Effect of Chemical additives on Crude oil of Western Onshore Field

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Abstract: **Midstream flow assurance is concerned with the ability to transport crude oil via pipelines without difficulty from wellhead to refinery. Crude oil deposits are located in reservoirs at high temperatures and pressures, resulting in substantial changes in their process conditions when extracted and transported through pipelines, causing a problem in flow of Crude oil. Conventional technologies, such as electric, emulsification, and thermal insulation, are extremely costly and may necessitate regular pigging in crude pipelines. Pour Point Depressant (PPD) plays an important role in decreasing pipeline transportation difficulties in the midstream sector. Due to the simplicity of managing many sorts of crudes, one of the most modern and recent methods of employing PPD is gaining popularity over traditional approaches. Different types of Chemical additive are used to solve various problems in order to do this. This research examines the importance and necessity of Chemical additives, as well as their effect on Pour point of Crude oil.**

Keywords: **Wax, Crude oil, Paraffin, Pour point depressant, chemical additive**

1. INTRODUCTION

Crude oil contains light and heavy hydrocarbons. Paraffinic, naphthenic, and aromatic components up to C60 are found in most stable oils. In addition, polar and asphaltenes are found. Light crudes also contain small amounts of heavier components in solution. Temperature plays vital role in solubility. As the oil cools, the heavy hydrocarbons become less soluble and can precipitate out as solid wax crystals. Wax crystals may precipitate with polar and asphaltenes. Paraffin deposition from crude oil at low temperatures is a crucial challenge for consumers of petroleum. Contained in lubricants, residual fuels and crude oil. Wax deposition is one of the primary flow assurance difficulties that creates many pipeline issues during crude oil production and transfer. Under reservoir conditions, paraffin wax is present in dissolved form in crude oil. In other words, the wax is soluble in crude oil above the cloud point. Cloud point or Wax appearance temperature (WAT) is the temperature at which components and crude precipitate. When the temperature in the pipeline drops, low molecular weight hydrocarbons begin to evaporate, reducing the solubility of wax in crude oil. As the temperature falls below the cloud point, wax crystallises, a process known as nucleation. The negative influence of wax deposition on formation results in decreased permeability, changes in fluid composition, and rheology in the reservoir. The minimal temperature at which crude oil continues to flow while cooling is known as the pour point. Crude oil fluidity decreases below the pour point due to wax precipitation, and when temperature drops further, crude oil ceases to flow and a pipeline obstruction occurs. As a result, crude oil production cannot be carried out smoothly. Chemical methods are methods in which chemicals are mixed with crude oil to reduce wax deposition in crude oil. These chemical additives are classified into three categories: Dispersants, Wax crystal modifiers and Pour point depressants. Pour point depressants are chemical additives which decreases the pour point of crude oil and improves the flow properties of crude oil even below pour point of crude oil.

2. EXPERIMENTAL PROCEDURE

Material

The crude oil sample was collected from Ankleshwar asset. The Chemical additives were obtained from vendor in order to study their effectiveness on the crude oil. The solvents used i.e., Toluene, Acetone, Xylene, Hexane and the other chemicals were provided by Department of Petroleum Engineering, PIT.

2.1. Characterisation of crude oil

The crude oil sample used for the study was brown in colour. To fully understand the behaviour of our oil sample it is important to determine its Physico-chemical characteristics. The density was determined using ASTM D1298. The sample was first heated above 60^0C to make it homogeneous. After that 400 ml Crude oil was transferred to 500 ml measuring cylinder. Then, the hydrometer was dropped into the cylinder and was allowed to settle. Readings on the hydrometer was noted down along with temperature at which density was measured. Then series of calculations were made to have equivalent value of specific gravity and API gravity. Water content was measured by using Dean and Stark method. 100ml of oil sample and 100ml of solvent (Toluene) were mixed in the round bottom flask. The water present in the sample can be removed azeotropically with the help of Dean and Stark apparatus. Volume of water collected in the trap was measured and calculations were made to find Water content.

ASTM D97 was used to determine the Pour point of our sample. The distillation of Crude oil was done by using ASTM distillation method. IBP (initial boiling point), different fractions and 210°C+ residue were obtained after distillation. 210°C+ residue was then further used for determination of Wax content and SARA analysis. 2.5g of 210°C+ residue was refluxed with 100ml of Hexane for 2 hours and kept in dark overnight. The solution was then filtered with Whatman paper no 42, and the filtrate (Maltene) was kept aside. On the other way, the filter paper containing asphaltene was refluxed with Hexane to remove remaining traces of Maltene. Asphaltene was then dissolved in Toluene and later, Toluene was distilled to obtain weight of Asphaltene. The Maltene obtained after filtration was divided into two parts. One part of Maltene was passed through hot silica till colourless. Acetone was then added to the filtrate to precipitate the Wax and kept at -20^0C overnight. Wax was then filtered, dried and weighed. The other part of Maltene was utilized for SARA analysis by using Column chromatography. Saturates were eluted using Petroleum ether, Aromatics were eluted using Toluene and Resins were eluted using Methanol.

2.2. Preparation of PPD solutions

Experiments were done using three industrial Pour point depressant X, Y, Z of unknown concentrations. Therefore, 10% PPD solution was first prepared using following method:

1g of PPD was dissolved in 10ml of toluene in order to obtain a solution with 1, 00,000 ppm of PPD concentration. With the normality or dilution formula $N_1V_1 = N_2V_2$, calculated the volume of prepared solutions needed to obtain different concentrations presented in the following table.

Table.I: PPD dosage

Concentration (ppm)	100	200	300	400	500
Volume (ml)	0.5	1	1.5	2	2.5

3. POUR POINT DETERMINATION

In a Beaker, 50ml of oil sample was heated in a water bath to the dosage temperature of 45°C. Following that, a desired amount of PPD solution at the desired concentration was added to the Beaker. This has been done repetitively for each concentration of each PPD. The treated oil was then filled to the level mark at 65°C, along with a cork and a thermometer attached to it. The sample was left at room temperature until it reached 45°C. The tube was then retained in Pour point device. The flow was tested every 3°C. The temperature at which it stopped flowing was measured, and the pour point was recorded as (+) 3°C.

4. RESULTS AND DISCUSSIONS

4.1. Analysis of Crude Oil sample

The Physico-chemical parameters of Crude oil are presented in the table below.

Table.II ASTM distillation data

Initial Boiling Point (IBP) = 50 ^{0}C

Temperature (^{0}C)	Distillate volume (ml)
50	1.0 ml
75	2.9 ml
100	6.3 ml
125	9.1 ml
150	10.3 ml
175	17 ml
200	20 ml
210	25 ml

Total Volume = 25ml

Table.III Physico-chemical properties of Crude Oil sample

Parameters	ASTM/IP method	Observed values
Water content	IP-358/97 ASTM D4006 81	Traces
Density (g/cc at 15 °C)	IP-160	0.8098
Specific gravity		0.8105
API gravity (°API)		43.0
Pour point (°C)	IP-441/99 ASTM D58533-11	27
Wax content (wt %)		17.3
Melting point of Wax (^{0}C)		54
Congealing point of Wax (^{0}C)		50
IBP (initial boiling point) (°C)		50
Saturates (%w/w)		78.7
Aromatics (%w/w)		12.3
Resins (%w/w)		8.8
Asphaltene content (wt %)	IP 143/04 ASTM D6560	0.2
Flash point (^{0}C)		38
Fire point (^{0}C)		40

The Density, Specific gravity and API gravity values helps to deduce that the sample is a light Crude oil having API gravity of 27.66. Crude oil sample is predominantly rich in Wax with a pour point of 27°C, which gives us reason to find the required PPD.

4.2. Pour point measurements

Different concentrations (100, 200, 300 and 500 ppm) of each of the three PPDs (X, Y, Z) were added to Crude sample at 45°C dosing temperature and heated up to 65°C, and Pour point behaviours were recorded for each chemical.

Table. IV Effect of PPDs

Pour Point of Crude oil = 27^{0}C

PPD	Concentration of PPD (ppm)	Pour point of treated oil (°C)	Depression ΔT (°C)
X	100	15	12
	200	6	21
	300	6	21
	500	6	21
Y	100	18	9
	200	15	12
	300	15	12
	500	9	18
Z	100	27	0
	200	27	0
	300	27	0
	500	27	0

According to the pour point data in the preceding Table, when treated with 100 to 500 ppm doses of X, the pour point continuously drops from 27 to 6°C. As the dosage is increased, the Pour point drops more, having a maximum impact at 300 ppm. PPD Y has been shown to lower the pour point of crude oil by up to 18°C at 500 ppm. PPD Z, on the other hand, has no impact as a pour point depressant on crude oil.

4.3. Comparative analysis of pour point depressants X, Y, Z effect on the sample

This comparison is beneficial for assessing the performance of the three PPD (X, Y, and Z) on the crude oil sample under consideration. The effectiveness of any PPD is proportional to its capacity to disperse paraffin wax components, lowering the pour point of crude oil. Figure (15) shows that the oil PPD X is the most effective in lowering the pour point of crude oil when compared to other PPDs.

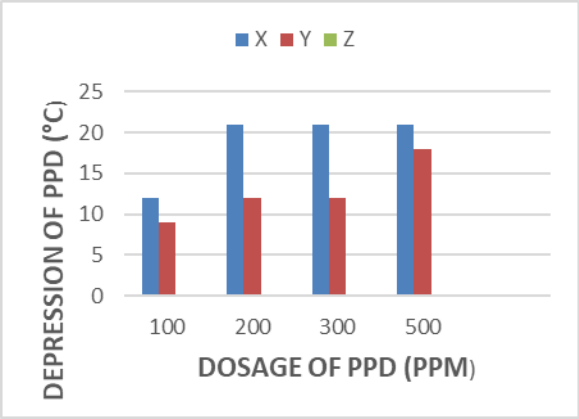

Fig. 1 Comparative effect of X, Y, Z

5. CONCLUSIONS

The influence of three distinct PPDs was studied on Western onshore crude oil. This study leads to the following conclusions:

The sample's density was 0.8098 g/cm^3 and its API Gravity was 43.0.

The sample investigated was light Crude oil with a high level of Wax, which plays a vital influence in the rheological characteristics of Crude oils.

This comparison is beneficial for assessing the performance of the three PPD (X, Y, and Z) on the crude oil sample under consideration.

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