ISSN 2181-8622

Manufacturing technology problems

Scientific and Technical Journal Namangan Institute of Engineering and Technology

Volume 9
Issue 4
2024

STUDY OF THE COMPOSITION AND MAIN CHARACTERISTICS OF PETROLEUM OILS AND THEIR EMULSIONS

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Abstract: The article considers the stability features of water-petroleum emulsions formed on the basis of oil from the Northern Ortabulak and Northern Shurtan fields. The study was conducted taking into account differences in the composition of oil, including the content of paraffins, resins, asphaltenes and sulfur, as well as under different temperature conditions. It was found that a high concentration of paraffins contributes to a decrease in the stability of emulsions, facilitating demulsification, while resins and asphaltenes increase the stability of emulsions, hindering their destruction. The results obtained provide an opportunity to better understand the mechanism of the influence of oil composition on the demulsification process and can be useful for increasing the efficiency of oil preparation for processing.

Keywords: water-petroleum emulsions, emulsion stability, Northern Ortabulak oil, Northern Shurtan oil, paraffins, resins, asphaltenes, demulsification.

Introduction. The study of the physical and chemical properties of oil, including density, viscosity, fractional composition, content of resins, asphaltenes, paraffins, sulfur, water and mechanical impurities, allows us to better understand the features of its processing and stabilization of emulsions. The composition of petroleum and its components, such as paraffins, resins and asphaltenes, significantly affects the formation and stability of water-petroleum emulsions, which can complicate transportation and processing.

Emulsions formed during oil production and refining vary in stability depending on the water content and composition of the original petroleum. It is important to understand the impact of these factors on emulsion stability, especially under different temperature conditions, as this allows us to evaluate and improve the effectiveness of demulsifying agents. The behavior of interfacial films formed by resins and asphaltenes has a significant impact on the stability of water droplets in emulsions, which requires additional analysis to optimize their destruction processes.

In this paper, a study was conducted of various oil samples from the Northern Ortabulak (NO) and Northern Shurtan (NSh) fields in order to identify factors influencing demulsification.

Experimental part

The density of oil was determined by the pycnometric method according to GOST 3900-2022. Kinematic viscosity was measured on a VPZh-2 viscosymeter in accordance with GOST 33-2000. The fractional composition of oil was determined by atmospheric distillation according to GOST 2177-99. The content of asphaltene (A) and resinous substances (RS), hydrocarbons and paraffins (P) was studied by the adsorption method according to GOST 11851-85. The total sulfur composition (S) of oil was determined by combustion in an air stream according to GOST 1437-75. The amount of water (W) in oil and residual moisture in dehydrated oil were determined using a Dean-Stark apparatus according to GOST 2477-2014. The amount of mechanical impurities (MI) was measured according to GOST 6370-83.

Results and discussion

Oil from NO (NO) has a higher density (988.4 g/cm3) compared to NSh (912.2 g/cm3). This indicates a higher saturation of heavy hydrocarbons in NO oil. Oil from NO also has a significantly higher viscosity (58.9 mm^2/s) compared to oil from NSh (15.2 mm^2/s). The former also has higher flash points (128.0 ºC) and viscosities (51.4 and 13.6 mPa), which indicates lower volatility of light components.

Table 1. Composition of oils from various oil refineries

Sample	Indicators, %					
	S	CD	A	P	W	MI
NO	2.18	5.32	3.96	1.23	89.2	0,1
NSh	0.79	4.88	2.15	9.56	27	0,1

Based on the data in Table 1, differences in the composition of oil from the NO and NSh fields can be noted. NO oil has a higher sulfur content (2.18%) compared to NSh (0.79%), which requires desulfurization to protect equipment and improve product quality. The resin content in NO oil (5.32%) is also slightly higher than in NSh oil (4.88%), which increases its viscosity and complicates processing.

NSh contains less asphaltenes (2.15%) versus 3.96% in NO, which reduces the density and viscosity of the oil, but simplifies processing. At the same time, NSh oil contains more paraffins (9.56% versus 1.23%), which can lead to its freezing in the cold, requiring additives to improve fluidity.

The water content in NO oil is significantly higher (89.2%) than in NSh oil (27%), which requires additional preparation before processing. Both samples contain the same amount of mechanical impurities (0.1%), which requires filtration to prevent equipment wear.

Based on these oil samples, water emulsions with an oil content of 5-90% were created. For this, oil was mixed with water in a glass beaker using a homogenizer (25°C, 6000 rpm, 10 min). To evaluate the demulsifying ability of the surfactant, the emulsion was poured into graduated cylinders (25 ml), a demulsifier was added and shaken in a shaker for 1 minute. Then the cylinders were placed in a water bath for thermostatting and the start time of demulsification was recorded.

Control samples were treated similarly, but without a demulsifier. To check stability, control samples were left for 14 days, during which time no stratification was observed. Stability was also checked by optical microscopy based on droplet size. All experiments were performed three times. The volume of separated water was recorded visually, and the demulsification efficiency was calculated as the ratio of the volume of separated water to the total volume of the emulsion.

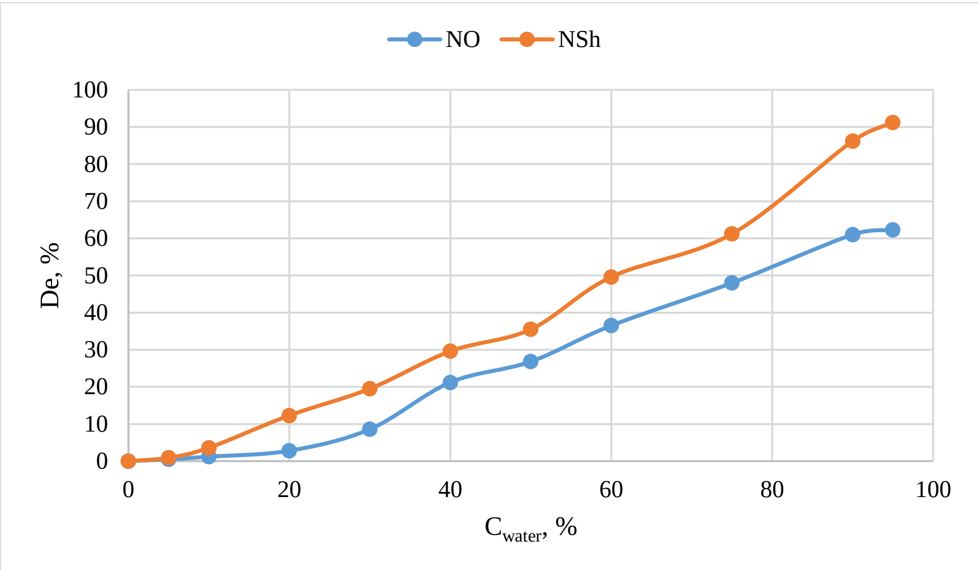


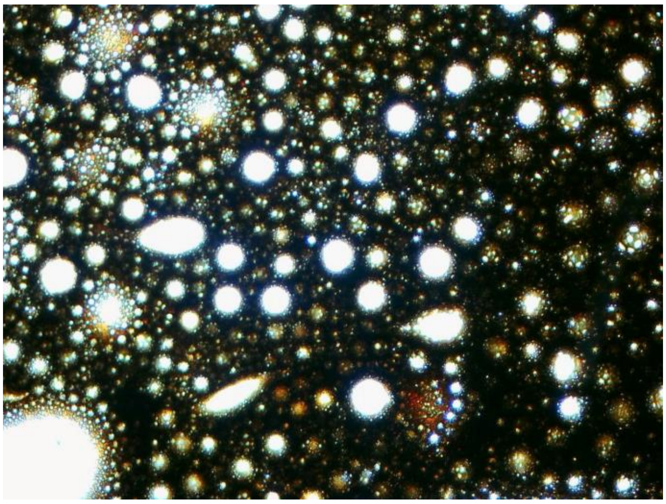
Fig. 1. Efficiency of demulsification of emulsions of various oils at room temperature depending on the water content in the system

Figure 1 shows how the degree of demulsification (DE, %) of emulsions from NO and NSh oils changes with increasing water content. With increasing water content, DE also increases, but emulsions based on NSh oil show higher DE values, especially at 50% water (NSh 35.5%, NO 26.8%) and higher. At the maximum level (90% water), DE for NSh exceeds 80%, while for NO it is only 61%.

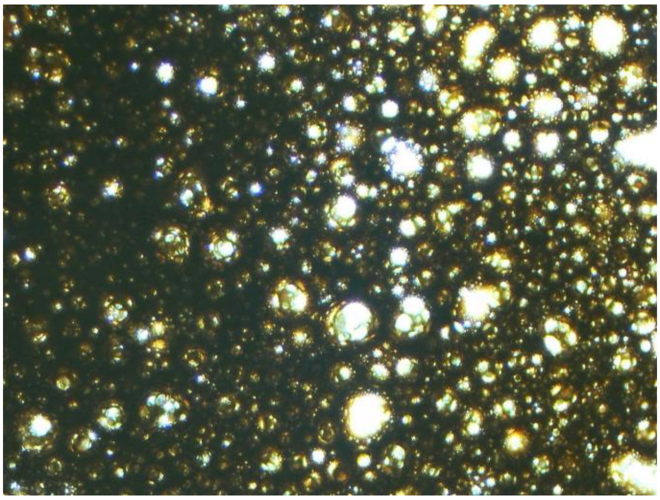
Emulsions from NSh oil are easier to demulsify due to the high content of paraffins (9.56%), which contribute to the formation of fragile emulsions, while NO oil with a high content of resins (5.32%) and asphaltenes (3.96%) forms more stable emulsions. Resins and asphaltenes in NO increase stability by forming structural films that are difficult to destroy, which reduces DE. Also, the high concentration of sulfur in NO (2.18%) increases the stability of interfacial films, complicating demulsification.

Thus, NSh oil forms less stable emulsions that are easier to break, while NO oil requires more effort to demulsify due to its more complex composition.

Figure 2 shows microscopic images of an emulsion with 30% water content stored at 25°C for 14 days. The emulsion based on NSh oil shows larger water droplets compared to the emulsion based on NO oil. The larger droplets in NSh indicate lower emulsion stability, which can be associated with the high content of paraffins, which reduce the stability of the aqueous phase and promote droplet coalescence.



NO



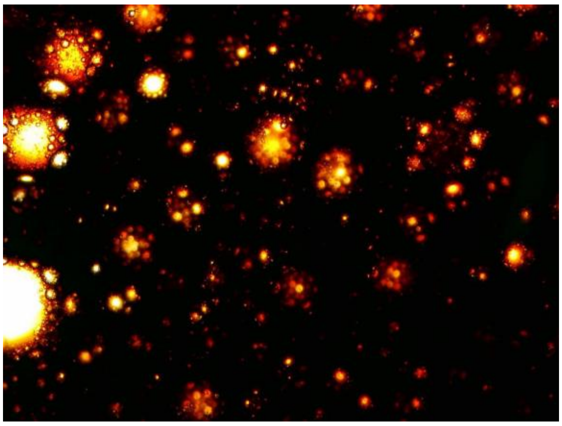
NSh

Fig. 2. Microscopic images of an emulsion with 30% water content.

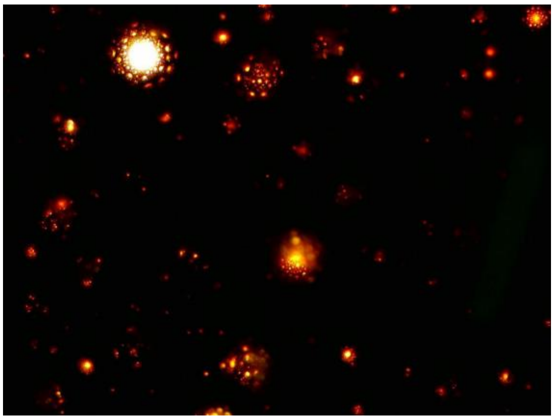
The NO oil emulsion shows a more uniform distribution of small droplets due to the high content of resins and asphaltenes, which stabilize the droplets and prevent them from coalescing. This makes the NO emulsion with 30% water more stable, preventing stratification, while the large droplets in the NSh emulsion indicate a tendency to phase separation.

Temperature affects the stability of emulsions: when it increases, the viscosity of oil and water decreases, which accelerates coalescence. In the emulsion of NSh, with a high content of paraffins, this process is enhanced, since the paraffins become more fluid, leading to rapid coalescence. The interfacial films in the emulsion of NO, stabilized by resins and asphaltenes, also weaken, which reduces its stability when heated.

In micrographs of emulsions maintained at 75°C (Fig. 3), the droplets in the NSh emulsion are noticeably larger, indicating its lower stability at high temperatures, probably due to the high content of paraffins, which promote the merging of droplets.



NO



NSh

Fig. 3. Microscopic images of an emulsion with 30% water content.

The NO emulsion is characterized by a uniform distribution of small droplets, which indicates its greater stability. In the NSh emulsion, water droplets are brighter and more sparse, which may indicate the beginning of phase separation. The dense arrangement of droplets in the NO emulsion indicates its stability even at high temperatures.

At 75°C, the NSh emulsion shows lower resistance to demulsification: large water droplets indicate the destruction of interfacial films. In the NO emulsion, due to resins and asphaltenes, the interfacial films remain stable, preventing the merging of droplets and maintaining the emulsion.

Thus, at 75°C, the NSh emulsion is prone to destruction due to unstable interfacial films caused by the high content of paraffins and the low content of resins and asphaltenes. In contrast, the NO emulsion remains stable due to these components, which maintain finely dispersed droplets even when heated.

Conclusion. The study showed that petroleum composition significantly affects the stability of water-petroleum emulsions. Northern Shurtan oil, with a high paraffin content and a low content of resins and asphaltenes, forms less stable emulsions, which simplifies their demulsification. While Northern Ortabulak oil, containing more resins, asphaltenes and sulfur, forms more stable emulsions that require additional efforts to break. An increase in temperature enhances droplet coalescence, especially in emulsions with a high paraffin content. The results obtained allow us to better understand the demulsification processes and can be useful for optimizing oil preparation for processing.

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