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Asphaltene Precipitation Investigation Using a Screening Techniques for Crude Oil Sample from the Nahr-Umr Formation/Halfaya Oil Field

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Abstract

Many oil and gas processes, including oil recovery, oil transportation, and petroleum processing, are negatively impacted by the precipitation and deposition of asphaltene. Screening methods for determining the stability of asphaltenes in crude oil have been developed due to the high cost of remediating asphaltene deposition in crude oil production and processing. The colloidal instability index, the Asphaltene-resin ratio, the De Boer plot, and the modified colloidal instability index were used to predict the stability of asphaltene in crude oil in this study. The screening approaches were investigated in detail, as done for the experimental results obtained from them. The factors regulating the asphaltene precipitation are different from one well to another, from the high-pressure-temperature reservoir to surface conditions. All these factors must be investigated on a case-by-case basis. Because the Halfaya oil field is still developing its petroleum sector, modelling, and forecasting the phase behavior and asphaltene precipitation is crucial. This work used crude oil bottom hole samples with an API of equal to 27 from a well in the Halfaya oil field/Nahr-Umr formation to create a thermodynamic model using Multiflash software. The data included the compositional analysis, the PVT data, and reservoir conditions. The thermodynamic model of asphaltene phase behavior was proposed using the Cubic-Plus association equation of state. All the screening techniques' results revealed the presence of an asphaltene precipitation issue (asphaltene unstable), which was confirmed by a thermodynamic fluid model. The aim of this paper is to predict the problem of asphaltene precipitation so that future proactive remedial methods can be developed to decrease the time and expense associated with it.

Keywords: Asphaltene, precipitation, Screening methods, CII, Multiflash software.

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1- Introduction

Fossil fuels, such as oil and gas, cover a significant portion of global energy needs. According to the US Energy Information Administration, global energy consumption would increase by 56% between 2010 and 2040. Because we've ran out of easy oil, the oil and gas industry now has to produce oil and gas in unusual and challenging environments, such as deep waters and difficult-to-reach reservoirs. Implementing a comprehensive flow assurance program, that is, ensuring continuous and cost-effective production and flow of oil and gas to refinery, is one of primary difficulties in the petroleum production [1]. Asphaltene has been a major topic in study over the last few decades; yet, oil corporations continue to have issues with asphaltene deposition, prompting both academics and industry to work together to solve the problem.

Asphaltenes are a polydisperse blend of crude oil's heaviest and greatest polarizable fractions [2]. Bitumen, crude oil, asphalts, and tar-mat all include asphaltenes. Asphaltenes are characterized in current operations by their solubility, being entirely soluble in the aromatic solvents like toluene, benzene, but insoluble in light paraffinic solvent like N-pentane (Normal-C_5) or N-heptane (N-C_7). The molecular weight, structure, and other features of the asphaltenes formed vary significantly depending on the normal alkane employed to precipitate them. The polydisperse nature of asphaltenes accounts for this variation. From the literature survey, Fig. 1-A and B illustrate the separation of asphaltenes from the identical crude oil sample using two distinct precipitants: normal pentane and normal heptane [3]. These figures, on the other hand, show pure asphaltenes extracted from an oil sample in the lab. Separated asphaltenes are not pure during oil production and appear as a second liquid phase, as depicted in Fig. 2.

Precipitation is defined by Zendehboudi et al [4], as the production of the solid state from the liquid phase, whereas deposition is definite as the adhesion of the solid phase to the reservoirs or wall of wellbores, which normally happens after precipitation. Asphaltene may also form flocculation, which are dense clusters of asphaltene [5, 6]. Because the flocculation has a high density, they

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tend to deposit and fill the reservoir's pore throat [7-9]. Several parameters/variables impact asphaltene destabilization (asphaltene precipitation and asphaltene deposition), including temperature, pressure, mixture characteristics, the quantity of precipitation. As a result of the changes in thermodynamic parameters, solid aggregation may emerge. In compared to other thermodynamic and process factors/characteristics, it has been experimentally established that pressure has the greatest impact on asphaltene precipitation [10].

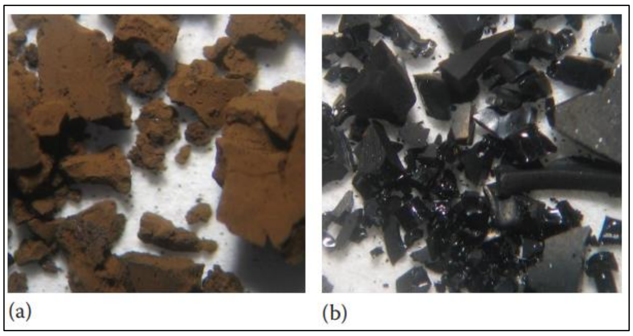

Fig. 1. Asphaltenes Separate from the Same Crude Oil Sample in the Laboratory, Using N-C_5 (A) and (B) N-C_7 [3]

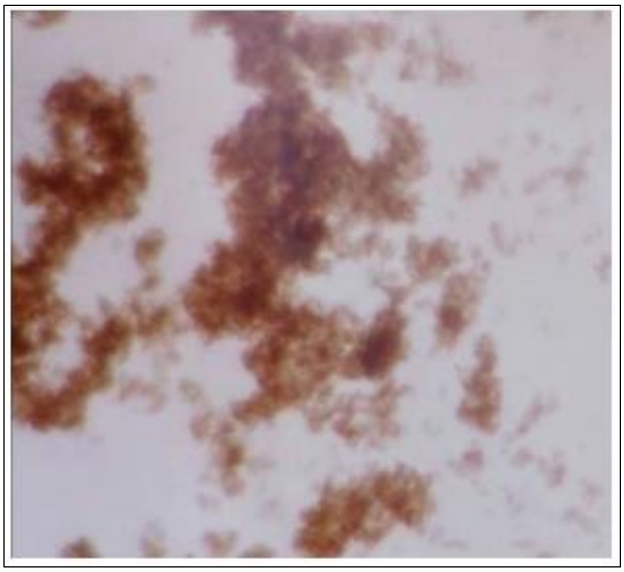

Fig. 2. Asphaltene Sample was Extracted from a Different Source without Any Treatment [3]

Because of its capacity to precipitate, deposit, and so impede the continual production of oil from subsurface reserves, asphaltene is described as the cholesterol of crude oil [11]. Asphaltene precipitation and deposition may negatively affect industrial systems' efficiency (and/or profitability), both upstream and downstream. Asphaltene precipitation and deposition can have negative impacts such as pore throat blockage, altered reservoir wettability, and decreased reservoir permeability. Aside from clogging flow facilities, solids growth in storage tanks, and fouling of safety valves, asphaltene precipitation or deposition in the downstream portion also causes these issues. Additionally, asphaltene may reduce catalyst conversion and activity, which may cause coke to build up in refineries [12].

Numerous methods for detecting asphaltene deposition in conventional oil reservoirs have been proposed, including the De Boer plot [13], the asphaltene/resin (A/R) ratio method [14], the colloidal instability index (CII) [15], the modification colloidal instability index (MCII) [16], the acoustic resonance technique, the filtration method, and the light scattering technique.

To control asphaltene deposition, two types of strategies have been devised and applied: inhibition and treatment. Adjustment of oil production conditions and parameters, as well as the use of chemical inhibitors, are examples of inhibitor strategies. The treatment procedures include biological, chemical, thermal, mechanical, and external strategies [12].

The Halfaya oilfield is located in the Southern Mesopotamian Basin of Iraq. The basin is also known as the Near Platform Flank of the Mesopotamian Foredeep. Similar to most fields in Iraq, the Halfaya oilfield is a NW-SE trending anticline, about 30km long and 10km wide. Warm, shallow water carbonates from the Oligocene to early Miocene and early to late Cretaceous, with sporadic clastic influence, particularly from the early Cretaceous and late Miocene, make up the majority of the petroleum system. To date, 9 oil-bearing carbonate and sandstone reservoirs and 14 oil systems have been discovered in the tertiary and cretaceous and the burial depth is 1900m–4400m. According to the development plan, Halfaya oil field is divided into 7 development reservoir strata.

The issue of asphaltene precipitation and deposition in the Halfaya oilfields/Nahr-Umr formation has received a lot of attention in the past years because much field evidence during logging jobs indicated the existence of an asphaltene issue in this formation's crude oil by detecting the asphaltene suspensions on the bottom hole tools. The main goal of this research was to forecast the precipitation of asphaltene in the HF-oil field using crude oil composition analysis, "Screening Techniques," which rely on sample analysis and reservoir data, and validation of these techniques using Multiflash software at reservoir and surface conditions.

2- Experimental Work

2.1. Materials

a. Reservoir data

Experimental and reservoir data were used in this study to simulate asphaltene precipitation. The simulation program for modeling uses the experimental data from compositional analysis and fluid behavior as input. For this investigation, a well in the Maysan Governorate/Halfaya oil field was chosen, and oil samples were collected from there. The name and specific location of this well are not published in this paper for reasons of secrecy. The well is referred to as HF-X in this study.

Table 1 shows the reservoir data collected from the Ministry of Oil-IRAQ.

Table 1. Reservoir Data

Parameters	It's value
Formation	Nahr-Umr
Reservoir fluid	Oil
Reservoir pressure , psi	5114 psig
Reservoir temperature, F°	243 F°
Saturation pressure @ 243 F°	1863 psig
Wellhead Pressure	893 psig
Wellhead Temperature	91 °F
Choke size	32/64
Sample	BHS (live oil)
Sampling depth	3500 m

b. SARA analysis

Saturates hydrocarbon-Aromatic-Resin-Asphaltene (SARA) crude oil analysis is a physical fractionation method which is based on the hydrocarbon components' solubility and polarity in different solvents and adsorbent materials. It is the most often used method for determining the composition of crude oil [17]. It divides the crude oil into four components. Each of these sub fractions is made up of chemicals with comparable properties [18-19]. N-paraffins, iso-paraffins, and cyclo-paraffins are saturates. Aromatic hydrocarbons are benzene derivatives. Resins and asphaltenes are aromatic ring and polycyclic compounds with certain aliphatic side chains that have a relatively high molecular weight. SARA analysis by high-performance liquid chromatography (HPLC) separates, identifies, and quantifies these fractions. Fig. 3 shows a procedure of the SARA analysis technique for distinguishing between crude oil's components.

1 cm3 of the crude oil is dissolved in n-heptane to make up the sample. The insoluble fraction is retained on the filter after vacuum. The filtered material is weighed and classified as asphaltene. The filtrated Maltenes are then sealed in chromatographic vials and repeatedly injected into the HPLC. At this stage, the separation between saturated and aromatic fractions occurs. Following that, after separation in the column, the sample travels to the UV-Vis and refractive index detectors, which give the analytical response. Due to their high polarity, the resins are trapped inside the HPLC column. To elute that fraction, the columns are back in using a dichloromethane/n-heptane mobile phase. The solution is collected in vials, and the solvent is evaporated under inert gas flow. The resin weight is then calculated by the weight difference. The final results are given the weight percentage of each fraction and the ratios between fractions (Table 2).

c. Compositional Analysis of Reservoir Fluid (BHS)

The measurement of the distribution of hydrocarbons and other components contained in samples of oil and gas is known as compositional analysis. To assess the breakdown of the sample's components, samples are studied using current chromatography methods. Gas compositions are determined by gas chromatography (GC) conforming to a modified GPA Standard 2286-95 method. This standard allows separation and quantification of hydrocarbons from C_1 through C_{15}^+ as well as H_2, N_2, Co_2 and H_2S. Atmospheric liquid compositions are determined by gas chromatography (GC) conforming to an 'in-house' Core Laboratories method. This methodology allows separation and quantification of hydrocarbons from C1 through C_{36}^+ (Core laboratories). Table 3 shows the compositional analysis of reservoir fluid sample as C_{36}^+ and plus-fraction properties.

The impact of increasing or decreasing the mole fraction of each component in the crude oil mixture is explored using asphaltene definition and depending on its solubility approach. Asphaltene becomes unstable (precipitation occurs) when the mole fractions of light components are high (such as: C_1, C_2, Co_2, N_2, etc.), but the opposite occurs with heavy components (such as: pseudo-component). The colloidal theory supports the idea that increasing the amount of resin in the mixture improves the stability of the asphaltene and minimizes the risks of precipitation.

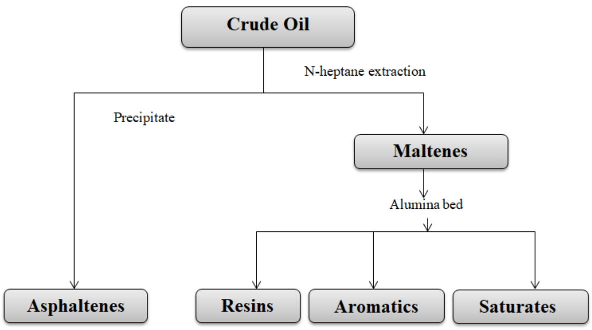

Fig. 3. SARA Fractionation Flowchart [19]

Table 2. SARA Fraction

Fractions	Wt %
Saturate hydrocarbon	63.23 wt %
Aromatic	24.36 wt %
Resin	5.11 wt %
Asphaltene	7.3 wt %
Hydrocarbons Ratio (Saturates / Aromatics)	2.6
Non Hydrocarbons Ratio (Resins /Asphaltenes)	0.7
Hydrocarbons / Non Hydrocarbons Ratio	7.06

2.2. Theory and literature survey

a. De-Boer Plot

De Boer et al. [13] devised a screening approach for determining the asphaltene precipitation tendency. The primary factors are the Hildabrand solubility variables and molar volume, and the model is based on the Flory-Huggins theory. According to De Boer et al., the oil's parameters/properties may be correlated to its in-situ density. They were discovered that lowering pressure reduces the solubility up to the bubble point, whereas lowering the pressure below the bubble point improves the solubility of asphaltene [13]. As a consequence, they proposed three zones inside the differential pressure of initial & bubble point conditions vs solubility at the initial density of the oil to demonstrate where the precipitation possibility is highest [13]. The three zones, namely: (A) severe problems, (B) possible problems, and (C) no problems.

Table 3. The Compositional Analysis of the Reservoir Fluid Sample to C_{36}^+

Component	Recombined Fluid Mole %
H_2	0
H_2S	0
Co_2	1.01
N_2	0.23
C_1	26.84
C_2	7.24
C_3	6.01
i-C_4	1.25
n-C_4	3.6
C_5(Neo-Pentane)	0.01
i- C_5	1.82
n- C_5	2.48
C_6	3.81
C_7 (M-C-Pentane)	0.55
C_7 (Benzene)	0.1
C_7 (Cyclohexane)	0.31
C_7 (Heptanes)	3.08
C_8 (M-C-Hexane)	0.53
C_8 (Toluene)	0.33
C_8 (Octanes)	3.22
C_9 (E-Benzene)	0.23
C_9 (M/P-Xylene)	0.51
C_9 (O-Xylene)	0.2
C_9 (Nonanes)	2.7
C_{10} (1,2,4-TMB)	0.24
C_{10} (Decanes)	2.95
C_{11}	2.82
C_{12}	2.41
C_{13}	2.22
C_{14}	1.85
C_{15}	1.77
C_{16}	1.56
C_{17}	1.32
C_{18}	1.24
C_{19}	1.2
C_{20}	1.04
C_{21}	0.92
C_{22}	0.83
C_{23}	0.75
C_{24}	0.68
C_{25}	0.61
C_{26}	0.56
C_{27}	0.51
C_{28}	0.49
C_{29}	0.46
C_{30}	0.44
C_{31}	0.43
C_{32}	0.38
C_{33}	0.35
C_{34}	0.35
C_{35}	0.29
C_{36}^+	5.27
Total	100%
Molecular Weight of C_{36}^+ (g mol-1)	988.1
Density of C_{36}^+ at 60°F (g cm^{-3})	1.0673

b. Asphaltene Resin (A/R) Ratio Approach

Jamaluddin et al [14] were the first to suggest the asphaltene-resin ratio technique. The model was then modified to identify two separate zones: stable and unstable, with the unstable zone being more prone to asphaltene precipitation due to the asphaltene to resin weight ratio [4].

c. Colloidal Instability Index (CII)

The crude oil is treated as a colloidal solution including the pseudo-components saturates, aromatics, resins, and asphaltenes, according to the Colloidal Instability Index. The CII is defined as the mass ratio of asphaltenes and their flocculants (saturates) to their peptizes (resins and aromatics) in crude oil, and it indicates the stability of asphaltenes in terms of these pseudo-components [20]:

$$\mathrm{CII} = \frac{\text{Asphaltene wt\%} + \text{Saturate wt\%}}{\text{Aromatic wt\%} + \text{Resin wt\%}} \tag{1}$$

The weight percentages derived from SARA analysis are used in the colloidal instability index just as they are in the asphaltene–resin ratio. The CII has been used to evaluate the stability of asphaltenes in crude oil-solvent mixtures. It has been demonstrated that indices related to the CII, such as the Saturates-Peptizers ratio (Saturates/Aromatics Resins), or the Asphaltene-Peptizers ratio (Asphaltenes/Aromatics Resins), may be used to correlate the stability of asphaltenes in crude oils and their mixture. Based on the vast database of crude oils, empirical evidence shows that values of 0.9 and higher suggest an oil with unstable asphaltenes, while values below 0.7 indicate an oil with stable asphaltenes; values between 0.7 and 0.9 indicate an oil with questionable asphaltene stability [20].

d. Modified Colloidal Instability Index (MCII)

In order to reduce the cost of conducting SARA analysis on the one hand and rely on data with reservoir conditions on the other, Akram Hamoudi et al [16] modified the CII equation by using PVT data (compositional analysis by chromatograph) instead of SARA analysis. The new equation named as the modified CII (MCII) as shown in Eq. 2. They employed three wells from Iraq's Kurdistan region in their research. After comparing the results to the original CII equation and using the de Boer plot, they decided that this modification was acceptable.

$$\mathrm{MCII} = \frac{Lc+Mc}{Hc+Nc} \tag{2}$$

Where: Mc = Mole % of medium hydrocarbons, Lc is a Mole % of light hydrocarbons, Nc is a Mole % of Non-hydrocarbons, Hc is a Mole % of heavy hydrocarbons.

- If MCII < 0.7, no Asphaltene problem.
- If MCII > 0.9, Asphaltene problem.
- If 0.7 < MCII< 0.9, may be a problem with Asphaltene.

The reservoir fluid components identified by PVT analysis can replace SARA fractions. Since the components are expressed as mole percentages and add up to 100, the inputs to the equation agree with the original one, but we still need to assign each component to one of the SARA elements. The equivalent SARA percentages for each component are shown in Table 4. The definition of each constituent in the SARA analysis served as the basis for the classification, which is based on molecular weight. For instance, aromatics have the lowest molecular weight, but asphaltenes have the most. The phrase "non-hydrocarbons" has been used to make up for the lost resin weight % because there are no resins. This equation may be changed to produce outcomes that are similar to the test data since the sum of the experimental data and the sum of the CII inputs both equal 100 [16].

Table 4. SARA Fractions Related to Hydrocarbon Components

The Name	Component group	SARA corresponding
Light component	C_1-C_5	Aromatices
Medium component	C_6-C_8	Saturates
Heavy component	C_9^+	Asphaltene
Non-hydrocarbon	CO_2, H_2, N_2, H_2S	Resins

Raad and Ayad Al-haleem [21] used the MCII model to investigate the asphaltene stability of crude oil samples from Buzurgan oil field. After comparing the MCII value to the previous study of this oil field, they found that it confirms the problem of asphaltene deposition in this oil field, demonstrating the accuracy of this equation in predicting asphaltene precipitation and providing more reliability to be used in subsequent studies.

2.3. Asphaltene phase envelope (APE) determination

A software called *Multiflash* was used to forecast the asphaltene phase envelope for the Nahr-Umr crude oil samples. The precipitation of asphaltene during the depletion of a reservoir is using a phase behavior that integrates an advanced solid thermodynamic model. This program enables modeling of up to three fluid phases that are in equilibrium with the solid. *Multiflash* employs the cubic-plus association CPA-EOS, which is the most widely used method for predicting oil and gas phase states. EOS is widely used by *Multiflash* to determine the phase behavior of reservoir fluids. It also calculates and predicts the interaction coefficients that are used to account for interactions between molecules that are not related. Fig. 4 depicts the basic processes involved in modeling an asphaltene precipitation model with *Multiflash*.

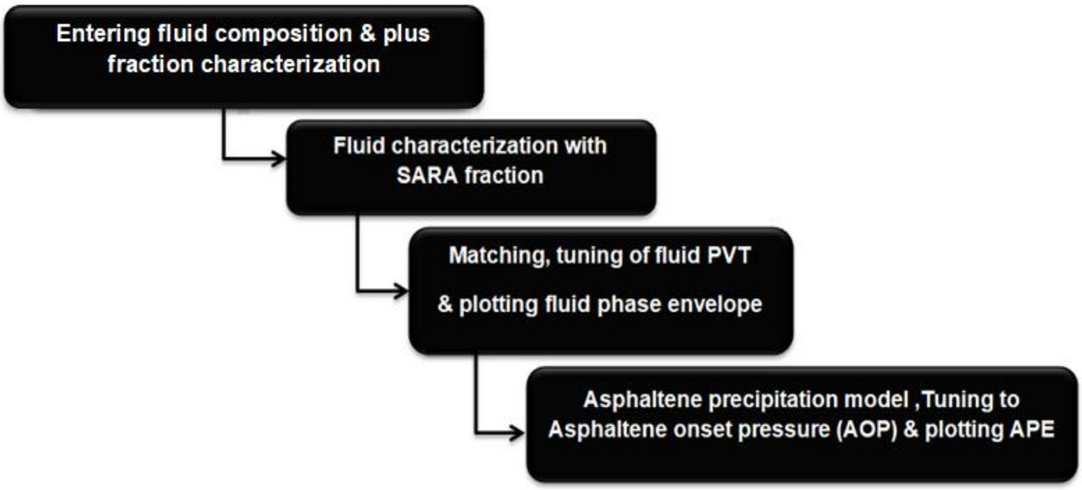

Fig. 4. The Flow Chart of Asphaltene Precipitation Modeling

3- Results and Discussion

a. Investigation of Asphaltene stability using De Boer plot

De Boer et al [13] worked on a variety of samples, both experimental and theoretical, all over the world. They were able to create a plot that is currently adopted by the majority of experts. First, since the samples in De Boers' plot are versatile, and second, because the plot considers reservoir conditions.

After projecting this data onto the plot (Fig. 5) with reservoir pressure = 5114 psig, bubble point pressure = 1863 psig, and fluid density in the Halfaya oil field/Nahr-Umr formation = 0.738 g/cm3, the result indicated that there was a chance of asphaltene precipitation (possible problem) in the HF-X well.

b. Investigation of Asphaltene stability using Asphaltene -Resin (A/R) Ratio

SARA fractionation, which is an analytical technique of dividing oil into four parts according to their polarity: saturates, aromatics, resins, and asphaltenes. It is one of the finest ways to describe an oil mixture. The SARA fraction values from an oil sample recovered from Well HF-X are shown in Table 2. The weight percentage of asphaltene is 7.3 wt%, whereas the weight percentage of resin is 5.11 wt%. The results indicate that the Asphaltene is unstable as well as the possibility of asphaltene precipitation, as shown in Fig. 6.

c. Investigation of Asphaltene stability using Modified Colloidal Instability Index (MCII)

To use Eq. 2, we must first compute the mole percentage of each group (Lc, Mc, Nc, & Hc) for well HF-X, as given in Table 3 and Table 4. Table 3 was divided into four groups, as indicated in Table 5.

$$MCII = \frac{Lc+Mc}{Hc+Nc} = \frac{49.25+11.93}{37.58+1.24} = 1.576$$

Since MCII = 1.576 (i.e. > 0.9), then the Asphaltene is unstable (Asphaltene problem).

Table 5. Classification of Components Corresponding to SARA Analysis

Component	Recombined Fluid Mole %	The Group	mole% summation for each group
H2	0	**Nc (non-hydrocarbons)**	Nc = 1.24
H2S	0		
CO2	1.01		
N2	0.23		
C_1	26.84	**Lc (light hydrocarbons)**	Lc = 49.25
C_2	7.24		
C_3	6.01		
i-C_4	1.25		
n-C_4	3.6		
C_5(Neo-Pentane)	0.01		
i- C_5	1.82		
n- C_5	2.48		
C_6	3.81	**Mc (medium hydrocarbons)**	Mc = 11.93
C_7 (M-C-Pentane)	0.55		
C_7 (Benzene)	0.1		
C_7 (Cyclohexane)	0.31		
C_7 (Heptanes)	3.08		
C_8 (M-C-Hexane)	0.53		
C_8 (Touene)	0.33		
C_8 (Octanes)	3.22		
C_9 (E-Benzene)	0.23	**Hc (heavy hydrocarbons)**	Hc = 37.58
C_9 (M/P-Xylene)	0.51		
C_9 (O-Xylene)	0.2		
C_9 (Nonanes)	2.7		
C_{10} (1,2,4-TMB)	0.24		
C_{10} (Decanes)	2.95		
C_{11}	2.82		
C_{12}	2.41		
C_{13}	2.22		
C_{14}	1.85		
C_{15}	1.77		
C_{16}	1.56		
C_{17}	1.32		
C_{18}	1.24		
C_{19}	1.2		
C_{20}	1.04		
C_{21}	0.92		
C_{22}	0.83		
C_{23}	0.75		
C_{24}	0.68		
C_{25}	0.61		
C_{26}	0.56		
C_{27}	0.51		
C_{28}	0.49		
C_{29}	0.46		
C_{30}	0.44		
C_{31}	0.43		
C_{32}	0.38		
C_{33}	0.35		
C_{34}	0.35		
C_{35}	0.29		
C_{36}^{+}	5.27		
	100%		100%

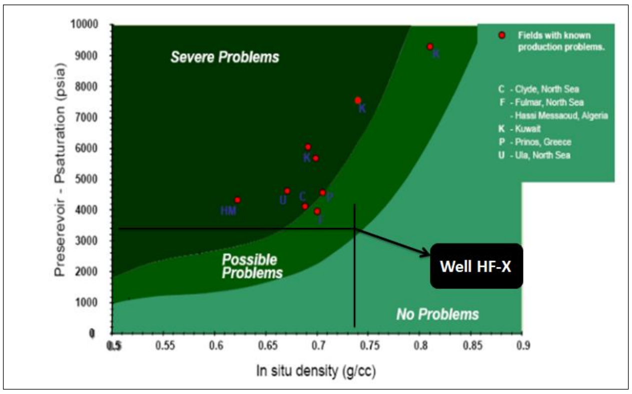

Fig. 5. HF-X Well Examination by De Boers Plot for Predicting Asphaltene Precipitation, De Boer Plot from [13]

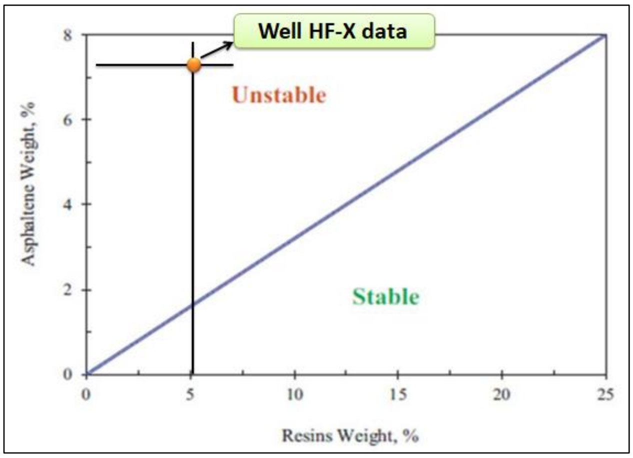

Fig. 6. HF-X Well Examination by Asphaltene/Resin Relationship for Predicting Asphaltene Precipitation, A/R Plot from [4]

d. Investigation of Asphaltene stability using Colloidal Instability Index (CII)

This approach uses Eq. 1 with a saturated weight percent of 63.23 wt percent, an aromatic weight percent of 24.36 wt percent, a resin weight percent of 5.11 wt percent, and an asphaltene weight percent of 7.3 (as given in Table 2). Because the value of CII is 2.39, and it is greater than 0.9, the findings indicate that there is a possibility of asphaltene precipitation (unstable asphaltene). This can be illustrated by Fig. 7.

$$\text{CII} = \frac{\text{Asphaltene wt\%+Saturate wt\%}}{\text{Aromatic wt\%+Resin wt\%}} = \frac{7.3+63.23}{24.36+5.11} = 2.39$$

Because CII= 2.93 (i.e. > 0.9) again there is an Asphaltene problem.

e. Validation of Screening Techniques with a Thermodynamic Model

We plot the asphaltene phase envelope (APE) and project the reservoir and wellhead conditions on it after completing the steps indicated in Fig. 4. Then, from the point of reservoir conditions to the point of wellhead conditions, we construct a line. We can see that the line passes through the three-phase region (APE), which indicates that once the pressure decreases below the AOP threshold, there is a probability of asphaltene precipitation (see Fig. 8).

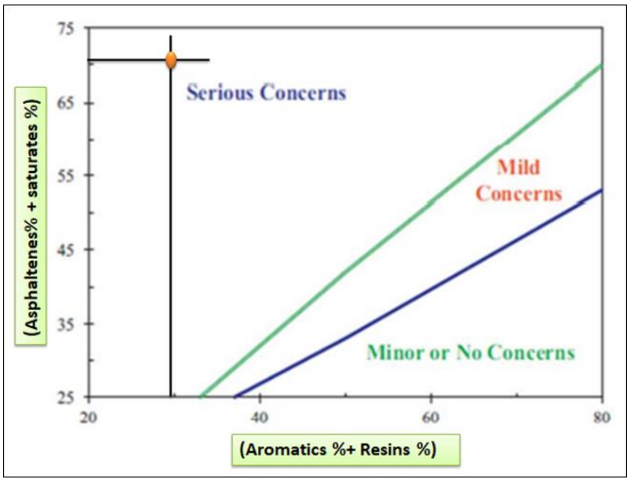

Fig. 7. HF-X Well Examination by CII for Predicting Asphaltene Precipitation, CII Plot from [20]

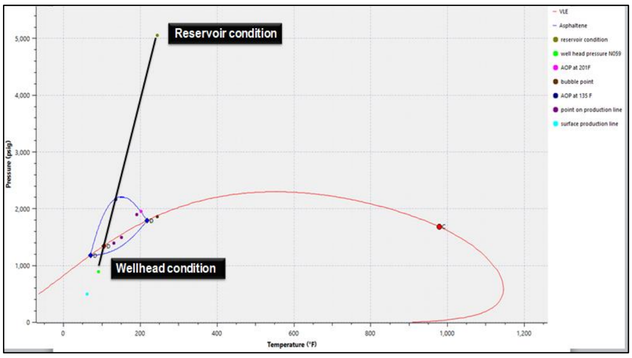

Fig. 8. Phase Diagram of Fluid and Asphaltene

As mentioned in Table 6, the results of the four screening methods may now be compared to the thermodynamic fluid model. Because these approaches indicate that asphaltene is unstable, there is a high probability that the problem of asphaltene precipitation will occur as production time and pressure drop. As a result, we require treatments to mitigate the risks posed by asphaltene deposition, whether in the reservoir or in the wellbore.

Table 6. Summary of Results

The well / Formation / Field	HF-X / Nahr-Umr / Halfaya oil field
De Boer Technique	Possible problem (Asphaltene precipitation)
Asphaltene -Resin (A/R) Ratio	The Asphaltene is unstable
Colloidal instability index (CII)	Unstable asphaltene (Asphaltene problem)
Modified colloidal instability index (MCII)	Unstable asphaltene (Asphaltene problem)
Thermodynamic model using CPA-EOS by *Multiflash*	High probability of Asphaltene precipitation

4- Conclusions

The following conclusions could be drawn from this study:

- Asphaltene stability in dead oil and live oil was predicted using investigation techniques. Data from real-world production systems and simulations of thermodynamic fluid models back up the indicators' efficacy. The need of accurate SARA data was underlined since it allows for more accurate calculation of asphaltene stability.
- Using *Multiflash* software, which employs EOS, the study demonstrated critical stages and methods necessary to complete a phase behavior model for asphaltene in wells in the Maysan Governorate. To model asphaltene, the model employed data from chromatograph and PVT analysis.
- All techniques demonstrated that asphaltene deposition is a real issue in the Halfaya oil field.

Nomenclature

A/R = Asphaltene/Resin ratio
AOP = Asphaltene onset pressure
APE = Asphaltene phase envelope
CII = Colloidal instability index
CPA = Cubic-plus Association
EOS= Equation of state
Hc = Mole % of heavy hydrocarbons
HF = Halfaya oil field
Lc = Mole % of light hydrocarbons
Mc = Mole % of Medium hydrocarbons
MCII = modified colloidal instability index
Nc = Mole % of non-hydrocarbons
SARA= Saturates Aromatic Resin Asphaltene

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التحقق من ترسب الأسفلتين باستخدام طرق الغربلة لعينة نفط من تكوين نهر عمر /حقل الحلفاية النفطي

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الخلاصة

ترسب الأسفلتين له تأثير ضار على عدد من عمليات النفط والغاز، بما في ذلك استخراج النفط، ونقل النفط، ومعالجة البترول. نظرًا للتكلفة الكبيرة لمعالجة ترسب الأسفلتين في إنتاج النفط الخام، فقد تم تطوير تقنيات الغربلة لتقييم استقرار الأسفلت في النفط الخام. تم استخدام مؤشر عدم الاستقرار الغرواني، ونسبة الإسفلت إلى الراتنج، ورسم De Boer، ومؤشر عدم الاستقرار الغرواني المعدل للتنبؤ باستقرار الأسفلتين في النفط الخام في هذه الدراسة. تم شرح طرق الغربلة بالتفصيل بالإضافة إلى النتائج التجريبية التي تم الحصول عليها. تختلف العوامل التي تنظم ترسيب الأسفلتين من بئر إلى بئر، ومن الخزانات عالية الضغط ودرجة الحرارة إلى ظروف السطح، ويجب دراستها على أساس كل حالة على حدة. نظرًا لأن حقل حلفاية النفطي لا يزال في طور التطوير، فإن وضع النماذج والتنبؤ بسلوك الطور و ترسب الأسفلتين أمر بالغ الأهمية. استخدم في هذا العمل عينات للنفط الخام (API =27) من قاع بئر في حقل حلفاية النفطي/طبقة نهر عمر لأنشاء نموذج ديناميكي حراري باستخدام برنامج Multiflash. تضمنت البيانات التحليل التركيبي، تحليل PVT، وظروف المكمن. تم اقتراح نموذج لسلوك طور الأسفلتين باستخدام معادلة الحالة التكعيبية CPA. تشير جميع نتائج تقنيات الغربلة إلى وجود مشكلة ترسيب الأسفلتين (الأسفلتين غير المستقر)، والتي تم تأكيدها باستخدام نموذج المائع الديناميكي الحراري. تهدف هذه الورقة إلى التنبؤ بمشكلة ترسيب الأسفلتين بحيث يمكن تطوير طرق معالجة استباقية للمشكلة وتقليل الوقت والتكلفة المرتبطة بها.

الكلمات الدالة: الأسفلتين، الترسيب، طرق الغربلة، مؤشر عدم الاستقرار الغرواني، برنامج Multiflash.