

# THE ADVANTAGE OF OIL CONTENT IN INJECTION WATER DETERMINATION BEFORE IMPLEMENTATION OF WATERFLOOD IN OILFIELD

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## ABSTRACT

*Before implementation of water flooding in oilfield, it will be good to determine oil content in the injection water. The results of laboratory tests provide valuable and useful information, firstly, whether reverse demulsifier is required or not to reduce oil content in water. Secondly, the test results can select the effective reverse demulsifier. S1 and S2 injection water contain very low oil content, so it is not necessary to add reverse demulsifier in the both injection water. High oil content is obtained in S3 injection. The 50 mg/L DKM reverse demulsifier does not work effectively to reduce oil content in the S3 injection water. Whereas, the 50 mg/L Prolab reverse demulsifier is effective and able to reduce oil content sharply in the S3 injection water with 95.46 % efficiency.*

**Key words:** Oil contents, injection water, methodology, emulsion block, reverse demulsifier

## I. INTRODUCTION

Crude oil is a mixture of a large amount of hydrocarbons, varying amount of waxes and low content of asphaltenes<sup>(1)</sup>. The carbon content normally is in the range of 83-87%, and the hydrogen content ranges from 10-14% (Sjöblom et al., 2002). In addition, small amounts of nitrogen, sulfur, oxygen, nickel and vanadium may be found in the crude oils. When injection water which has high oil content is injected into reservoir as displacement fluid in water flooding process, it will result in emulsion block and can cause plugging in reservoir rock<sup>(2,3,4,5,6)</sup>. Refer to the MIGAS Guidelines in SPE 27177 that the allowable oil content in injection water is 25 mg/L<sup>(7)</sup>. This paper is focused on firstly, to determine oil content in injection water. Secondly, to decide whether or not reverse demulsifier is required to minimize oil content in the injection water. Thirdly, if, reverse demulsifier is required, to determine optimum concentration of reverse demulsifier to reduce oil content in injection water effectively. Therefore, it is very important and useful to determine oil content in the injection water before implementation of water flooding in oilfield.

## II. EMULSION

Definition of an emulsion is a colloidal dispersion of one liquid (disperse phase) in another (continuous phase).

Type of emulsion can be divided into three parts<sup>(8,1)</sup>:

- a. Oil in water.
- b. Water in oil.
- c. Complex/multiple emulsions.

Figure 2.1 shows example of emulsion of photomicrograph:

- a. Water in oil emulsion.
- b. Oil in water emulsion.
- c. Water in oil in water emulsion.
- d. Presence of solids.

As mentioned above when injection water (containing high oil content) is injected into reservoir as displacement fluid in water flooding process, it will result in emulsion block and can cause plugging in reservoir rock as described in Figure 2.2.

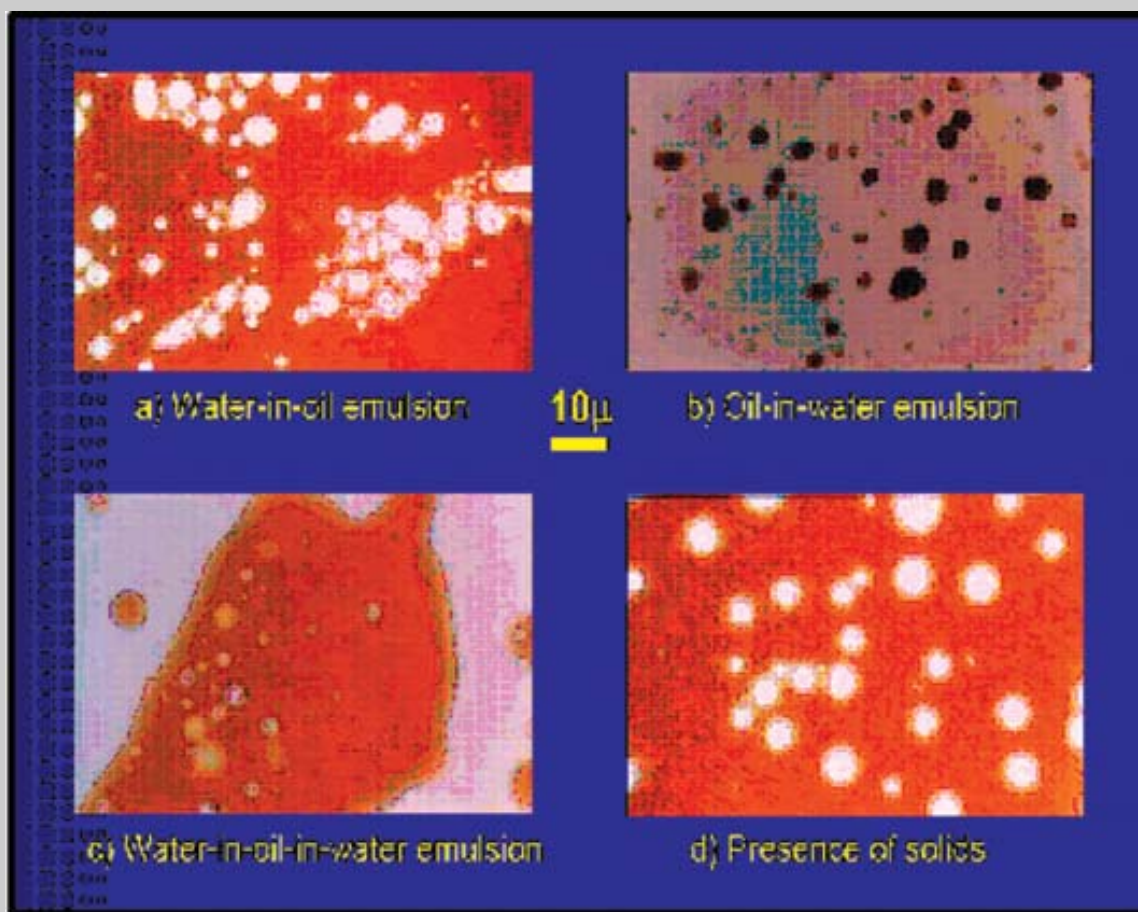


Figure 2.1  
Emulsion Photomicrographs

### III. METHODOLOGY

Infra red spectrometry is used to calculate oil content in produced water samples<sup>(9)</sup>. Principle of infra red spectrometry is to adsorb infra red. Infra red beam is adsorbed by each organic substance with different characteristics, so that the produced adsorption spectrum is specific for each substance. Relationship between adsorption with concentration can be explained by Lamber-Beer law. This law expresses connection between continued intensity ( $I_t$ ) and initial intensity ( $I_o$ ) in a medium with certain thickness. It can be written mathematically:

$$A = \log (I_o/I_t) = a \times b \times c$$

where:

A = Absorbance.

a = adsorption coefficient.

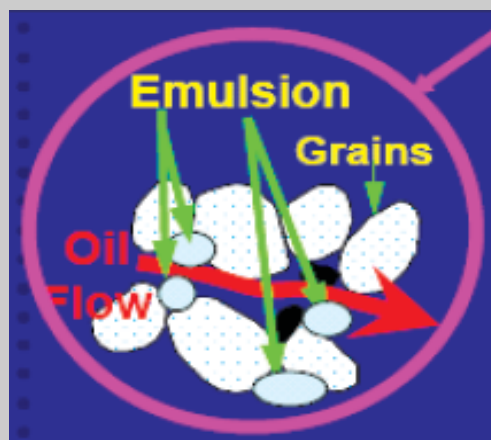


Figure 2.2  
The occurrence of plugging is caused by emulsion block problem

- b = medium thickness
- c = concentration.

In practice, a and b values are constant, so that equation above shows straight line equation. Oil content (ppm) in water sample can be calculated in the equation below.

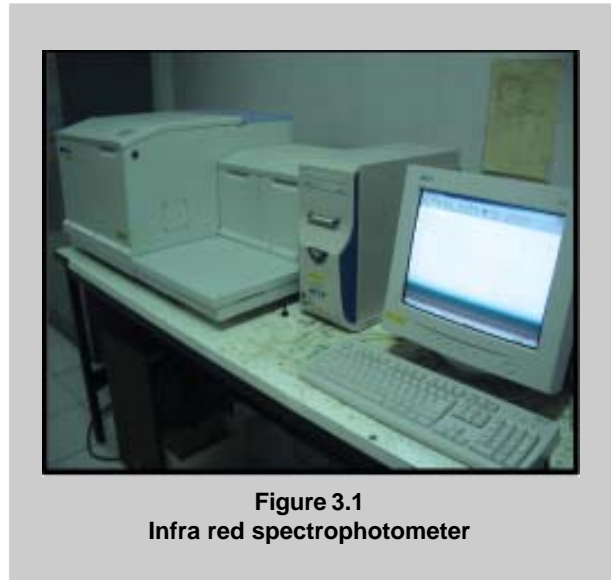
$$ppm = \frac{1000 \times A \times Vol.CCl_4 \times fp}{Vol.sampel \times a_{(std)}}$$

- A = Absorbance
- Fp = dilution factor
- Vol. CCl<sub>4</sub> = volume CCl<sub>4</sub>
- a = adsorption coefficient

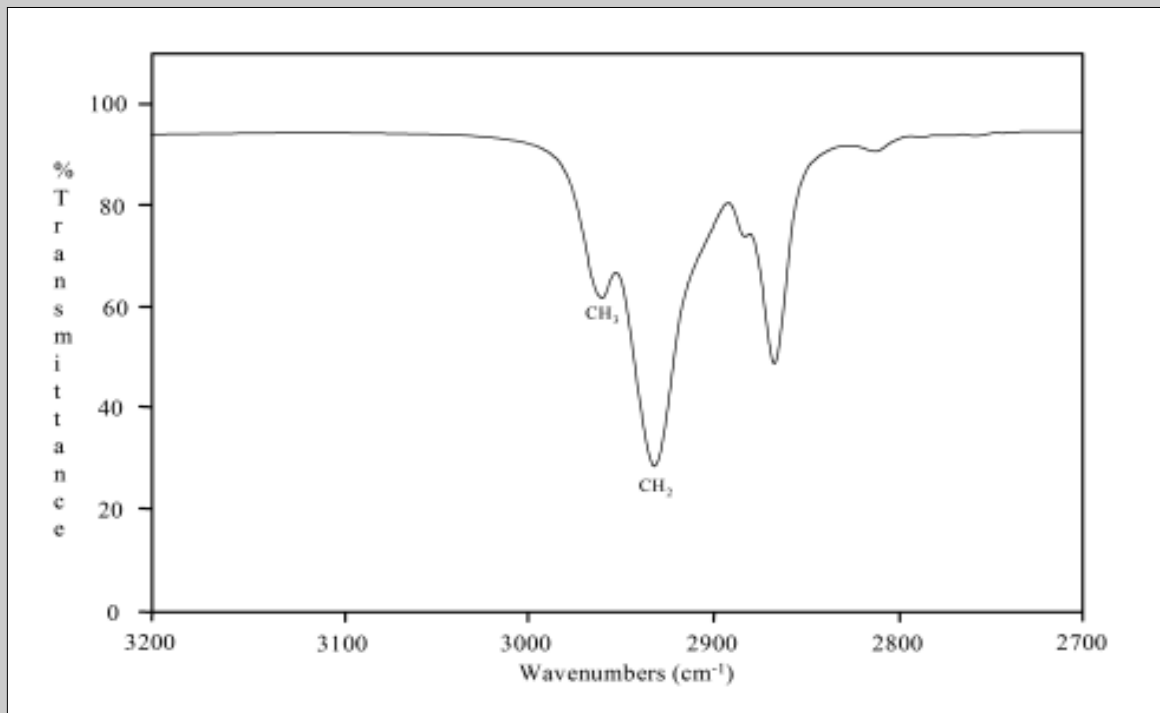
Figure 3.1 is infra red spectrometry equipment. Before the infra red spectrometry equipment is used to determine oil content of produced water sample, at first, the equipment has to be calibrated in order to produce an accurate laboratory test result. A spectrum standard solution in Figure 3.2 shows CH<sub>3</sub> and CH<sub>2</sub> hydrocarbon groups, where CH<sub>3</sub> appears at 2960 cm<sup>-1</sup> and CH<sub>2</sub> at 2925 cm<sup>-1</sup> at wavelengths. While, an example of analyzed water sample spectrum can be seen in Figure 3.3.

#### IV. RESULTS AND DISCUSSIONS

Determinations of oil content in S1, S2 and S3 injection water use CONCAWE I/72 method and infra red spectrometer. Based on the laboratory test results presented in Table 4.1 and Figure 4.1, it can be summarized briefly, that :



**Figure 3.1**  
Infra red spectrophotometer



**Figure 2.2**  
Standard solution spectrum

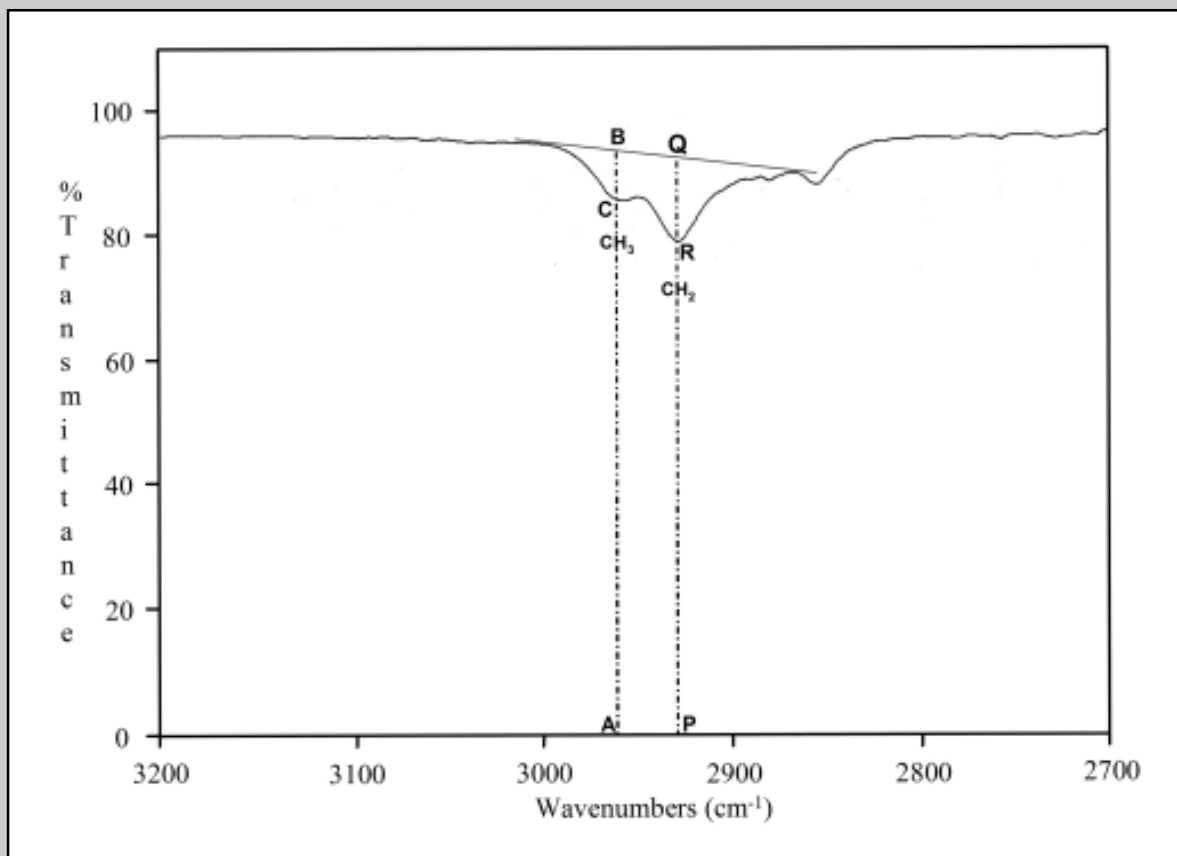


Figure 3.3  
Example of the analyzed water sample spectrum

Table 4.1  
The results of oil content determination before addition of reverse demulsifier into injection water

No.	Water Sample	Oil Content (mg/L)
1	S1 injection water	0.00
2	S2 injection water	1.01
3	S3 injection water	146.79

Table 4.2  
The results of oil content determination after addition of DKM reverse demulsifier into S3 injection water

No.	Water Sample	Oil content (mg/L)
1	S3 injection water	146,79
2	S3 + 2.8 mg/L DKM - RD	137,15
3	S3 + 10 mg/LDKM - RD	133,96
4	S3 + 15 mg/L DKM - RD	129,09
5	S3 + 30 mg/L DKM - RD	118,36
6	S3 + 50 mg/L DKM - RD	96,96

- a. The oil contents are 0.00 mg/L for S1, 1.01 mg/L for S2 and 146.79 mg/L for S3 injection water samples.
- b. S1 and S2 injection water samples contain very low oil content (<25 mg/L). Reverse demulsifier is not required to reduce oil content.

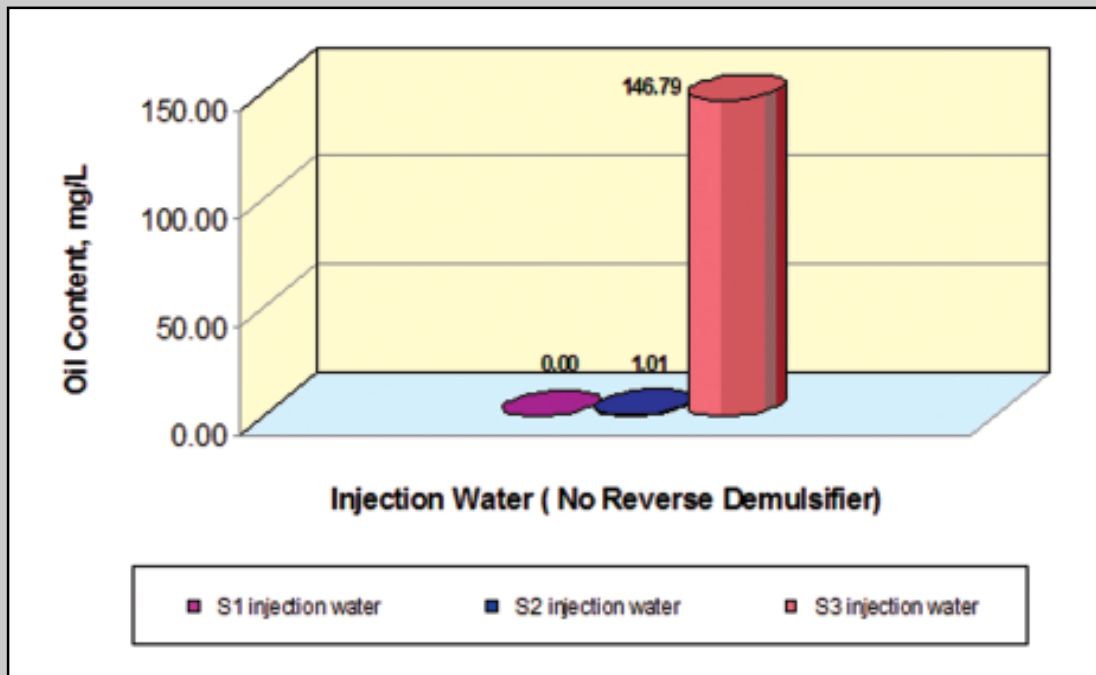


Figure 4.1  
Plot of oil content determination results  
before addition of reverse demulsifier into injection water

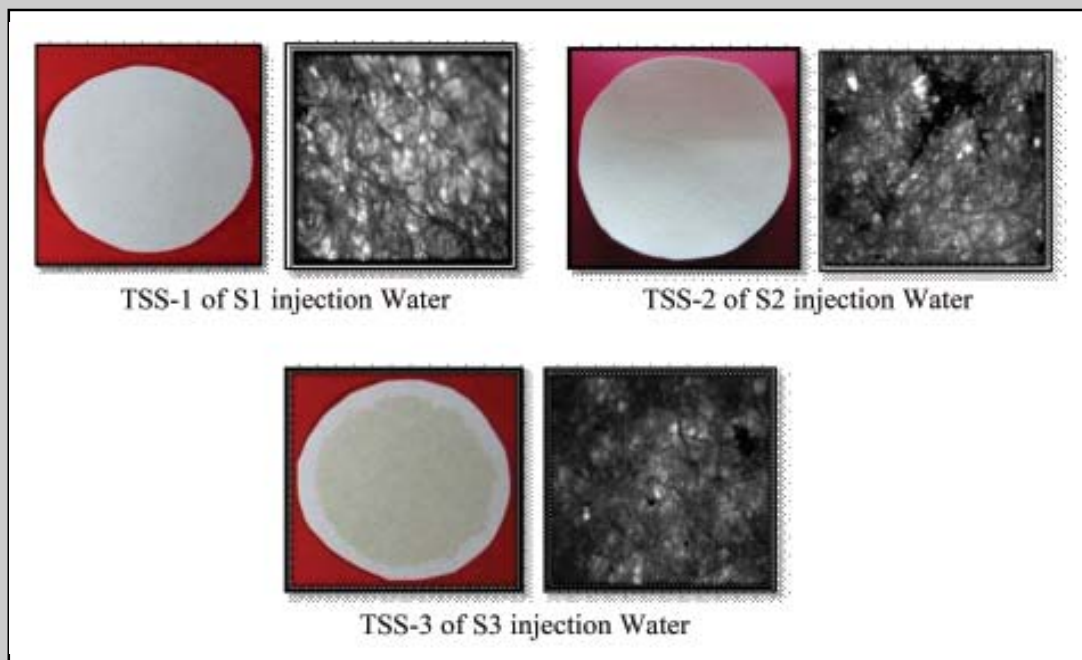


Figure 4.2  
Performance of Total Suspended Solids (TSS) from S1, S2 and S3 water samples

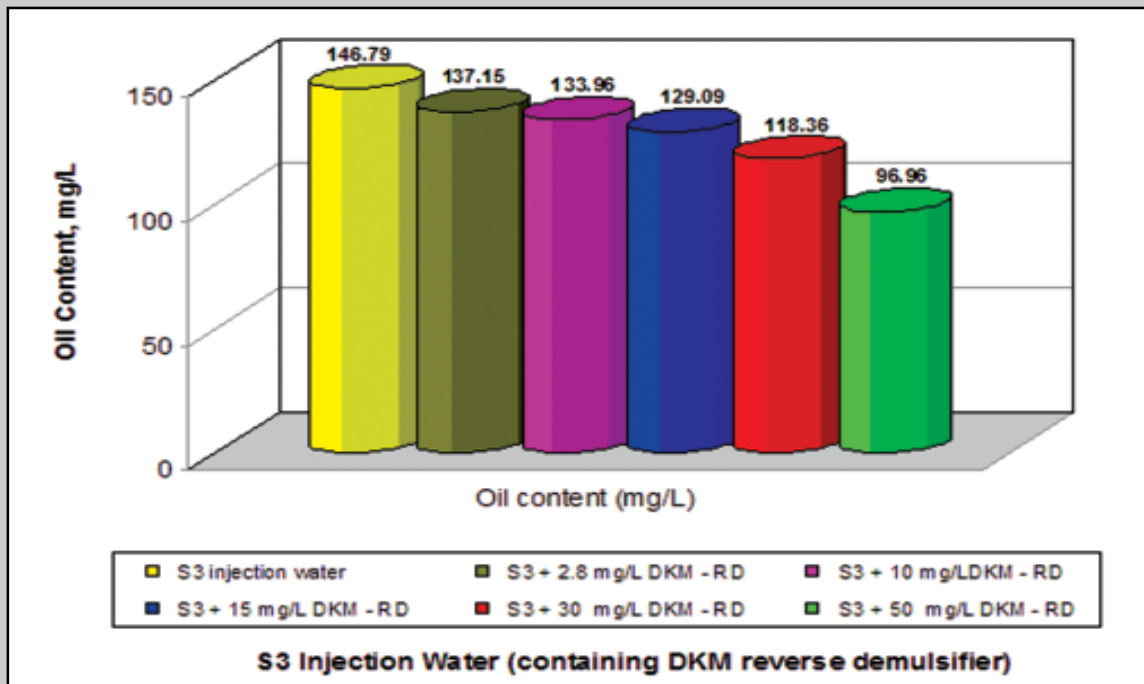


Figure 4.3  
Influence of DKM reverse demulsifier on oil content in S3 injection water

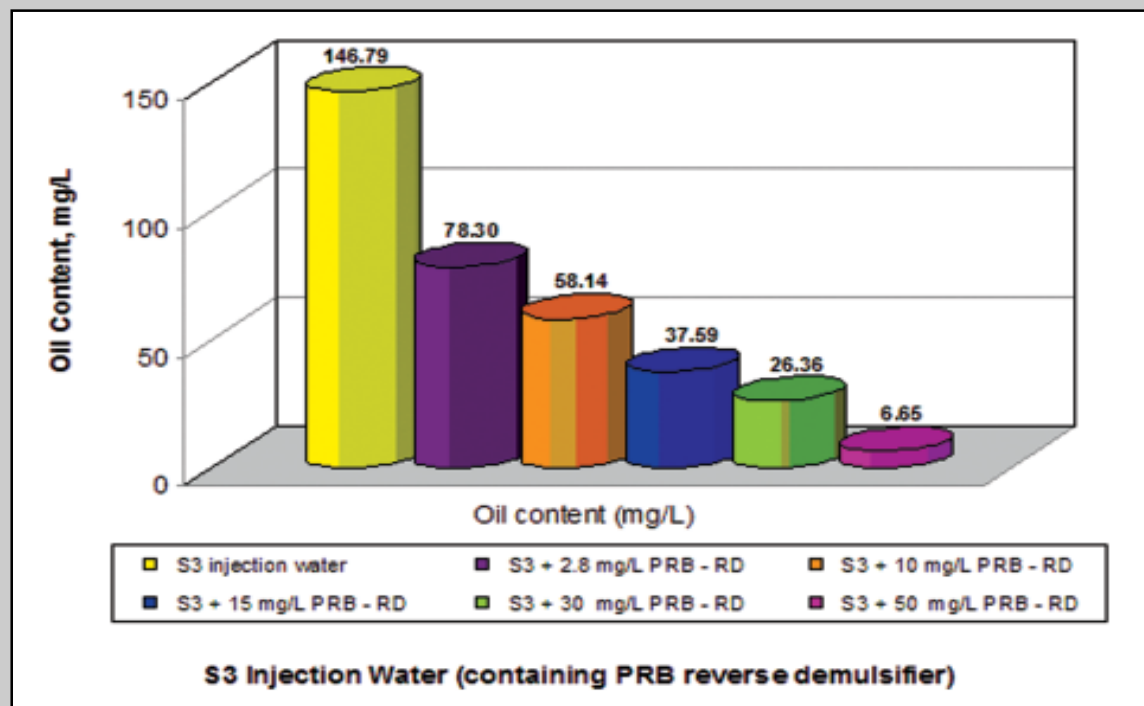


Figure 4.4  
Influence of PRB reverse demulsifier on oil content in S3 injection water

c. The oil content in S3 injection water is 146.79 mg/L. It is almost six times higher than the allowable oil content in injection water based on the MIGAS guidelines. Further treatment by using reverse demulsifier is required to decrease oil content.

To identify whether the are solids particles contain ed in crude oil or not, microscope camera is used to see existence of crude oil content in the analyzed water samples. Performance of total suspended solids (TSS) from S1, S2 and S3 injection water samples can be seen in Figure 4.2.

Two types of reverse demulsifier are used to reduce oil content in S3 injection water, namely: DKM – RD and PRB RD. To see the influence of reverse demulsifier on oil content in water, each reverse demulsifier is added into the S3 injection water at 2.8 mg/L, 10 mg/L, 15 mg/L, 30 mg/L and 50 mg/L concentrations. Next, oil content analysis is carried out. Table 4.2 and Figure 4.3 show influence of DKM reverse demulsifier on oil content in S3 injection water. The DKM reverse demulsifier can reduce oil content from 146.79 mg/L to 96.96 mg/L. The trend of curve goes down gradually or in other word; the DKM reverse demulsifier works with low efficiency around 33.94 % after addition of 50 mg/L DKM – RD into the S3 injection water. Whereas, the PRB reverse demulsifier works very effectively to reduce oil content in S3 injection water. Table 4.3 and Figure 4.4 indicate that after addition of 50 mg/L PRB reverse demulsifier into S3 injection water, the obtained oil content in S3 injection water is 6.65 mg/L with 95.46 % efficiency.

## V. CONCLUSIONS

Based on all laboratory tests results, it can be concluded as follows:

1. The results of oil content determination in S1, S2 and S3 injection water samples are 0.00 mg/L,

**Table 4.3**  
The results of oil content determination after addition of PRB reverse demulsifier into S3 injection water

No.	Water Sample	Oil content (mg/L)
1	S3 injection water	146,79
2	S3 + 2.8 mg/L PRB - RD	78,30
3	S3 + 10 mg/L PRB - RD	58,14
4	S3 + 15 mg/L PRB - RD	37,59
5	S3 + 30 mg/L PRB - RD	26,36
6	S3 + 50 mg/L PRB - RD	6,65

1.01 mg/L and 146.79 mg/L respectively.

2. S1 and S2 injection water donot result in emulsion block problem and donot cause plugging in rock formation, because both have very low oil content (< 25 mg/L).
3. The oil content in S3 injection water is very high (146.79 mg/L). It exceeds the allowable oil content in water based MIGAS guidelines. The fluid results in emulsion block problem and can cause plugging in rock formation.
4. The 50 mg/L DKM reverse demulsifier shows low efficiency (33.94 %), so, DKM – RD is not effective to reduce oil content in S3 injection water.
5. The 50 mg/L RB reverse demulsifier works very effectively to reduce oil content in S3 injection with optimum efficiency (95.46 %).

## VI. ADVANTAGE

The results of laboratory tests give valuable and useful information:

- a. For injection water (containing very low oil content), it is not necessary to buy and add chemical substance (reverse demulsifier) into the injection water.
- b. The effective reverse demulsifier to reduce oil content in injection water can be selected.

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