Effect of Power and Frequency of Ultrasonic Energy towards Diesel Separation from Sand

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Produced sand is considered as one of major problems during the production of petroleum. When produced sand rise up from the well into the separator, it actually contains some crude oil in it. Produced sand cannot be disposed without proper treatment. Therefore, a method for separating the crude oil from the produced sand and at the same time treat the oil sand so that it can be disposed into the environment without harming it has been known as ultrasonic separation technique.

Keywords— produced sand, crude oil, ultrasonic energy, separation method.

I. INTRODUCTION

In oil and gas industry, produced sand or oil sand has been considered as major problem that rises during the production of crude oil. Oil sand is referred to a mixture containing sand, water, clay and bitumen. It migrates from the reservoir induced by the flow of reservoir fluids [1]. When the sand particles started to disintegrate from its parent rock, it will flow along with the reservoir fluids into the borehole. Produced sand is the initial point of various problems which related to oil and gas industry that eventually will affect the completion process [1]. This is because oil sand can caused problems which may affect the crude oil production process. For example, sand production can erode equipment, plug wells, and not to forget reduce well productivity [2].

Restraining forces is the force that hold the formation sand in place by opposing the fluid forces in which restraining forces consist of friction between sand grains, natural cementation, the fluid pressure in the rock's pores, and also the capillary pressure. The engineers must have a detailed knowledge of in-situ, mechanical strength of the formation and the ways in which rocks can fail so that they can predict the Sand Production [1]. Usually there are several factors which affect the production of oil sand such as unconsolidated formations, water break-through for weak to intermediate strength formations, reservoir pressure depletion in relatively strong formations, abnormally high lateral tectonic force in relatively strong formations, and sudden change in flow rate or high flow rate [3].

Oil sands can be found in nearly 70 countries. Alberta, Canada, is home to the largest known oil sands deposits, underlying about 140,000 square kilometers of boreal forest after Saudi Arabia [4]. Although Albertan oil sands extraction was not officially recognized as economically viable until 2003, production in the province are known more than doubled between 1995 and 2004, to 1.1 million barrels a day [5]. It is predicted that the region can produce up to five million barrel per day or maybe more by 2030.

Oil sands possess treat to the environment as it is considered toxic because of the bitumen in mixture. Some of the known environmental effects of oil sand extraction process are: 1. Greenhouse Gases (GHG) emission is intensive, 2. More water is needed for the extraction process, 3. The tailing of the process is toxic and may affect aquatic life, and 4. Reclamation process will be difficult due to tailing as the surrounding changes with the mining and tailing process [4]. Therefore, a separation process of crude oil from produced sand with much greener technology or possess zero treat to the environment is needed for much safer surrounding.

Ultrasonic energy is a mechanical energy which travels through a medium by vibrating particles. The term "ultrasound" applies to all sound waves with a frequency above the audible range of normal human hearing, about 2 Hz to 20 kHz [6]. Ultrasonic or ultrasound cannot travel in vacuum. Some animals utilize ultrasound for navigation (dolphins) or hunting (bats) using the information carried by back-scattering sound waves [20]. It needed medium to travel normally solid, liquid or gasses. Between the three medium, ultrasound travel the fastest in solid for about 5,850 m/s, followed by liquid about 1530 m/s, and gasses about 340m/s [18]. The type of sound waves produced depends on the medium it travels. Ultrasonic or ultrasound is environmental friendly as it possesses neither treat nor effect to the environment.

On the other hand, ultrasound is harmful towards human health and the effect is severe. One of the most well-known effects of ultrasound is hearing loss. Human hearing covers frequencies range between 20 Hz to 20 kHz [28]. Besides that, as ultrasonic waves pass through a tissue they tend to heat it up [34]. It is also claimed that if a person is being exposed to ultrasound at level at least 180 dB for ~50 minutes could be fatal.

II. METHODOLOGY

A. Materials

Materials used in this experiment are sand, diesel bought from Shell, water as medium, a modified container with 68 kHz Piezo Electric Transducer, and 100 watt Power Generator. The volumes of diesel used are 1.5ml and 2.5 ml. The sands were taken from Faculty of Civil Engineering, UiTM Shah Alam. It was later weighted in 10g, 20g, and 30g respectively.

B. Sample Preparation & Equipment Setup

The sand sample was taken to mimic the sand produced during production of petroleum. Firstly, the sand samples were sieved by using 300μm sieve. Sand less than 300μm were removed and later washed using tap water. The sand sample was later filtered to retrieve all possible sand samples. Next, the sand sample was dried in an oven at 60º for 24 hours. After the sand samples were dried out, it was weighted into respective mass which is 10g, 20g, and 30g with ±0.003 error.

As for the diesel, two respective volume were measured which are 1.5ml and 2.5ml using measuring cylinder. The diesel was stored in a 500ml beaker with a sealant to protect the diesel from impurities.

The electrical equipment was setup with the 100 watt Power Generator was placed near the power source. Later, it was connected to the modified container with Piezo Electrical Transducer using electrical wire. The poles of the container were set red for positive, meanwhile black for negative. The Piezo Electrical Transducer has a fixed frequency of 68 kHz.

The sand samples were weighted for initial measurement of 10g, 20g, and 30g using electronic weighting balance. Meanwhile, the diesel was measured at 1.5ml and 2.5ml. The three samples of sand were mixed with 1.5ml diesel first. Later, three sand samples with the same weight were mix with 2.5ml of diesel. All six samples were mixed thoroughly and were left for 30 minutes for the diesel to be absorbed into the sand particles. After 30 minutes, the mixed samples were weighted to measure the weight of sand and diesel together. All measurement for the six samples were recorded for analyzes.

Later, the mixed sample was placed in the modified container attached with 68 kHz Piezo Electrical Transducer and filled with 350ml of water as in F.

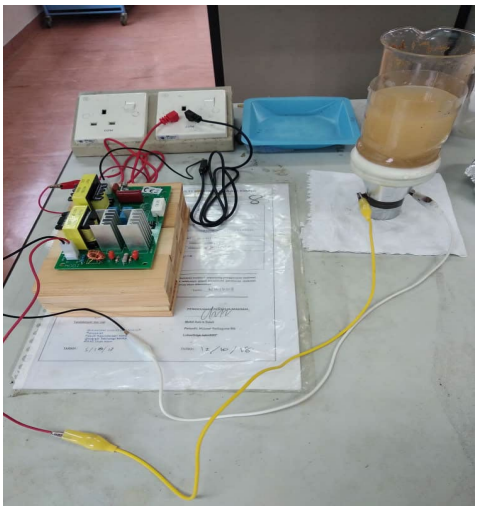

Figure 2.1

C. *Separation of diesel from sands*

This experiment started when the power source turned on and the time for the experiment is set for 30 minutes. The separation process was observed to confirm that separation is happening. After the 30 minutes time set for the experiment run out, the mixed sample was filtered using portable sieve to recover the sand. After that, the sands were dried at room condition on the sample container for a day.

After being left for a day to dry, the sands were weighted again to measure the weight after the separation process. The final measurement of sands after separation is important as it is used to compare with the initial measurement to calculate how much diesel had been separated from the sands. This experiment was repeated for about three times for each weight to get an average reading for each weight. This experiment also being carried out for 45 minutes to compare the separation percentage for each parameter tested.

III. RESULTS AND DISCUSSION

In this test, the weight of the sand was tested to study the effect of ultrasonic energy towards different sand weight. This is to identify whether the weight of the sand affecting the separation percentage as claimed in several journal.

Table 3.1: Comparison of different sand weight on the separation percentage (30 minutes)

Trail No.	Initial Sand Weight (g)	Sand with diesel (g)	Weight after separation (g)	Separation Percentage (%)
1	10.003	11.254	9.8150	87.21
2	10.001	11.310	10.115	89.43
3	10.002	11.666	9.7020	83.17
4	20.001	21.320	18.852	88.42
5	20.001	21.970	19.040	86.66
6	20.003	21.552	17.770	82.45
7	30.001	32.272	29.071	90.08
8	30.002	31.507	24.182	76.75
9	30.002	31.343	27.572	87.97

From result shown on table 3.1 above, the time taken that was set for 30 minutes mostly gave the separation percentage above 80 %. Compared to 20g and 30g, 10g weight gave higher percentage of separation which shows that lower sand weight tends to separate quickly than higher sand weight.

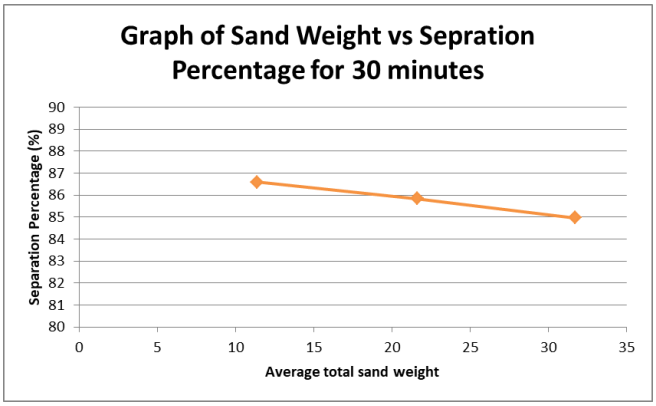

Figure 3.1 Graph of Sand Mass vs Separation Percentage for 30 minutes test

Figure 3.1 shows the increment value of separation percentage as the weight of sand became lower. This is because lower sand weight need less cleaning time compared to higher sand weight

But, if the test results were being observed carefully, most of the weight of sands after the separation method ranged lower than the initial sand weight. This is due to several reasons in which, the bubbles produced during ultrasonic treatment explode and caused the sand to break into smaller parts which will later being observed as sediment. Besides that, the weight lost maybe happened during sample preparation in which the mixture of sand and diesel being transferred from one container into other container where the mixture might be sticking around the container and was hard to retrieve.

The next test is about the influence of different time which this time around, the same test has been carried out, but the time taken for the test to run has been changed to 45 minutes instead of 30 minutes. This test is conducted to identify whether different time taken shall results in higher percentage of separation of the diesel from the sand.

Table 3.2: Comparison of different sand weight on the separation percentage (45 minutes)

Trial No.	Initial Sand Weight (g)	Sand with diesel (g)	Weight after separation (g)	Separation Percentage (%)
1	10.002	11.153	10.519	94.32
2	10.001	11.319	10.801	95.42
3	10.001	10.964	10.892	99.34
4	20.001	21.325	19.604	91.93

5	20.001	21.970	20.852	94.91
6	20.003	21.552	19.770	91.73
7	30.001	32.172	29.507	91.72
8	30.002	31.907	28.682	89.89
9	30.002	31.743	28.772	90.64

From the results obtained above, the separation percentage of diesel from sand samples is higher than the previous test. This shows that, the time for the treatment of ultrasonic energy affect the results of the separation. This can be said that the longer the time taken for the sands sample to be exposed on ultrasonic energy, the higher the percentage of separation for the diesel. Moreover, the 10g test still shows the highest separation percentage compared to 20g and 30.

The test results for 30 minutes and 45 minutes of treatment time were later averaged to be compared to see the different in separation percentage of different time taken. The average values ware later calculated to compare the three tests carried earlier in order to compare the results obtained to show the effect of separation of diesel on different time taken, different weight of sands, and also different volume of diesel.

Table 3.3: Comparison on average value of sand weight and separation percentage for both, 30 minutes and 40 minutes

30 Minutes			45 Minutes		
Initial Average Mass (g)	Final Average Mass (g)	Average Percentage Separation (%)	Initial Average Mass (g)	Final Average Mass (g)	Average Percentage Separation (%)
11.410	9.877	86.57	11.145	10.737	96.34
21.614	18.554	85.84	21.616	20.075	92.87
31.707	26.942	84.97	31.941	28.987	90.75

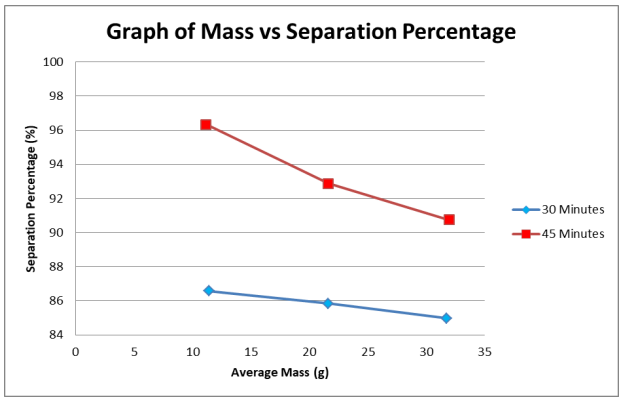

Figure 3.1

From table 3.3 and figure 3.1, the percentage of separation for the 45 minutes separation test is higher than the 30 minutes. The results obtained from the two tests showed a big gap between both tests. This implies that the time taken for the separation method affect more the separation process rather than different weight. This may be due to small gap between all three weights.

From figure 3.1 it can be said that the separation method using ultrasonic energy gave high percentages of separation. Figure 3.1 also shows that the increased weight results in lower percentage values. This maybe because more weight results in more space for the diesel to be absorbed into the pores, which indicated that more time is required for a complete separation.

The calculation used for this experiment is just from simple formula in which the normal calculation for percentage is done where the formula is as follows:

(Final weight of sand/Weight of sand after mixed with diesel)*100%

If more sand can be retrieved after the separation process, the results for the final weight can be improved and results in higher separation percentage reading.

It is also recommended that the experiment is carried out for as long as 1 hour and 30 minutes in which the results for the separation is expected to be 100% which means complete separation can be carried out. Also, the sand is recommended to be above 500μm as smaller sands particles tends to break in smaller part during the ultrasound method.

Let's not forget the frequencies and power or ultrasonic can be varies. If more ranged set of data is obtained, the likelihood of identifying the optimum frequencies and power of ultrasonic energy can be determined

Last but not least, instead of using diesel, it is recommended the usage of heavier crude to achieve a higher range of data to be compared as the initial objectives of using ultrasonic energy method to treat and separate the crude from produced sand.

IV. CONCLUSION

Ultrasonic energy shows an outstanding result for the separating of diesel from produced sand

ACKNOWLEDGMENT

Thank you to my supervisor and Universiti Teknologi Mara. Please acknowledge the grant provider (if any).

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