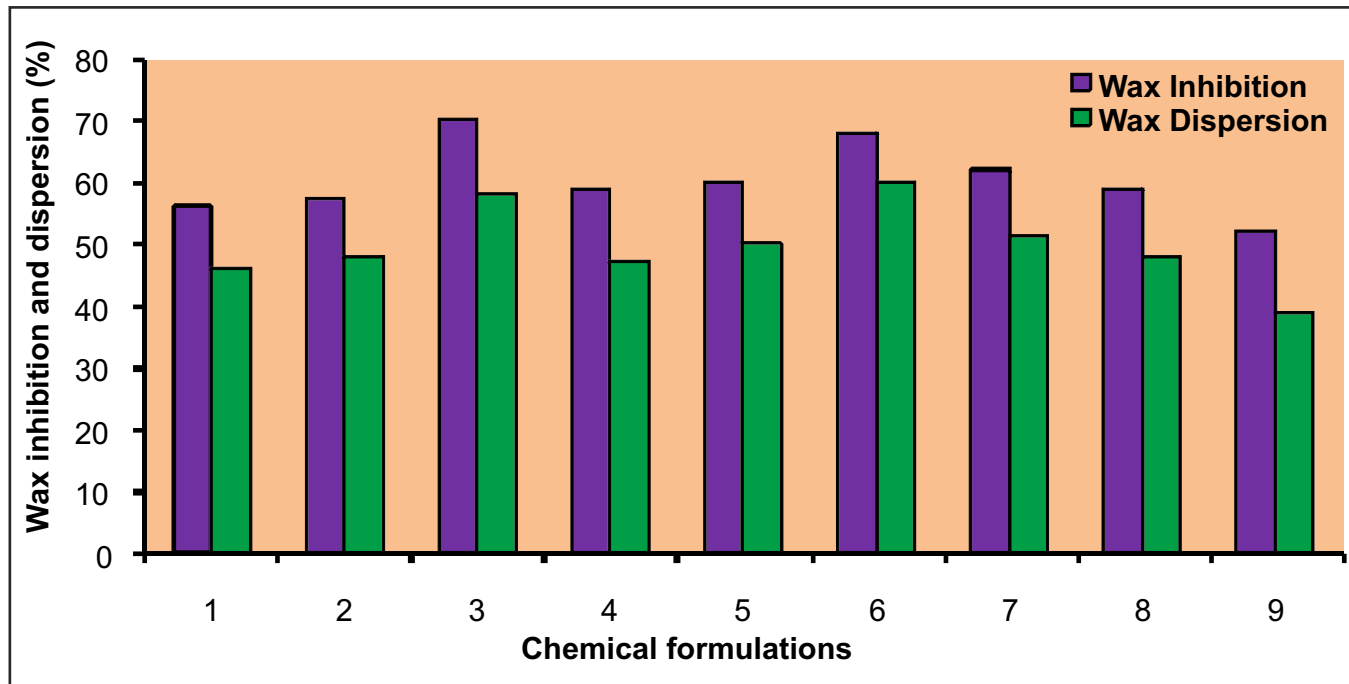


Fig. 4: Bar diagram showing dose optimization of wax inhibition and dispersion studies of Anklav-A crude oil

1. Aquat ER 482(2000 ppm)
2. Aquat ER 482(2500 ppm)
3. Aquat ER 482(3000 ppm)
4. IGPPD 12048SK (2000 ppm)
5. IGPPD 12048SK (2500 ppm)
6. IGPPD 12048SK (3000 ppm)
7. EC 5353A (2000 ppm)
8. EC 5353A (2500 ppm)
9. EC 5353A (3000 ppm)

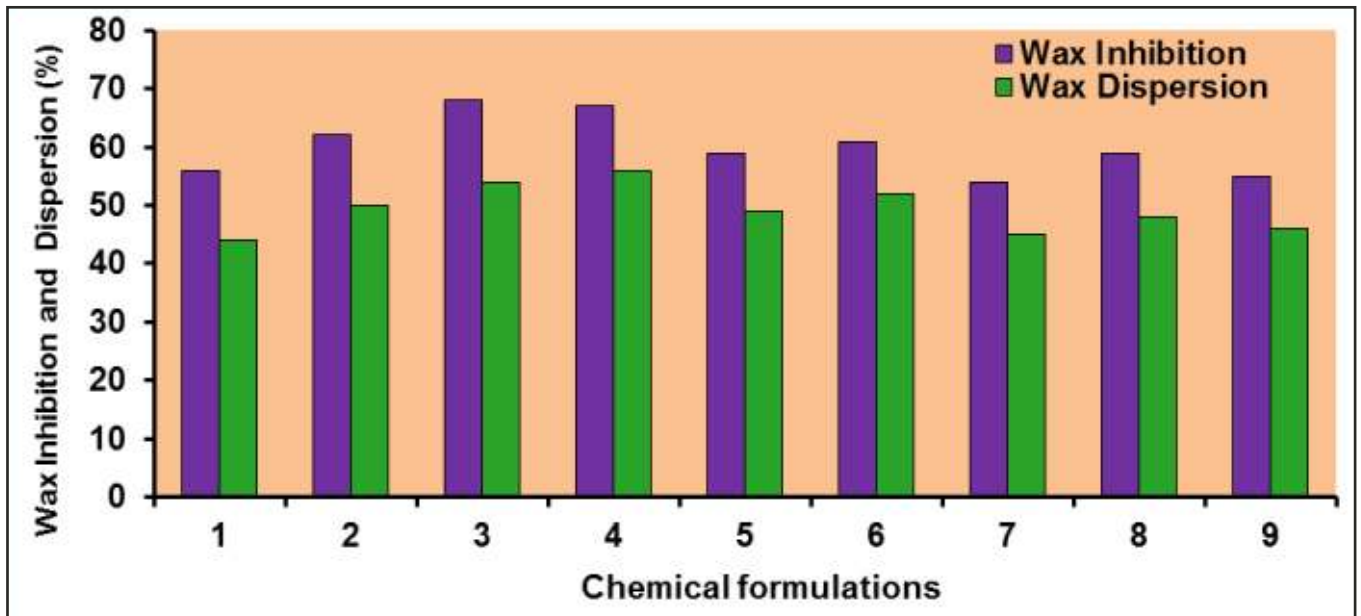


Fig. 5: Bar diagram showing dose optimization of wax inhibition and dispersion studies of Anklav-B crude oil

- | | | |
|----------------------------|------------------------|-----------------------------|
| 1. Aquat ER 482 (2000 ppm) | 4. EC 5353A (2000 ppm) | 7. IGPPD 12048SK (2000 ppm) |
| 2. Aquat ER 482 (2500 ppm) | 5. EC 5353A (2500 ppm) | 8. IGPPD 12048SK (2500 ppm) |
| 3. Aquat ER 482 (3000 ppm) | 6. EC 5353A (3000 ppm) | 9. IGPPD 12048SK (3000 ppm) |

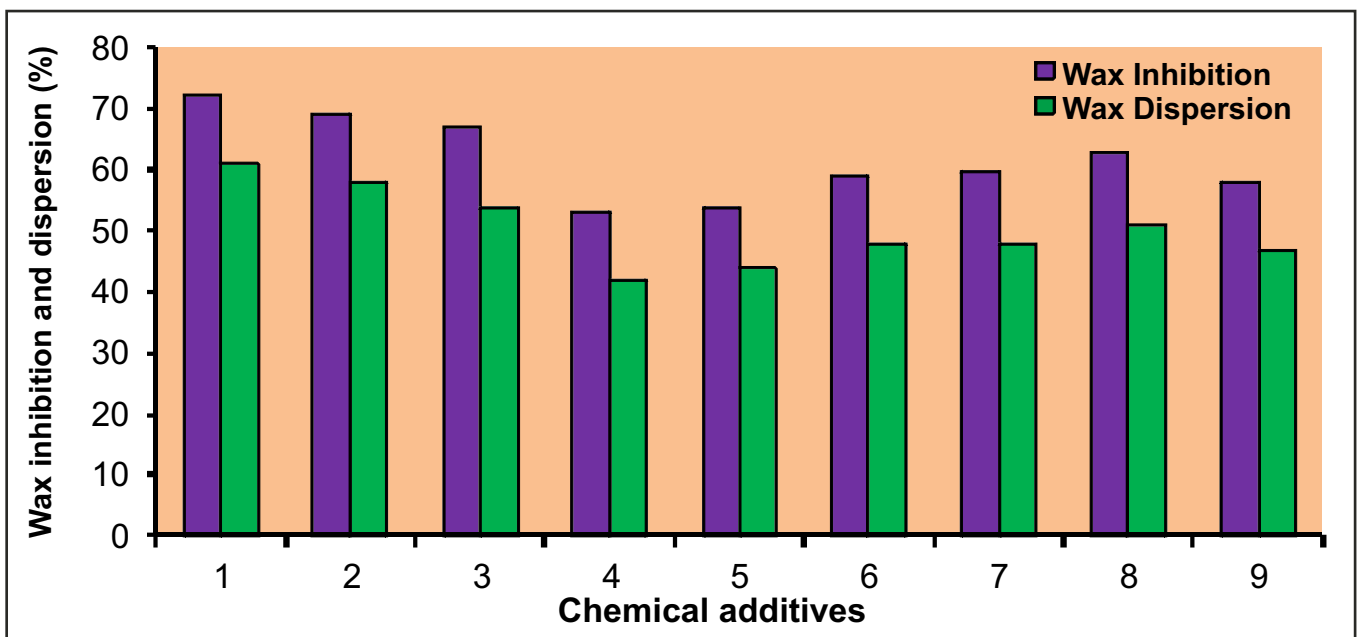


Fig. 6: Bar diagram showing Dose optimization of Wax inhibition and dispersion studies of Anklav-C crude oil

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|----------------------------|------------------------|-----------------------------|
| 1. Aquat ER 482 (2000 ppm) | 4. EC 5353A (2000 ppm) | 7. IGPPD 12048SK (2000 ppm) |
| 2. Aquat ER 482 (2500 ppm) | 5. EC 5353A (2500 ppm) | 8. IGPPD 12048SK (2500 ppm) |
| 3. Aquat ER 482 (3000 ppm) | 6. EC 5353A (3000 ppm) | 9. IGPPD 12048SK (3000 ppm) |

CONCLUSIONS

Based on rheological, wax inhibition and wax dispersion studies following conclusions have been drawn:

- Anklav-A, Anklav-B and Anklav-C crude oils are of medium gravity with high pour point 39°C, 42°C and 39°C respectively.
- The three crude oils of Anklav-A Anklav-B and Anklav-C are having high asphaltene content of

12.24wt%, 9.9wt% and 7.31wt% respectively which seems to be the main factor contributing to their high viscosity ranging from 78220 cP to 86500 cP at 20°C.

- The three identified chemical formulations, viz., Aquat ER 482, EC 5353A and IGPPD 12048SK reduced the viscosity of the three studied crude oils of Anklav-A, Anklav-B and Anklav-C by 87% to 97% at 20°C, and identically depressed the pour point to 27°C except that the chemical IGPPD 12048SK in 2500 ppm dose was able to reduce the pour point of Anklav-C crude oil up to 30°C.
- Wax inhibition and wax dispersion efficiency of the three identified chemical additives varies from 52% - 72% and 39% - 61% respectively for the three crude oils.
- Any of the above identified chemical formulations could be implemented for the improvement in the flow behaviour of the studied crude oils.

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