A STUDY OF ASPHALTENE PRECIPITATION PROBLEMS IN SOUTHERN IRAQI FIELDS

H.L. Swadi
College of Engineering, University of Basrah

ABSTRACT

Asphaltene precipitation is one of crucial problems in oil well production that can lead to unpredictable production trends in oil industry. Several authors have investigated the precipitation of asphaltene and to predict onset of asphaltene, but the problem has not been fully understood yet. In general, two major concepts were proposed to describe the mechanism of asphaltene deposition. The first principle suggests that asphaltene can be dissolved in true liquid state which potential precipitate based on the thermodynamic states; pressure, temperature and fluid composition, while the other principle describe as phaltene to be soil particles which is suspended collide in the crude oil as stabilized by resin modules. The solution of adjustment production system design can be considered as a first step to mitigate asphaltene formation in production system. SARA analysis (Saturate, Aromatic, Resins, and Asphaltene) is a proactive analysis to the crude oil to anticipate the likelihood of asphaltene deposition. It is worth to state the two major evidence of asphaltene deposition, it mostly occurs within bubble point pressure as well as the likelihood of asphaltene precipitation is encountered in light crude oil. There for a deep investigation of oil composition as well as well operation condition should be conducted that require fully integrated design of production system to come up with the optimum operating conditions. In this research, several offset wells that suffers from asphaltene deposition have been analyzed based on the operating pressure, temperature profile, PLT log, SARA analysis and production system design.

Keywords: *Asphaltene; Thermodynamic States; SARA Analysis; Aromatic; PLT log*

1. Introduction

Asphaltene is of the convoluted problem in oil an industry that lead to detrimental effect on the oil production and deteriorate the field development plan. In fact, the asphaltene precipitation cause block off the production path for the oil and eventually lead to shut down the oil well. Many authors have investigated the root causes of asphaltene and some of them related the problem to the alteration in the pressure, temperature and composition of the oil (Alsubaih, et.al., 2019). While the second school of researchers considers asphaltenes to be solid particles, which are suspended colloidally in the crude oil and are stabilized by large resin molecules. However, the problem is not fully understood and expensive cleanup operation are required to re-operate the oil well after being shut down. Basically. the problem may evolve an any stage of the life of oil well especial if the type of oil ranging from light to medium oil. Interestingly, the asphaltene precipitation is rarely occurred in heavy oil if it is operated efficiently (Alsubaih, et.al., 2020). The well is considered in onset of asphaltene problem if it is having high under saturated pressure and consequently the deposition taking place around the saturation pressure (Aqrawi, etal., 2010).

The general proactive procedure is to operate the oil well in the recommended condition by selecting the appropriate choke size bottom hole pressure, and the tubing size which the pith of this paper. Therefore, meticulous monitoring of the production condition is necessitating to ensure asphaltene free production along with trenchant well design. Studying the composition of the crude oil is also crucial in prognosticate the root cause of the asphaltene precipitation that routinely conducted through SARA analysis. Away from formation damage and alteration to the reservoir wett ability, the asphaltene depositing causes a damage to production system component. It is considering a serious petroleum production problem and should be treated efficiency. Contacting the asphaltene envelop is of the effective method to determine the upper and lower limited of the operation pressure in which the asphaltene can be commencement(Ayhan,2002).Furthermore, the tubing size design with a proper choke size can make big different avoiding this problem.

In this paper, several oil well that experience asphaltene problem have investigating and production logs have interpreted in a field in southern Iraq for X- limestone reservoir. Then, asphaltene envelop has constructed to bounded the operation pressure within the safe conditions. After that, the appropriate chose and tubing design have suggested to mitigate the flow blockage in these wells.

2. Reservior Background

X- reservoir is a lower cretaceous formation, which is one of the main producing reservoirs in the south of Iraq. It is comprised of oil-bearing sandstone interbedded with shale sequences with different extension and connectivity between the layers (Khaleel, 2015, Alsubaih, et.al., 2020. Ahmed, et.al, 2021). Some of these shale layers are totally impermeable; therefore, they divide the reservoir in three major units with different formation quality and oil properties; A, B, and C units. Units A and C has similar quality and oil properties (API = 24), while unit B has lighter oil of 32 API. Oil reserve in unit B was estimated to be 72% of the total reserve in X-reservoir, whereas unit A was estimated to have 12 % and the remaining 16% in unit C. Reservoir and aquifer connectivity were observed to be relatively poor in units A and C while this weak aquifer support totally disappear in unit B as shown in Fig. 1.

3. Asphaltene Chemistry

Asphaltene is defined as heaviest and most polarized component of petroleum fluid. It is not pure component and consisting of thousands of salability like species that various in chemical structure, size and shape. On the other hand, asphaltene species have many common features; it is containing n-alkane chains, cyclic alkanes as well as polynuclear aromatics (Siavash, et.al., 2017, Speightand Moschopedis, 1982). Furthermore, it possesses heavy metal such as nickeland iron. Sulphur, nitrogen and oxygen are the heteroatom that also present in asphaltene. Its imputed as well dissolved in aromatic solvent such as benzene, xylene, and toluene but it is not solvable in normal alkane solvent like normal heptane and hexane.

4. Methodology

4(a) SARA Analysis

SARA analysis is the breakdown of the percentage of the saturate, aromatic, resin, and asphaltene in the crude oil. Theory of SARA is come from the classic school of colloidal that assume the core of solid particles are composed of asphaltene surrounded by aromatic and resin. This concept is widely used in oil industry to determine the potential of asphaltene deposition. It is well understood that reservoir with high asphaltene fraction may not suffering from deposition but rather the reservoir with high saturated fraction may be candidate for it(Speight and Moschopedis,1982,Raad and Ayad,2020). The SARA analysis is illustrated in the Fig.2 and procedure of this analysis is out of the paper scope.

4(b) Colloidal Instability Index (CII)

It is defined as the ratio of sum asphaltene and saturate to the sum of resin and aromatic. It is used to indicate the susceptibility of the crude oil to onset asphaltene. CII calculate by formula Eq. (1) (Raad and Ayad, 2020):

CII= Saturated+ Asphaltene/Aromatic+ Resins (1)

Colloidal instability index is utilized to measure the stability of the crude oil as the crude oil stabile that mean the asphaltene will not precipitate. The quantitate evaluation of CII indicate that when CII value less than 0.7 the crude is stable and when it is greater than 0.9 the crude oil is unstable. The value between 0.7 to 0.9 is considered as mild present of asphaltene problem in other word it may or may not occur (Siavash, et.al., 2017and Romanova, et.al., 2006).

4(c) The Asphaltene Problems in Southern Iraq

Asphaltene problems in some X- reservoir wells in southern Iraq fields and find an effective solution. Numerous wells experience flow assurance caused by asphaltene that led to shut in the wells and then rub PLT (production log tool). Table 1 show some wells that experience asphaltene problems with the operation parameters. The majority of this wells are dry well or they have really low water cut. The reservoir pressure of these wells is found to a bit above Psat and it is gradually declining during the last two years.

4(d) Well #1Asphaltene Diagnostic Analysis

The four PLT surveys shows significant variation in temperature and pressure in the wellbore at different time of production. As the conditions are changing and moving toward the Asphaltene envelope, asphaltene was forming in the wellbore at depth of 3000m and it affected the speed of the spinner. 3000 psi, 180F as shown in Fig.3.

4(e) Well #2 Asphaltene Diagnostic Analysis

Asphaltene was observed to be depositing at depth of 2800 to 3000 psi as the pressure and temperature in this interval is within the asphaltene deposition envelope. It can be noticed the Asphaltenes have an effect on Spinner curves as shown in Figs. (4 and 5). The bigger opening of choke help to minimize asphaltene effects as the rate was higher so it helps to wash out the deposited asphaltene.

5. Results and Discussion

5(a) Thermodynamic Equilibrium Core of the Asphaltene and Tubing Size Investigation

The alteration in the thermodynamic equilibrium is core of the asphaltene remediation in the paper. As clearly find out the problem is observed in the depth interval in which the pressure drop reach to the bubble point pressure. This fact considers a key factor that the designer should consider when the asphaltene inimitable. Thus, it is crucial to design the tubing and choke sixes that insure shallow asphaltene dropout that consequently cause ow hydrostatic column and sufficient pressure to push the asphaltene out. According to asphaltene envelop, the pressure range to onset dropout is 2605 to 3270 psi while the temperature bounded between 158 to 210 F. The saturation pressure is around 3050 psi while reservoir temperature 210 F.

Fig.6 show the investigation of different tubing size and it can be concluded that tubing size of 5 inch is sufficient to achieve the required driving force to push the asphaltene and mitigate the effectiveness of tubing blockage.

In other hand, the later conclusion in agreement with pressure drop for tubing 5 inch as illustrate in Fig.7 which more than 2000 psi.

The choke sizes evaluation for 5-inch tubing can be buttress the concept of priding sufficientlifting force to the hydrocarbons inside the tubing that reach to 2200 psi when 0.75 choke being used as indicated in Fig.8. However, the production rate has decrease from 3000 STB/day to 2500 STB/day but it is help significantly in mitigate the rate of asphaltene precipitation.

5(b) SARA Analysis and Colloidal Instability Index (CII)

The offset wells data from field in southern Iraq have been collected and used in this analysis. The SARA and CII have summarized in Table 2 for two wells. Then PVT and reservoir properties data were fed to a commercial software to predict the onset of the asphaltene. Also, production history of the wells was investigated and revealed the choke sizes were not properly selected.

All last date has fed to a commercial software and asphaltene envelop were constructed in which the upper and lower limit of the onset asphaltene has determined in different range of temperatures as shown in Fig.9. After that, since the asphaltene precipitation have been diagnostic in different depth interval inside the tuning, pressure gradient analysis has conducted.

6. Conclusion

The design of the petroleum production system components has massive effect on the overall thermodynamic that related directly on the asphaltene dropout. By changing the tubing, choke sizes and production rate the likelihood of the onset asphaltene can be reduced by proving sufficient pressure to left any accumulation to undesired product out of the tubing. This method can make big different in remediation and mitigation this problem in cost effective manner.

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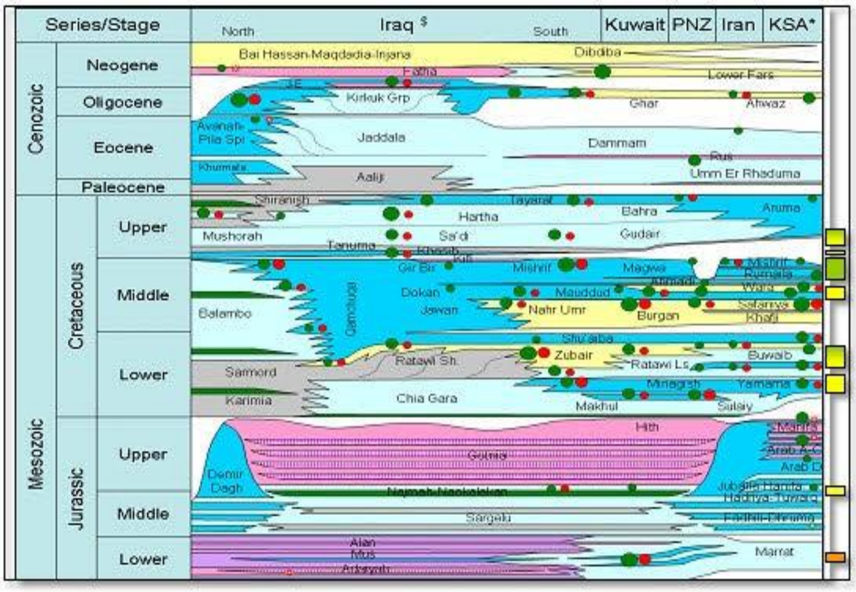

Figure 1: X- Reservoir in Southern Iraq

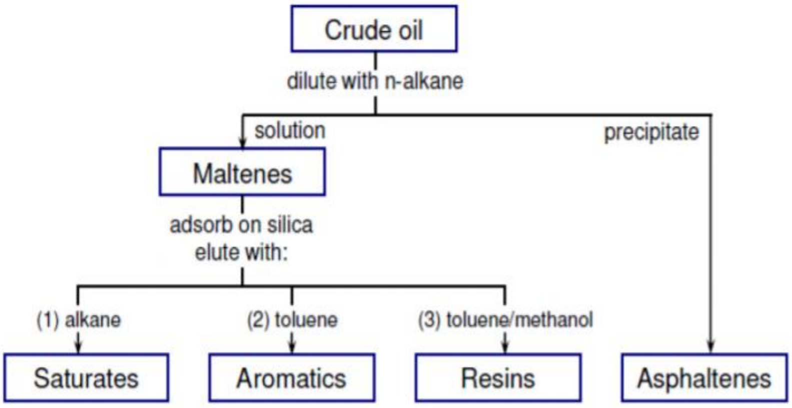

Figure 2: SARA Analysis.

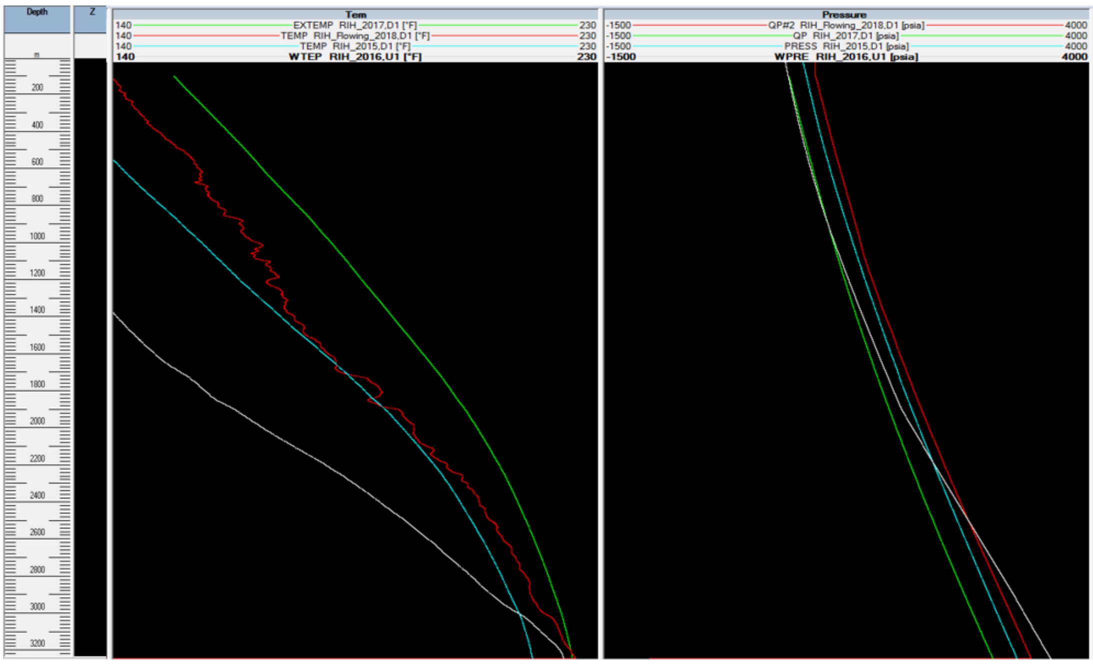

Figure 3: PLT Log for Well #1.

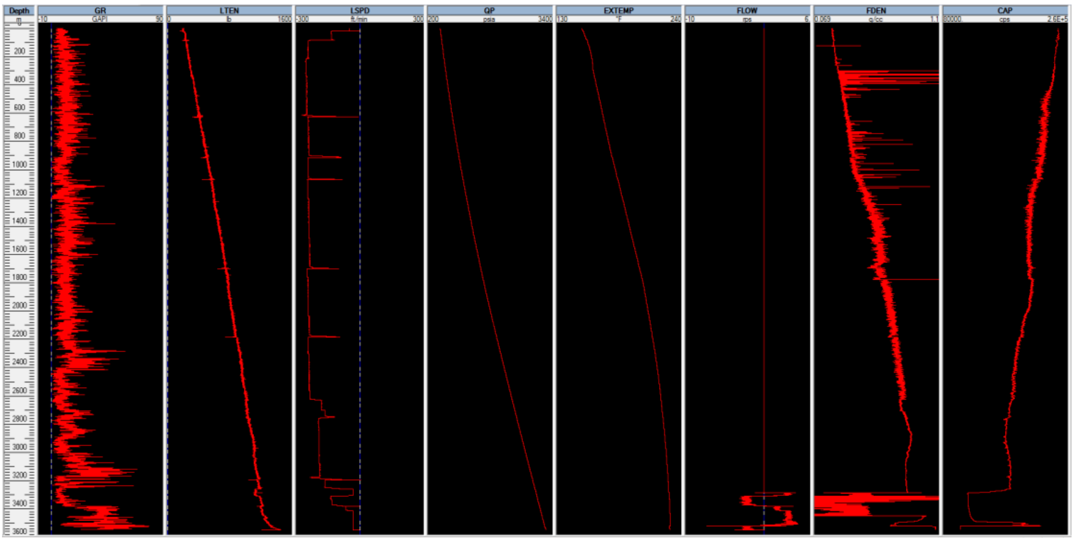

Figure 4: PLT Log for Well #2

Figure 5: The Asphaltene Accumulation Effect on PLT Tool.

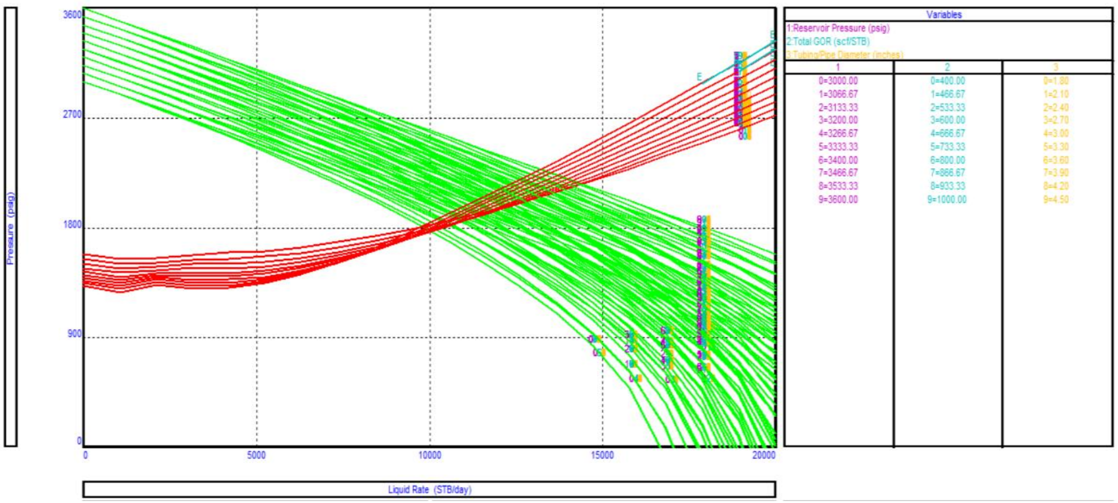

Figure 6: Tubing Size Investigation

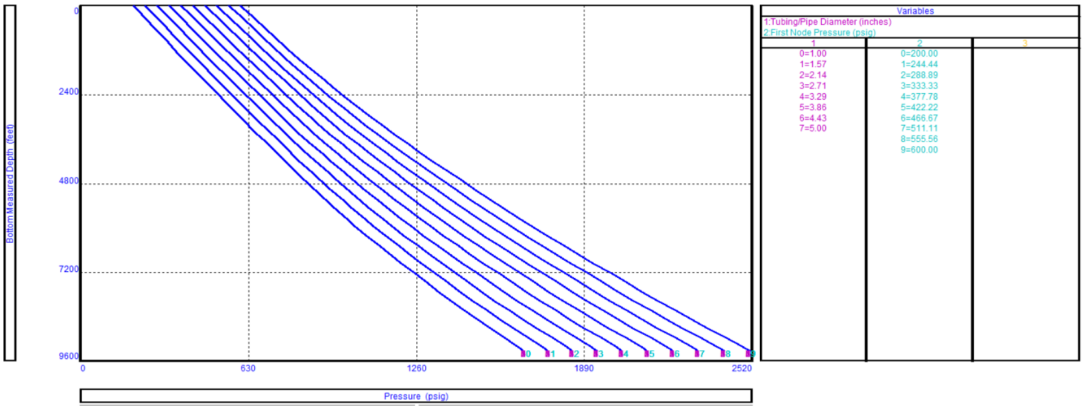

Figure 7: Pressure Gradient for Several Wells

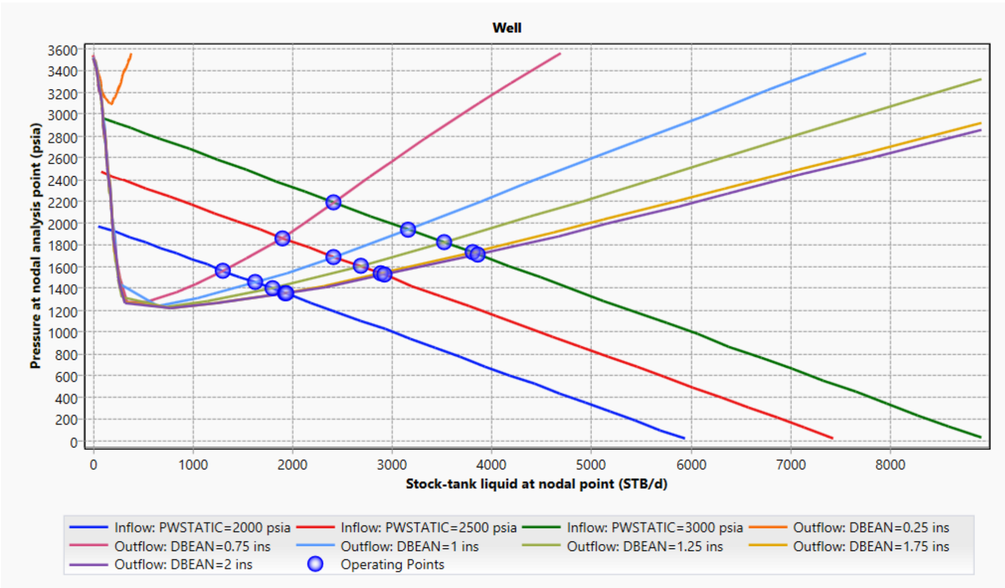

Figure 8: Investigation of Choke Performance.

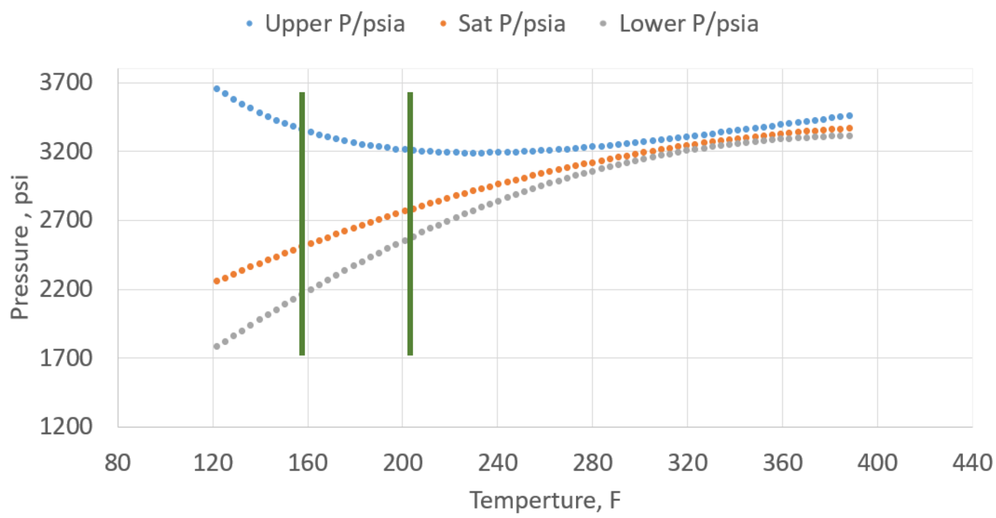

Figure 9: Asphaltene Envelop

Table 1: Production History For Some Wells in Southern Iraq

Well	Utility	Status	Pressure (Psia)	Date	Production rate bbl/day	Choke
1	Producer	Flowing	3401	2018	2815	32
2	Producer	Flowing	3512	2018	3697	74
3	Producer	Flowing	3404	2018	2740	50
4	Producer	Shut in	3490	2018	≈1500	
5	Producer	Flowing	4043	2018	4534	64
6	Producer	Flowing	3778	2017	4050	50
7	Producer	Flowing	3755	2018	2554	32

Table 2: SARA Analysis for Two Wells in Southern Iraq

Properties	Well #1	Well #2	unit
Wax Appearance Temperature	18.5	<-3.0	°C
Wax Dissolving Temperature	30	<-3.0	°C
Total Acid Number	0.05	0.03	mg KOH/g
SARA Analysis			
Saturates	49.4	27.7	%wt
Aromatics	37.4	47.8	%wt
Resins	11.0	14	%wt
Asphaltenes	2.2	10.5	%wt
CII	1.06	0.62	