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Evaluation of Metal Mesh, Premium and Wire Wrap Screen Coupon Using Sand Pack Test

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Abstract*— The experiment aims to evaluate the performance of sand screen coupons at various flow rates using sand pack test. The sand screen coupons used in this study include wire wrapped, metal mesh and premium screen coupons with the aperture size of 150 µm. The sand pack test is conducted using three types of the formation sand samples such as Tidal Channel (TC), Tidal Sand Flat (TSF) and Lower Shore Face (LSF). The performance of the sand screen is determined by its filtering efficiency based on the amount of produced sands. The sand pack test is conducted using the sand retention test equipment. Dry sieve analysis is firstly conducted to obtain the particle size distribution of the formation sand samples. The grain size of D50 is used throughout the experiments to tailor with the aperture size of sand screen. Whereas, the uniformity coefficient (Uc), and sorting coefficient (Sc) are determined by the S - Curve. Later, the sieved sand sample is placed directly onto the screen and the wetting fluid, brine is flowed through the sand pack and screen at 0.5 L/hr, 1.0 L/hr and 1.5 L/hr respectively with the same flowing interval for each set of experiment. The pressure build- up in the cell to 2 bar is observed before the bottom valve is open for flow. Finally, the amount of sand retained in the screen is evaluate which is the significant of this experiment. The results of the sand pack test are compared based on the sand retentive ability of the screen coupons. An efficient screen coupon should have the ability to retained amount of sand from the sand retention cell. Metal Mesh and Premium Screen Coupon achieves the most consistency in their sand retaining performance. Whereas, wire wrapped screen coupon exhibits an increasing amount of sand production as the flow rate increases. This trend exists in all sets of experiments regardless of formation type sand samples and flow rates. The significance of this study concludes that a proper selection of standalone screen (SAS) would result in a drastic improvement in limiting the migration of sand into the wellbore. In this study, metal mesh and premium screen coupon retained the amount of sand efficiently compared to wire wrapped due to the design of the screen.*

Keywords*— Sand control, Sand Retention Test, Sand pack Test, Sand Screen*

I. Introduction

Production of formation sand is one of most critical problem faced by the oil and gas industry. Many approaches for solution have produced as a preventive aid but the cost too expensive to conduct. One of the low cost and effective method to prevent sand production by using screen [1].

An unconsolidated formation sand requires the assistance of sand screen inhibit the migration of formation sand. For open hole completion where Stand Alone Screen (SAS) directly retains the formation sand [2]. Sand Retention Testing (SRT) used to evaluate the performance of the screen which involved laboratory tests toperformancevarious screen coupon using reservoir sand [3]. The purpose is to select a sand screen to determine the efficiency of sand retention ability.

Several factors contribute to sand retention test as there is no specific industry standard on how to conduct and interpreted the result [4]. The factor which have a significant impact on the result are PSD of the grain size, type of reservoir sand, wetting fluids and flow rates[5,6].

Study on the effect of flow rate with various screen coupon by using different type of reservoir can be very complex because of the interaction between the numerous parameters. The past studies are limited to the range of output. This can be partially solved using SRT equipment by sand pack test.

II. Objectives & Scope Of Study

I. *Objectives*

This experimental study aims to evaluate the performance of the screen coupon using sand pack test with the influences of various flow rates and formation sand.

II. *Scope ofstudy*

This study focuses on the sand retention ability of the sand screen coupon through sand pack test. The sand screen coupons used in this study include wire wrapped, metal mesh and premium screen coupons with the aperture size of 150µm. Furthermore, brine is flowed into the sand retention cell at the flow rates of 0.5 L/hr, 1.0 L/hr and 1.5 L/hr respectively. The sand pack test is conducted using three of the formation sand samples: Tidal Channel (TC), Lower Shore Face (LSF), and Tidal Sand Flat (TSF) with the grain size of D_{50}.

III. Procedures

A. *Sand CharacterizationStudy*

Dry sieve analysis is conducted to determine the particle size distribution of the formation sand samples. It uses sieves of different sizes, including the pan and cover. The stacking of sieves is arranged accordingly from 425 µm, 300 µm, 212 µm, 150 µm, and 63 µm respectively. The whole set of equipment is placed on the sieve shaker equipment as in the Figure 1.

Figure 1: Dry sieve analysis equipment

Then, the weight of the sand samples before sieving, sieves and pan are also recorded. The sands are poured onto the top sieve and start agitating for a period of 10 minutes. Later, the weight of the retained sand sample by each sieve is recorded. Lastly, the sieved samples are segregated according to the range of grain sizes. The same procedures of dry sieve analysis are repeated for Tidal Channel (TC), Lower Shore Face (LSF) and Tidal Sand Flat (LSF) sand. For the sand pack test, a particle size distribution of D_{50} is selected.

B. *Conducting Sand PackTest*

The sand pack test is conducted using sand retention test equipment, which mainly consist of sand retention cell, valves, pump and reservoir tank.

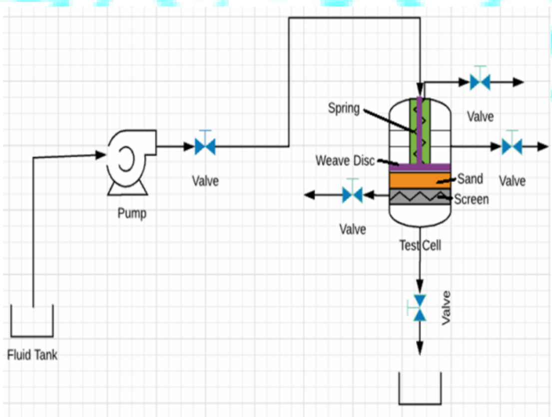

Figure 2: Set up of Sand Pack Test.

The sand pack test is started by filling up the reservoir tank of the sand retention test equipment with selected experimental fluid, which is brine in this research. Brine is often used in sand retention testing due to its ability to disperse more sand compared to oil and methanol. It is found that oil does not completely disperse the sand pack, especially the finer grains. Consequently, it resulted in the sand to be bypassed and not carried out by the oil[5].

The sand screen coupon is placed inside the sand retention cell. After that, the formation sand samples are poured onto the screen coupon inside the cell. Once the cover of the retention cell is assembled and tightened, the sand is then compressed with spring and piston to form a sand pack. While leaving the valve on the cover opened, the sand retention cell is then filled up with fluid (brine) at the designated flow rate. Once the cell is filled completely, the top valve is closed and let the pressure build up to 2 bar. The bottom valve is then opened to release the fluid, with the flowing interval of 10 minutes. The fluid is collectedand the produced sand is filtered. The weight of the filtered sand is measured. The experiment is repeated at 0.5 L/hr, 1.0 L/hr and 1.5 L/hr with new sand in every set up. The reason of not using the sand repeatedly is due to the tendency of the sand to be muddy and result in potentialplugging.

Lastly, the retentive ability of the screen is calculated based on the amount of sand retained in the cell. The percentage can be computed with the equation of

$$Sand\ Screen\ Retentive\ Ability = 100\% - \frac{Weight\ of\ Sand\ Produced\ (g)}{Weight\ of\ Sand\ Originally\ in\ Cell, 15\ g} \times 100\%$$

Generally, a sand screen will have a higher sand filtering efficiency when they manage to retain most of the sand in the retention cell.

In summary, the manipulating variables of this research include 3 sand screen coupons: Premium Screen, Metal Mesh Screen and Wire Wrapped Screen; 3 formation sand types: Tidal Channel (TC), Lower Shore Face (LSF), and Tidal Sand Flat (TSF) at the designed flow rates.

IV. Result

A. *Sand Characterization Study on TC, LSF and TSFSand*

The Tidal Channel (TC), Lower Shore Face (LSF) and Tidal Sand Flat are sedimentary facies extracted from the North Malay Basin which located around 300 km offshore of the Terengganu Gas Terminal in the Gulf ofThailand.

Dry sieve analysis is conducted in order to determine the particle size distribution of the sand samples. The sieves used are 425 µm, 300 µm, 212 µm, 150 µm, and 63 µm respectively. The results of sieve analysis of TC are displayed in the table below.

Table 1: Dry Sieve Cumulative Percentage of the TC Sand Samples.

Mesh Size	Particle Interval Size (µm)	Weight Retain (g)	Frequency of Occurrence (%)	Cumulative Percentage (%)
425	425	7	4.67	100.00
300	300 - 424	5	3.33	95.33
212	212 - 299	7	4.67	92.00
150	150 - 211	58	38.67	87.33
63	63 - 149	64	42.66	48.66
Pan	40 - 62	9	6.00	6.00
Total		150	100	-

A total of 150 g of TC Sand samples are sieved. The weight of each retained sand and individual sieve pan are measured. The frequency of occurrence and cumulative percentage are computed. It is found that the TC sand samples has the highest frequency of occurrence with the particle interval size between 63 µm to 149 µm with 42.66%, while the lowest frequency of occurrence belongs to the particle interval size between 300 µm and 424 µm with only 3.33%. The S-Curve of the TC samples are illustrated in the S-Curve below, which determines the D_{50} of the TC sandsamples.

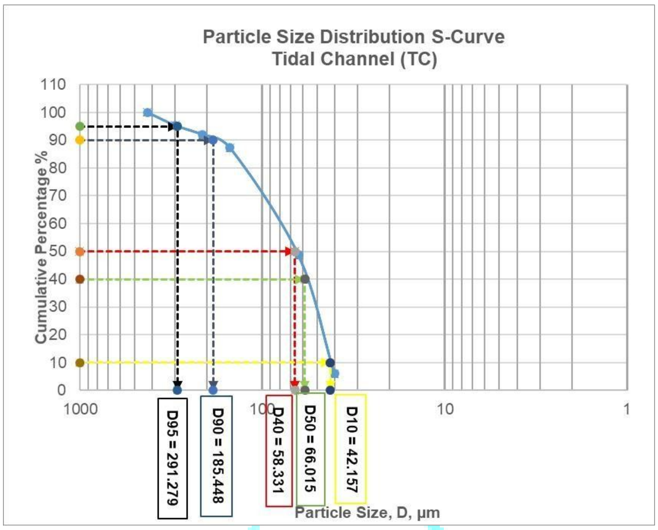

Figure 3: Dry Sieve S-Curve of the TC Samples.

In addition, the table 4.2 shows the results of the dry sieve analysis of the LSF samples. A total of 219 g of LSF samples are poured into the dry sieve. The highest percentage of sand occurrence is at the particle size interval of 63 µm to 149 µm (36.99%), followed by particle size of 150 µm to 211 µm with 32.42%.

Table 2: Dry Sieve Cumulative Percentage of the LSF Sand Samples.

Mesh Size	**Particle Interval Size (µm)**	**Weight Retain (g)**	**Frequency of Occurrence (%)**	**Cumulative Percentage (%)**
425	425	22	10.04	100
300	300 - 424	12	5.48	89.96
212	212 - 299	18	8.22	84.48
150	150 - 211	71	32.42	76.26
63	63 - 149	81	36.99	43.84
Pan	40 - 62	15	6.85	6.85
Total		219	100	-

Looking into the S-Curve of LSF sand samples, the D_{50} falls around 73.531 µm. The particle size distribution of the LSF sand samples are illustrated as below.

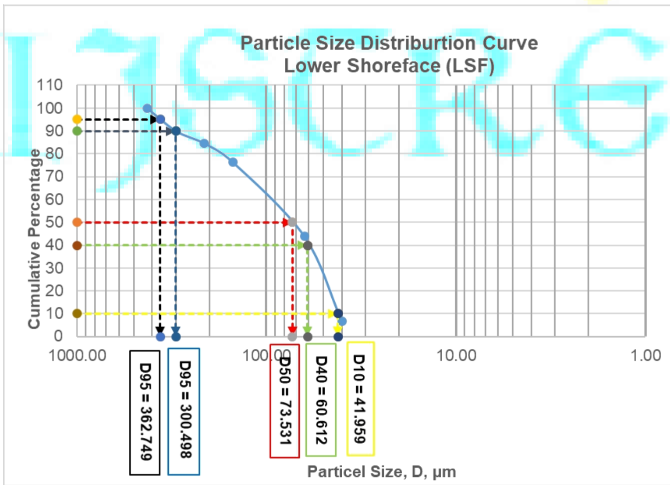

Figure 4: Dry Sieve S-Curve of the LSF Samples.

Furthermore, 174 g of TSF sand are poured onto the dry sieve. The highest frequency of occurrence belongs to the particle size interval of 150 µm to 211 µm with 43.1%.

Table 3: Dry Sieve Cumulative Percentage of the TSF Sand Samples.

Mesh Size	Particle Interval Size (µm)	Weight Retain (g)	Frequency of Occurrence (%)	Cumulative Percentage (%)
425	425	10	5.75	100
300	300 - 424	8	4.6	94.25
212	212 - 299	7	4.02	89.65
150	150 - 211	75	43.1	85.63
63	63 - 149	68	39.08	42.53
Pan	40 - 62	6	3.45	3.45
Total		174	100	-

Whereas, looking into the S-Curve of TSF sand samples, the D_{50} falls around 78.079 µm. The particle size distribution of the TSF sand samples are illustrated as below.

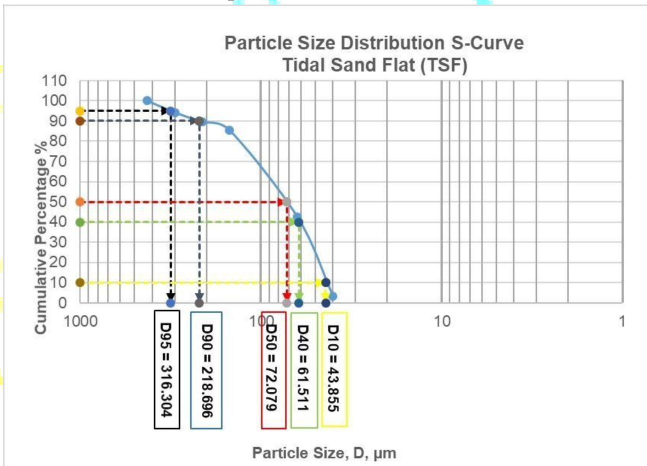

Figure 5: Dry Sieve S-Curve of the TSF Samples.

B. Experimental Results of Sand Pack Test Using TCSand

At all flow rates, premium screen and metal mesh screen are able to persist their performance in retaining sand. Despite sharing the same aperture size with the others, wire wrapped screen shows the increasing trend of sand production as the flow rate increases. Looking into the perspective of the screen retentive ability, metal mesh screen manages to retain most of the sand in the retention cell at all flow rates, followed by premium screen. At 0.5 L/hr, the percentage of sand retained by premium screen and metal mesh screen are almost twice the percentage by wire wrapped screen. Wire wrapped screen exhibits trend of an increasing amount of weight produced and declining sand retentive ability. At 1.5 L/hr, only 12.06% of TC sand is able to be retained in the sand retentioncell.

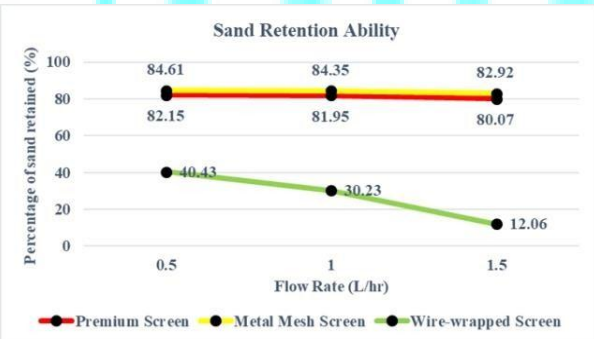

Figure 6: TC Sand Retentive Ability of Premium Screen, Metal Mesh Screen, and Wire-Wrapped Screen.

C. Experimental Results of Sand Pack Test Using LSFSand

Similarly, the experiment has been conducted nine times using brine and LSF sand as sand pack. Each run of the experiment requires 15 g of LSF sand samples and shares the same flowing interval period of 10minutes.

Premium sand screen and metal mesh screen offer a reliable sand control performance by retaining almost 90% of the sand in the retention cell at all flow rates. Whereas, wire wrapped screen tend to retain LSF sand better compared to TC sand at all flow rates. At 0.5 L/hr, it provides an acceptable level of sand control with 73.6% of sand remained in the cell. In the same way with the sand pack test using TC sand, wire wrapped screen tends to lost it sand control performance as the flow rate increases.

Figure 7: LSF Sand Retentive Ability of Premium Screen, Metal Mesh Screen, and Wire-Wrapped Screen.

D. Experimental Results of Sand Pack Test Using TSFSand

Besides TC and LSF sand, TSF sand is also used as sand pack for the sand retention test. The outputs of sand pack test using TSF sand are almost identical as the LSF sand. This is because the porosity of the LSF and TSF samples are very similar, with 21.54% and 22.18% respectively. The porosity of LSF and TSF are considered very good due to its value ranging from 20% to 25%. From the perspective of porosity, it can also justify the reason on why the sand pack test that uses TC sand manage to produce more sand compared to LSF and TSF. It is probably due to the excellent porosity of TC samples(34

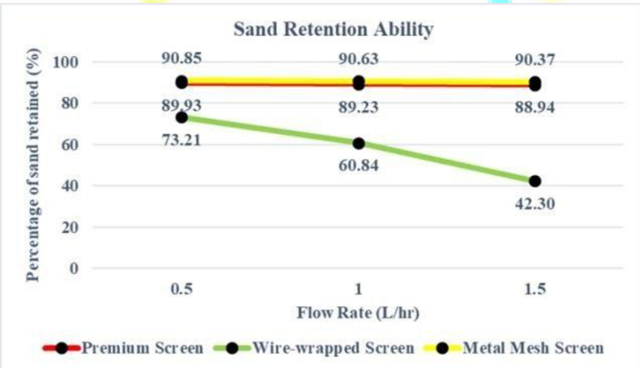

Figure 8: TSF Sand Retentive Ability of Premium Screen, Metal Mesh Screen, and Wire-Wrapped Screen

V. Conclusion And Recommendation

Different types of sand screen are has their ownabilityto retain the migration of sands while sharing the same aperture size. The performance of the sand screens is benchmarked among each other based on the amountof sand production based on the three formation sand samples are used, they include Tidal Channel (TC), Lower Shore Face (LSF), and Tidal Sand Flat (TSF) sedimentary facies extracted from the North Malay Basin in Malaysia-Thailand Joint Development Area (JDA). As the reservoirs in North Malay Basin are poorly compacted and have only minor cementation, it is highly prone to sandproduction.

Surprisingly, metal mesh screen achieves the highest sand retaining efficiency with an average of 88.48% of sand remained in the retention cell, compared to premium screen and wire wrapped screen. Through sand pack test, its excellent sand retaining ability justifies the reason of it being commonly preferred in unconsolidated formation. Besides, premium screen also offers a promising reliable sand control by retaining an average of 86.99% in the sand retention cell. The performance of premium screen and metal mesh screen are fairly stable at all flow rates and formation sand types. As metal mesh screen and premium screen offer almost identical performance, the selection of screen ought to be considered in terms ofcost.

Whereas, wire wrapped screen offers an acceptable level of sand control with an average of 62.41% at 0.5 L/hr. However, it loses its filtering efficiency dramatically asflow rates increase. At 1.5 L/hr, it achieves only 12.06%, 45.43% and 42.30% of sand retaining ability for TC, LSF and TSF samples respectively. Therefore, its performance is relatively poorer compared to premium screen and metal meshscreen.

The outcomes of this sand pack test conducted for wire wrapped screen also prove that it has a lower tendency of screen plugging which is associated with sand particles that stuck between wires.

This research on sand pack test is essential as there is currently no agreed standards or guidelines from the industry that can be applied on its procedures or interpretation of the results [7]. Looking into the selection of fluid for sand pack test, the other commonly used fluid is methanol due to its dispersive characteristic as well. For future work, it is recommended to conduct the sand pack test using Methanol for the observation of its dispersive characteristics in a sand pack test. One of the feedbacks received from this sand pack test is that the sand pack test ought to be conducted using hydrocarbon such as oil. From the previous sand retention test adopted by some of the literatures, sand is less dispersed in oil due to its non-wetting characteristics. Consequently, only a very minimal amount of sand is able to pass through the screen. Due to the appearance of oil being opaque, it is difficult to determine whether the sand has been efficiently filtered from the collected fluid as well. Instead of brine, it is advised to use oil as the experimental fluid in sand pack test to mimic the down holeenvironment.

On top of that, it is suggested to also monitor thepressure development of the sand pack test. Prediction of screen plugging tendency is possible through the monitoring of pressure in the sand retention cell. In addition, due to limited core samples available, the tested screen coupons for the sand pack test consist of only metal mesh screen, premium screen and wire wrapped screen. It would be great to experiment with more types of sand screens such as expandable screen, sintered mesh screen, woven metal fibre screen and Dutch twill screen to broaden the scope of study in screen performance.

In terms of engineering design, it is recommended for the sand screen designers to make modifications on metal mesh or premium screen for future improvements. For instance, the Research & Development (R&D) engineers should consider on how to reserve the excellent filtering efficiency of the metal mesh or premium screen in retaining formation sand while improving its rate of fluid production. Vice versa, for wire wrapped screen, its sand retention ability ought to be improved, especially at a high flow rate condition, while remaining its excellent rate of fluid production.

Moreover, it is recommended to carry out the study in SRT but using slurry test whereby can do comparison with the sandpack test.

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