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Demulsification Studies on Crude Oil of Western Onshore Fields

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ABSTRACT

Oil production and transit via pipelines results in the formation of water-oil emulsions due to the presence of shear forces and pressure and it may also contain hydrocarbons such as asphaltenes, waxes, resins, crude solids, and carboxylic acids, which act as natural emulsifiers. The co-production of water and crude oil may cause a number of issues. This could include the cost of pumping or transporting water by tanker or pipeline, corrosion of production infrastructure (such as pipes, pumps, and downstream distillation columns), and industrial catalyst poisoning of the downstream. Demulsification is the process of dissolving an emulsion into its constituent incompatible phases (i.e. water and oil Emulsions are always encountered as planned or natural occurrences in the petroleum business, thus it's a vital process. In this study, oil was taken from the #Ank27 field in the Cambay basin of India in order to investigate the temperature-dosage optimization of the chemical demulsification process. Parameters such as water content, density, API gravity and pour point were determined using ASTM methods Bottle test is employed to check the efficiency of the demulsifiers

INTRODUCTION

Water separation from crude oil is a critical step in petroleum refineries since it is required prior to oil refining. A crude oil emulsion is a dispersion of water droplets in oil.Emulsions are divided into three categories: (i) oil-in-water, (ii) water-in-oil, and (iii) multiple emulsions (like water-in-oil-in-water and oil-in-water-in-oil).In the oil industry water-in-oil emulsions are more commonand therefore the oil-in-water emulsions are sometimes referred to as “reverse” emulsions. Previous scholars have proposed a variety of demulsification procedures; nevertheless, there are two basic demulsification approaches in use today: physical and chemical approaches. In the chemical method, a suitable demulsifier is added to the emulsion, whereas in the physical method, heating, mechanical, or electrical methods are used. The thermochemical approach, which requires heating and the addition of a demulsifier, is the most widely used emulsion separation method in the industry.

❖ Demulsifier Mechanism

The emulsions must go through numerous processes before being split into water and oil phases during the demulsification process. Creaming and sedimentation, flocculation, Ostwald ripening, and coalescence are the mechanisms involved in this process.

a) Creaming and Sedimentation

The difference in density between water and oil causes both sedimentation and creaming. Water droplets in an emulsion settle at the bottom of the continuous oil phase during sedimentation, which is a critical mechanism of petroleum demulsification. Creaming, on the other hand, is the rise of oil droplets to the water's surface. As a result, whether sedimentation or creaming happens is determined by whether the dispersed particles are water or oil.

b) Flocculation

During flocculation, water droplets in crude oil emulsions clump together, generating aggregates called flocs. The amount of water in the emulsion, the temperature of the emulsion, the viscosity of the oil, the density differential between the oil and the water, and the electrostatic field all influence the flocculation rate.

c) Coalescence

Coalescence is an irreversible process in which small droplets merge or coalesce to produce a bigger one, and it is an important phase in fossil oil demulsification. The coalescence process produces fewer emulsion droplets and, almost always, full demulsification of crude oil emulsions. A high rate of flocculation, the lack of mechanically strong coatings, high interfacial surface tension and water cut, low interfacial velocity, and heat are all necessary for successful coalescence.

d) Ostwald Ripening

Another method for demulsifying petroleum is Ostwald ripening. The process by which drops grow in size is known as Ostwald ripening. The process occurs because the dispersed particles within the continuous phase have finite solubility, forcing drops of varying sizes to move toward one another. Larger volume fractions have faster growth since it is easier for the drops to interchange material. The solubility of heavy oil in water or water in oil is limited, slowing the drop growth process. The stability of an oil-in-water emulsion is dependent on the drop growth process via Ostwald ripening.

Materials and Methods

Crude oil was collected from the Western onshore field. The demulsifiers are collected from the industry.All chemicals are of laboratory grade.

- ✓ **Characterization of the crude oil sample**

ASTM methods were used to experimentally determine the characteristics of crude oil such as water content, density, API gravity and pour point.

- ✓ **Water Content**

It's the most important and first test on the crude oil sample. The dean and stark apparatus distillation process was used, and the ASTM D95 test method was followed. For refining, purchasing, selling, and transporting items, the water content of oil products is critical. It was done initially after removing loose water from the sample and then later after demulsification.

- ✓ **Density and API Gravity Determination**

A hydrometer was used in this experiment following the ASTM 287 test method. This method is one of the most practical one for determining the density or relative density (specific gravity) of liquids. It can handle both light and heavy oils. The goal of this experiment is to measure and investigate the density and specific gravity of various liquids using a hydrometer.

- ✓ **Pour Point Test**

Pour point is the minimum temperature at which oil can flow. Below this temperature, an oil loses its flow characteristics, i.e. when it becomes overly thick and loses flow. Because it's used to determine what temperature the oil runs at, it has a lot of implications, especially inside motors.
The ASTM D97 standard is a method for determining the pour point of any crude oil sample. It demonstrates the ability of the oil sample to pump at various temperatures.

Results

- ✓ **Characterization of the crude oil sample**

Determined the parameters of crude oil by ASTM methods.
Loose wate removed from the sample = 22.5%

Table 1 Density, Specific Gravity and API gravity obtained.

S.N.	Parameters	Result
1.	Density	0.8563 g/cm^3
2.	Specific Gravity	0.8480 g/cm^3
3.	API Gravity at 15°C	35.35

Table 2 Demulsification studies on crude oil.

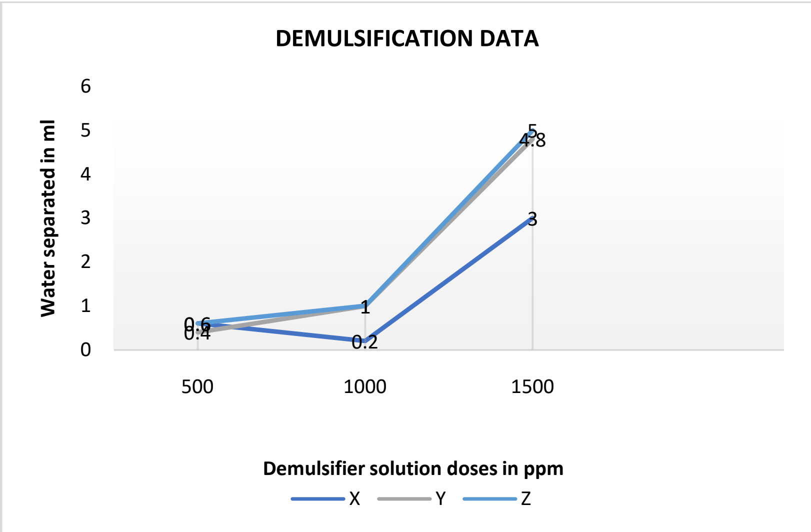
Demulsifier code	Dose (ppm)	Water Content (ml)	Oil Content (ml)	Remarks
X	500	0.6	49.4	-Clear separation -Pale yellow
	1000	0.2	49.8	-Clear separation -Pale yellow
	1500	3	47	-Clear separation -Hazy Water
Y	500	0.4	49.6	-Clear separation -pale yellow
	1000	1	49	-Clear separation -pale yellow
	1500	4.8	45.2	-Clear separation -pale yellow

Z	500	0.6	49.4	Clear Water
	1000	1	49	Clear Water
	1500	5.0	45	-Clear separation - pale yellow

Discussions

Three demulsifiers, X, Y and Z are used in this study. Demulsifier Z at 1500ppm dosage gave the best result. Amount of water separated was 5 ml. The separation was clear and the colour of separated water was pale yellow.Presence of few scattered tiny oil droplets was observed in the separated water. Demulsifier X and Y also showed a similar result with maximum separation at 1500ppm dosage. Similar to demulsifier Z, demulsifier Y also showed the presence of scattered oil droplets in the separated water at 1500ppm dosage. Lower dosages of all three demulsifier produced only a low level of water separation.

Initially. before proceeding to the experiments loose water was removed from the taken sample. 22% of loose water was separated.



Graph 1 : Variation of water separation with respect to demulsifier dosages

Graph showing variation of water separation with respect to demulsifier dosages in various bottle test experiments is given above

Conclusions

The following conclusions were drawn after analysing the results of the experiments:

- For the demulsification of highly stable w/o (water in oil) emulsions, oil soluble demulsifiers are commonly used.
- In all three experiments on the crude sample taken, demulsifiers worked best at high dosages under similar dosing and curing conditions with maximum separation of water.
- According to the results discussed above, optimal demulsification occurred at a dosage of 1500ppm at 90°C.
- There is a slight difference in separation effectiveness depending on the demulsifier used; this can be explained by the demulsifier's affinity for the oil components, as all other conditions (temperature, oil volume, and type) were kept constant throughout the bottle testing processes.
- In order to effectively demulsify tough emulsions, higher doses of demulsifier are required, as well as high temperatures.

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