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Research paper

Studies on Effect of Temperature on Asphaltene precipitation using Multi Stage Extraction

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Abstract

In the case of asphaltene extraction, single stage extraction given a maximum yield at 30°c with the sample to solvent ratio of 1:25. The time taken for the extraction process is 24 hours. In the case of long step extraction process its sample to ratio is 1:4. When the temperature increased in the process the yield also started increasing. The maximum yield we could get in the temperature range of 30°c to 50°c. It is possible to reduce the extraction time by increasing the temperature and it gives a good yield of asphaltene with the usage of multi-stage process. It increased the asphaltene presence about 69% in the solvent. The asphaltene yield at 30°c give raise an extraction of 85% in a six-stage extraction process. It is possible to get the same extraction percentage in a temperature of 50°c with three stage extraction process.

Keywords: *Asphaltenes, Single stage extraction, Multi stage extraction, Extraction time, Yield*

1. Introduction

Crude of petroleum may be very complicated for the low-boiling point components (Hobson,et al 1986). Easy analytical checks are made for the crude oil and the results are used with empirical correlations to evaluate feed crude for the specific refinery. Crude characterization is crucial to estimate feedstock properties for refinery devices, produce an optical quantity of completed merchandise and to provide an economic assessment for crude oil. Mostly there are two varieties of crude oils, light crude oil and heavy crude oil (Bhatnagar, et al 1996). Each and every crude oil includes many components in it, maltenes and asphaltenes (Dave, et al 1996). Maltenes are soluble and asphaltenes are insoluble are insoluble components. The heavy crude oil possesses more amounts of asphaltenes in comparison with the light crude oil (James G. Speight, et al 2001). Asphaltenes are the maximum polar and heaviest components of crude oils (Auflem IH, et al 2002). Asphaltenes consist of polyaromatic condensed earrings with short aliphatic chains and heteroatoms inclusive of nitrogen, oxygen, sulfur, and various metals crude oils soluble in aromatics consisting of benzene and toluene, however are insoluble in mild aliphatic together with pentane and heptane(Piyarat Wattana, et al 2003). The petroleum asphaltenes is a capital causes for precipitation throughout oil recovery process, causing the problem of natural deposition and water-in-crude oil formation. During the field operations asphaltenes mostly used to precipitate because of stress, temperature, and composition of crude oil. In addition asphaltenes make contributions to the high viscosity and the coking tendency of heavy oils and bitumen. Precipitation and deposition of asphaltenes will occur in production of reservoir fluid, transportation of produced fluid and processing operations (L. A. Pineda, et al 2007). The asphaltene contents present in the crude oil will cause problems during the process of production and refining of crude oil as well. In production, the main troubles are the reservoir damage, discount of nicely productivity, plugging of the tubing (Martin Fossen, et al 2007). Manufacturing centers are also feel many problems with the properties of the asphaltene also the crude oil value will come down with the percentage of asphaltene content in the crude oil. So it is more important to reduce the amount of asphaltene in all the aspects. To reduce the amount of asphaltenes from the crude oil there are many techniques available like, precipitation, adsorption, and de-structurisation (C. A. Nwadinigwe, et al 2015). Precipitation method is very useful method in these and it can be optimized with changing some factors like temperature, pressure, and composition of the crude oil (Sebastien Simon, et al 2016). Lowering the pressure and combination of oil with injected solvent in stepped forward oil healing are successfully inducing of asphaltene precipitation in reservoir (Makhmut R. Yakubov, et al 2016).

2. Materials and Methods

2.1. Sample source

Crude oils gathered from South India and Gujarat, North India and ONGC-Rajahmundry, denoted by Crude 1 and Crude 2 were subjected to asphaltene extraction.

2.2. Sample preparation

The process was carried out the usage of non-stop agitating with the help of a stirrer (eyela, nz-1000 series) at a 120 rpm. Extraction of asphaltenes from oil became executed in a Multi stage extraction at room temperature for 48hrs. Six versions of the sample to solvent ratio (1:10, 1:15, 1:20, 1:25, and 1:30 w/v) had been examined in a 150 ml beaker. Oil samples weighing 1 g had been positioned in 10 ml, 15ml, 20ml, 25ml and 30 ml of pentane so one can put together sample combos. To get impact of temperature on yield of asphaltene the process is carried at 25°c as well 30°c, 40°c and 50°c. The range of extraction degrees and most excellent extraction time had been determined. In a sample ratio of 1:25 asphaltene is extracted at temperature ranging 30 °C and 50 °C. At each temperature, the time for extraction is between 5 to 150 min so that the amount of time in every condition can be understood.

Multistage cross-current extraction became used to decide the ideal variety of extraction levels. The extraction procedure can be done in a stirring tank.

2.3. Multi stage Extraction

Firstly, the solvent is added to the feed and the residue is separated by mixing and settling. Then it is again extracted by clean pentane at every extraction level (6stages). Residue separation is done in filtration step and the extracts were accumulated and these extracts were measured as the proportion of asphaltenes (asphaltenes/oil).

3. Results and Discussion

The four physical properties specific gravity, API gravity, pour point and viscosity of samples were given in Table1. Higher specific gravity of the Oils indicates the more resistance to flow. Likewise, API gravity less than 200 considered as Heavy crudes.

Table 1: Physical properties of crude oils

Properties	Units	Method	Crude 1	Crude 2
Specific gravity	None	Hydrometer	0.935	0.952
API gravity	°API	ASTMD 28	19.28	16.97
Pour point	°C	IP15/55	8	31
viscosity	CP	P226/91	1.98	3.01

The characterisation of the samples has given in Table 2. The crude oil sample contains 24.3% and 11.36% of the dry weight amount of asphaltene contents (Table2). These amounts were made for the asphaltene recovery calculations.

Table 2: Analysis of raw crude oils

Parameter	Crude 1	Crude 2
Maltenic content	75.3%	88.7%
Asphaltenic content	24.3%	11.3%

It is clear that asphaltene yield percentage is increasing with the rise in the sample to solvent ratio. Crude1 sample showing a greater asphaltene yield in this extraction process, but in the case of crude2 sample showing a slight difference in comparison with the crude1. The raise in the sample to solvent ratios ranging from 1:25 to 1:30, and 1:30 to 1:40, contributed a small increase in asphaltene generation in solvent. Sample to solvent ratio 1:25 is obtained as the minimum ratio which is necessary for a stable yield of asphaltene in the solvent. In the extraction process with single stage increased the asphaltene generation in the solvent by raising the sample to solvent ratio. There is no such considerable difference is obtained between 01:25 and 01:30 sample to solvent ratio. So it is very clear that in a sample to solvent ratio of 01:25 is more convenient in this process.Even for a large amount of solvent addition greater than 1:25 in the mixture, asphaltene remained for single stage extraction process.

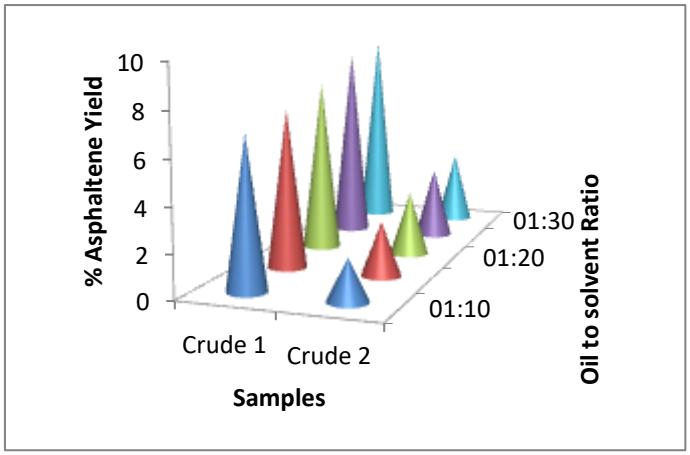

Fig. 1: Weight of Asphaltenes Precipitated for different solvent ratios in samples

For the sample to solvent ratio of 1:25, when the extraction time is raised the asphaltene yield percentage also increasing considerably. It is not possible to give a huge time to get a very accurate extraction of asphaltene in any situation. From this it is advisable to take the extraction time of 72 hours, since asphaltene yield difference in the time of 72 hours and 96 hours is very much low.

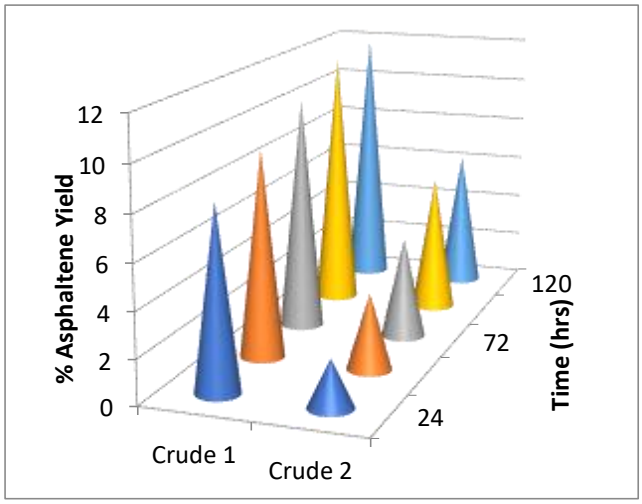

Fig. 2: Weight of Asphaltenes precipitated from sample to solvent ratio of 1:25

For the same sample to solvent ratio of 01:25 effect of stages is checked. To increase the percentage of Asphaltene Yield ,usage of multistage cross-current method can be applied. This method will increase the generation of asphaltene and to minimise the application of large amount of solvent usage.Using same volume of solvent it is possible to extract more amount of asphaltene. The sample to solvent ratio of 1:25 is used in a six-stage extraction process and found convenient for the better extraction of the asphaltene from the mixture. As number of stages of extraction process is increased the extraction of asphaltene also increasing. It is observed that more time is taking to do a variety of staged extraction process, even is not shown a considerable range of asphaltene yield. If temperature also added with the increase in the stages, more amount of asphaltene yield can be extracted.

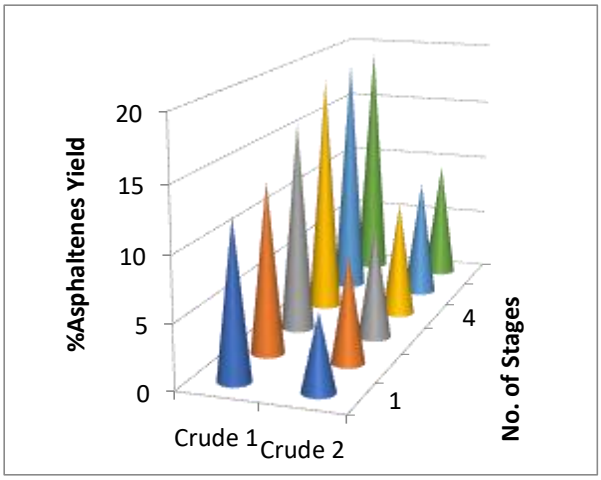

Fig. 3: Weight of Asphaltenes precipitated from sample to solvent ratio of 1:25

Extraction temperature

The extraction of the crude oil sample give almost same amounts of asphaltenes yield at 25°C as well with the 30°C in the case of single stage extraction process. When the temperature is raised in the process the asphaltene amount in the solvent also began to rise. Yield of asphaltenes in crude 1shown the values 12.3%, 13.2% and 16.5% of dry weight with the temperature rise of 30°C, 40°C, and 50°C respectively. High temperature is used to minimize the viscosity and by that to reduce the mass- transfer resistance. When the temperature rise for the extraction process, the diffusion ability of the solute (oil) and solvent rise, which will cause greater generation of asphaltenes.The yield of the oil will reduce because of the less solvent density in sample solution with the increase in the temperature.

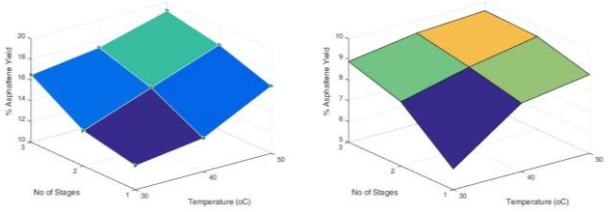

Fig. 4: Effect of temperature on Yield of Asphaltenes

Giving temperature more than the solvent boiling point will not encourage the oil yield. The extraction yield will increase directly with the time taken for the extraction process, specific temperature ranges for the process. So, it is found that the extraction time as well the temperature of the extraction playing a vital role and it affect the overall diffusion coefficient and extraction yield of asphaltene.

3.1. Optimal extraction time at 30 °C and 50 °C

To find out the maximum time needed for extraction of asphaltene two temperatures were selected (30°C and 50°C). After three extraction phases, the yield of asphaltene is increased at 30°C.

There was a rapid increase in the yield during first phase (extraction time from 5-30min.), and there is a slight increase in the 2nd phase (30-60 min.), then the stationary phase was further followed and noted after 60 min. The initial point of saturation of asphaltene is at the extraction time of 60 min. An extraction time of 120 min. resulted in the highest yield that is 3.75% of dry weight, however the extraction time of 30 min. resulted in yield that is 3.29% and 1.44% of dry weight respectively (these are lower than those extracted after 120 min.). These 12% further can be extracted at 90 min.

Multistage extraction are suitable in 30 min (fig 4) at a temperature of 30°C or else if 50°C is used for 5-30 min. that results in highest yield of asphaltenes. However, an extraction time of 20 min. was selected for the multistage extraction at 50°C.The yield will be higher in 50°C than 30°C.These reports were agreed and justified that increase temperature had a positive effect on extraction of asphaltene.

3.2. Cross-current Multi stage extraction at 30 °C and 50 °C

When the extraction was done by a single stage, then some asphaltenes content remained in the residue of oil. Also conclude the optimum number of extraction levels by investigated a multistage method using cross-current extraction at 30 °C and 50 °C. When the crude oil extracted at 30°C using 6-stage (30min/stage) respectively, then the asphaltenes recovery was 80%. Only 3-stage extraction was enough to get 80% asphaltenes recovery at 50°C.

4. Conclusion

When the extraction temperature increases then the asphaltenes yield also increasing in the solvent form biomass. When the extraction was performed at 50°C, then extraction time and optimum number of stages reduced. The percentage of Asphaltene yield recovery was increased by repeated extraction. Required only few stages for operations, cross-current operation is particularly practical and economical and more flexible. A sample solvent ratio of 1:25 at 50°C in a 3-stage extraction (20min/stage) was the best method for Asphaltene extraction form Crude oil.

Acknowledgement

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