Evaluation of Dry Sieving Method in Particle Size Analysis for Sand Control Applications

by

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CERTIFICATION OF APPROVAL

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A project dissertation submitted to the
Petroleum Engineering Programme
Universiti Teknologi PETRONAS
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(PETROLEUM)

Approved by,

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(Mrs. Noor Ilyana binti Ismail)

UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

May2014

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgments, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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NOR FARINA BINTI SALEHUDDIN

ABSTRACT

The knowledge of grain / particle size distribution is very crucial in designing optimum liner openings, screens or gravel pack sizes. Sieve analysis, a simple method of grain size measurement, generally used to describe the characterizations of formation sand. However, this practice is questionable since it relies solely on the measurement of the grain / particle without taking into account some factors that affect the sand production. Dry sieving method may give a true weight distribution of sand particles, however, the effect of fluid flow in hydrocarbon production was found not catered.

Evaluation of dry sieving method in particle size analysis for sand control applications is a project to discover the limitations of dry sieving technique in determining the grain/particle size distribution of the formation sand. In this project, a comprehensive study on the factors that influenced the tendency of sand production in oil and gas wells were done. An in-depth understanding of dry sieving procedures and the basic concept of sand particle measurements also have been covered in order to understand how dry sieving method works. A laboratory works have been conducted to critically observe the overall procedure of this method.

With the thorough understanding of its procedure, the limitations of dry sieving method has been outlined. Dry sieving analysis is not a suitable method to be used in determining sand particle size distribution for wells that is having major sand sizes which is smaller than 0.044mm. In addition, this method is also not catering any fluid flow effect throughout its analysis. However, regardless of these limitations, dry sieving method is still desirable in determining the particle sand distribution because of its easiness and cheaper as compared to other method.

For future studies, a comparative study is suggested to be done to strengthen the result and findings of this project. There are two (2) suggestion on how to conduct the comparative study. First is by comparing dry sieving method results with another particle size distribution method results. Another suggestion is to compare dry sieving method to mathematical modelling result.

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CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

The production of formation sand into wells is one of the significant problem that still haunting oil and gas industry. In order to cater sand production problem in a well, among the commonly used sand control completion techniques are stand-alone screens and gravel packing. When analyzing the effectiveness of these applications, it can be stated that the performance of these techniques are partially effective (Moslavac, B., Matanovic, D., & Cikes, M., 2012). This can due to improper selection of screen's openings and gravel sizes.

It is important to design the right well screen openings because: 1) too small sizing will cause total or partial plugging; and, 2) if the sizing is too big, it will not functioning well as the sand can easily seeps through the screen. "Sand screen selection relies on accurate particle size information for the sands that need to be controlled" (Beare, S., & Ballard, T. J., 2013). Hence, the knowledge of grain / particle size distribution is very crucial to design optimum liner openings, screens or gravel pack sizing.

The grain / particle size distribution is determined through sieve or laser particle size (LPS) analysis of sand samples. Sieve analysis, a simple method of grain size measurement, generally used to describe the characterizations of formation sand. The grain / particle size distribution is defined in term of its mass or volume, and by dividing the formation sample into size fractions, the determination of the weight of these fractions can be done. Usually, sieve analysis is suitable for particle sizes more than 44 micrometer.

This project will focus on the particle size analysis using dry sieving method. The objective is to find the limitations of dry sieving in particle size analysis and understand what conditions to best use this method.

1.2 PROBLEM STATEMENT

Evaluation of grain / particle size distribution by using dry sieving method is usually said to be a common practice in designing optimum screen openings and gravel sizes. However, this practice is questionable since most of the wells still producing sand, even after the installation of sand control completions have been done. Hence, the effectiveness of sand control completions' performances are partially effective.

1.3 OBJECTIVES

The objective of this project is to:

- To find the limitations of dry sieving technique in determining the grain/particle size distribution of the formation sand for sand control applications

1.4 SCOPE OF STUDY

The scope of study for this project are simplified as follows:

- Investigation of factors influencing the tendency of sand production
- Investigation of the measurement technique to conduct dry sieving method in determining the grain size distribution

1.5 RELEVENCY OF PROJECT

The project is deemed as important as it is looking into new possibilities of finding the best conditions and recommendations to use dry sieving method for particle size analysis. By evaluating the limitations of dry sieving method, a proper selection of screen sizes can be done. With an experiment conducted, a comprehensive study of dry sieving method procedure was investigated. Consequently, this project is very much relevant as the subject matter is not widely studied into its' maximum potential.

1.6 FEASIBILITY OF PROJECT

The project is feasible since it is dealing with a specified scope of experiment. In this experiment, the dry sieving experimental procedure will be studied thoroughly on how it can actually measure the sand particle. It is within capability of the student to conduct the study with the guidance from the supervisor. It is positive that this project is able to be conducted and completed with the given time frame.

CHAPTER 2

LITERATURE REVIEW

2.1 SAND PRODUCTION CAUSES

Based on World Oil: Modern Sand Face Completion Practice Handbook by William, K., Ott, P.E., and Joe, D.W., there are several factors that influence the tendency of a well in producing sand. These factors can be categorized as rock strength effects and fluid flow effect.

2.1.1 Rock Strength Effects

Rock strength effects in this case is referring to the degree of formation consolidation and reduction of pore pressure throughout the life of the well.

2.1.1.1 Degree of Formation Consolidation

Based on an article written by Friendman, R.H., Suries, B. W., and Kleke, D. E. (1988), there are two main considerations in sand consolidation; placement of sand grains and strength of the formation. Cementation of the sand grains is said to be the ability to maintain open perforation tunnels. The cementation of a sandstone is typically a secondary geological process and as a general rule, older sediments tend to be more consolidated than newer sediments.

According to Kuncoro, B., Ulumuddin, B. and Palar, S. (2001), unconsolidated formation is a formation in a fluid state. It is uncommon to have a grain to grain contacts of sand particles in this kind of formation. The production of formation fluid in this kind of formation can result in sand production together with the fluid produced.

2.1.1.2 Reduction in Pore Pressure

Pressure in the reservoir is said to give support of the weight of the overlying rock (William, K. et al, 2001). Throughout the producing life of a well, the reservoir pressure will subsequently depleted. Therefore, some of the support of the overlaying rock is removed.

Since lowering the reservoir pressure will increase the stress on the formation itself, Moslavac, B et al., (2012) stated that, at some point, the formation sand grains may break loose or maybe crushed, creating fines that will produced along with well fluids.

2.1.2 Fluid Flow Effect

Fluid flow from reservoir to well is the consequence of the differential pressure; well pressure is smaller than reservoir pressure. Penberthy, W.L. Jr. and Shaughnessy, C.M. (1992) states that the drag force caused by this flow is related to the velocity-viscosity product at any point around the well. Hence, when fluids flow toward the wellbore, there will be tendency for some of the formation material to flow together with the fluids.

There are two (2) effects of fluid flow that influence sand production in oil and gas well; fluid viscosity, and fluid viscosity.

2.1.2.1 Fluid Viscosity Effect

The frictional drag force exerted on the formation sand grains is created by the flow of reservoir fluid. This frictional drag force is directly related to the velocity of fluid flow and the viscosity of the reservoir fluid being produced. High reservoir fluid viscosity will apply a greater frictional drag force to the formation sand grains than will a reservoir fluid with a low viscosity. The influence of viscous drag causes sand to be produced from heavy oil reservoirs that contain low-gravity, high viscosity oils even at low-flow velocities.

2.1.2.2 Fluid Velocity Effect

The production of reservoir fluids creates pressure differential and frictional drag forces that can combined to exceed the formation compressive strength. This shows that there is a critical flow rate which pressure differential and fractional drag forces are not great enough to exceed the formation compressive strength.

The particle erosion rate is highly dependent on the particle impact velocity. According to Oilfield Wikipedia, the accepted erosion rate is proportional to the particle impact velocity raised to a power of n (typically n ranges between 2 and 3 for steels). If the velocity is exceeded the settling velocity, the sand grains will start to move.

In cases where erosion is an issue, the particle impact velocity will be close to the velocity of the fluid carrying the particle. Therefore erosion is likely to be worst when the fluid flow velocity is high. Small increases in fluid velocity can cause substantial increases in the erosion rate when these conditions prevail.

TABLE 1 - Settling Velocity of different sizes sand grains in Water (Penberthy, W.L. Jr. and Shaughnessy, C.M., 1992)

GRAIN SIZES (mm)		SETTLING VELOCITY (ft./sec.)
1mm	=	.3281 ft./sec.
2mm	=	.6562 ft./sec.
3mm	=	.9843 ft./sec.
4mm	=	1.3124 ft./sec.
5mm	=	1.6405 ft./sec.

2.2 SAND PARTICLE SIZE DISTRIBUTION

According to Cheel, R., (2005), sand particle distribution consist of a statistical data of different sizes sand distribution. It usually represented either in the form of frequency distribution curve, or a cumulative distribution curve. Edward (2013) mentioned, to simplify the particle size distribution data interpretation, the result can illustrated by using one of these parameters:

- Mean – 'average' size of a population
- Median – size where 50% of the population is below/above
- Mode – size with highest frequency.

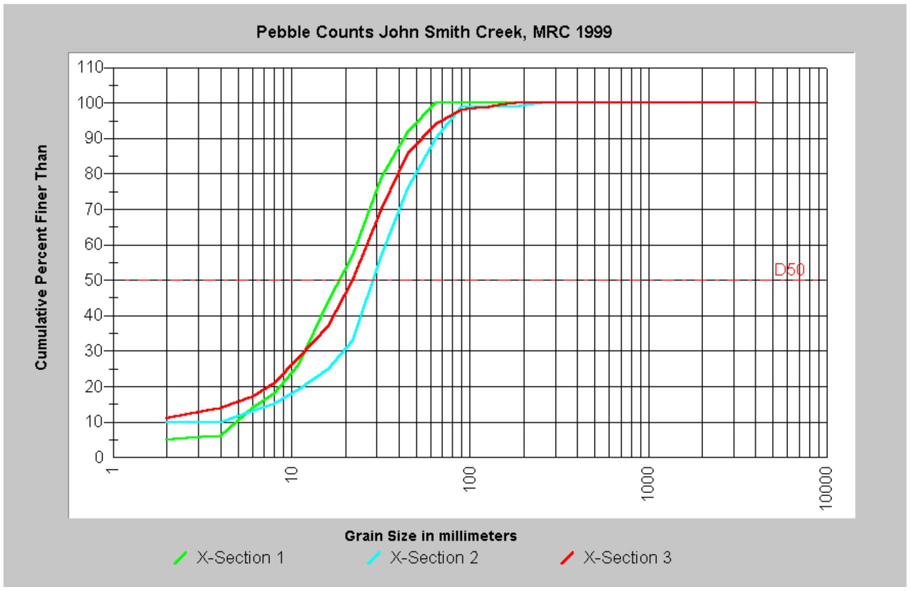


FIGURE 1 - Sand Size Distribution Plot from Sieve Analysis (Source: Mendocino Redwood Company)

2.2.1 Particle Size Distribution (PSD) Data Interpretation

Interpretation of dry sieving analysis data can be represented in both graphical and statistical methods (John, R.A., n.d.). Histogram or bar chart can be used to indicate graphically the percentage of the samples in each class. Cumulative curves are very useful in differentiating the sorting of formation graphically. A better sorted formation will have closer curve approaches the vertical – major percentage of sediment occur in one class. Significant percentages of coarse and fine end-members show up as horizontal limbs at the ends of the curve.

The most widely used method of describing particle size distributions are D values. The D10, D50 and D90 are commonly used to represent the midpoint and range of the particle sizes of a given sample. Particle size distributions have been traditionally calculated based on sieve analysis results, creating an S-curve of cumulative mass retained against sieve mesh size, and calculating the intercepts for 10%, 50% and 90% mass. Below is the representation of D10, D50 and D90 by the X axis (diameter) value where the cumulative volume curve crosses 10%, 50% and 90% on the Y axis.

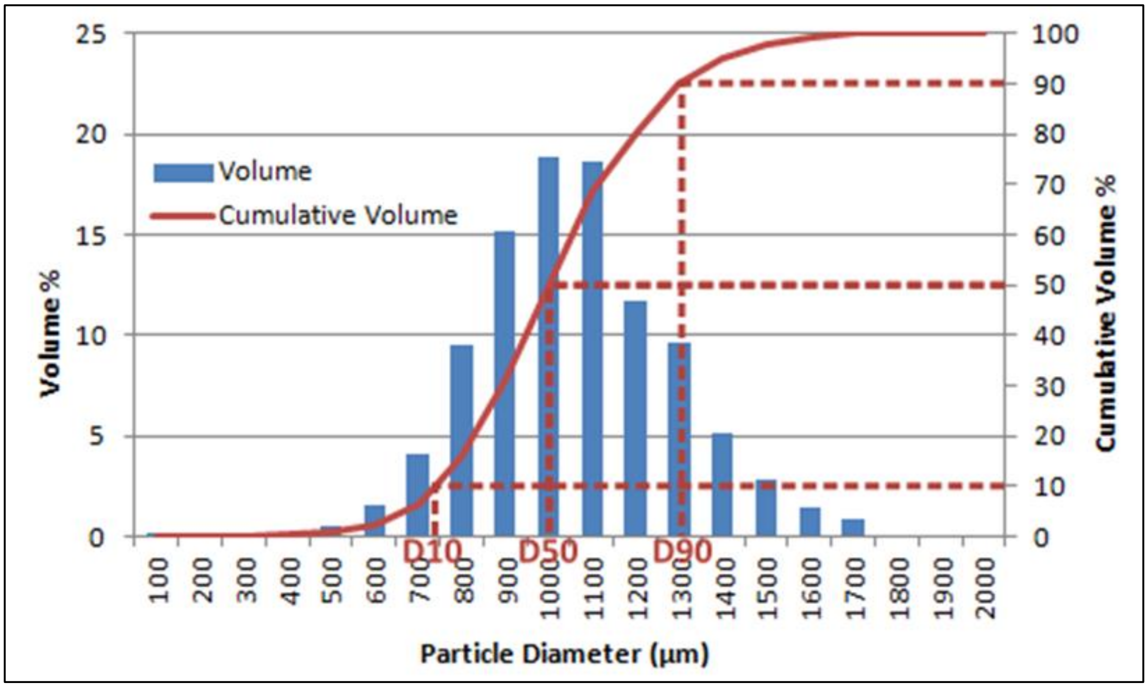


Figure 2 - Cumulative Volume Curve of Particle Size Distribution Analysis (Source: Inopharmal Labs Company)

2.2.1.1 Mean

Mean is the average particle size in the distribution analysis result. It is a very valuable measure for the sample.

2.2.1.2 Median

Median is the diameter at which 50% of the particle are courser and another 50% of it is finer. It can be retrieved from cumulative curve that intersect the 50% line.

2.2.1.3 Mode

Mode is the most frequently occurring particle class in distribution analysis result. It can be shown by using histogram graph where it the highest point of the curve.

2.2.1.4 Standard Deviation

Standard Deviation is used to measure the degree of sorting. A better sorted formation will have closer curve approaches the vertical – major percentage of sediment occur in one class. Significant percentages of coarse and fine end-members show up as horizontal limbs at the ends of the curve (John, R. A., n.d.).

2.3 DRY SIEVING METHOD

FIGURE 3 - Dry Sieving Facility. (Source: W.S Tyler, 2008)

Sieve analysis is the classic laboratory work implementation on a formation sand sample to determine grain / particle size distribution for sand control applications. The analysis is done by using a series of mesh having gradually smaller screen sizes. The formation sample is placed on the top of the mesh series and it will seeps through the screens until it faces the screen which has smaller openings than the size of the grains.

U.S. Series Mesh Size	Sieve Opening (in.)	Sieve Opening (mm)	U.S. Series Mesh Size	Sieve Opening (in.)	Sieve Opening (mm)
2.5	0.315	8.000	35	0.0197	0.500
3	0.265	6.730	40	0.0165	0.420
3.5	0.223	5.660	45	0.0138	0.351
4	0.187	4.760	50	0.0117	0.297
5	0.157	4.000	60	0.0098	0.250
6	0.132	3.360	70	0.0083	0.210
7	0.111	2.830	80	0.0070	0.177
8	0.0937	2.380	100	0.0059	0.149
10	0.0787	2.000	120	0.0049	0.124
12	0.0661	1.680	140	0.0041	0.104
14	0.0555	1.410	170	0.0035	0.088
16	0.0469	1.190	200	0.0029	0.074
18	0.0394	1.000	230	0.0024	0.062
20	0.0331	0.840	270	0.0021	0.053
25	0.0280	0.710	325	0.0017	0.044
30	0.0232	0.589	400	0.0015	0.037

TABLE 2 - Standard Sieve Opening (Bashir, A., 2007)

Amila, W. A. (2011) mentioned, by using dry sieving method, preparation the formation sample is done by removing the fines, then, drying the remaining samples in oven. The sample is powdered using a mortar and grinder, if necessary, to ensure individual grains are filtered rather than conglomerate grains. The formation sample then, is placed in the sieving apparatus. Mechanical vibration is used to assist the particles in seeping through and on to the various mesh screens. The weight of the formation sample retained on each screens can be determined by deducting the weight of the mesh before and after the process. Table 2 provides a reference for mesh size versus sieve opening.

An accurate gravel packing information can be gathered if the analyzed data from the sieve analysis is precise. Hence, the formation sample used for sieve analysis must be true representative of the formation itself. Bashir, A. (2007) stated that a sample should be taken within the formation or at every lithology change possibly in every 2 to 3 ft.

2.3.1 Dry Sieving Data Analysis

In order to further understand the use of data obtained from dry sieving method, there are three (3) basic parameters that should be comprehended; sand particle shapes, mineral compositions and sorting.

2.3.1.1 Sand Particle Shape

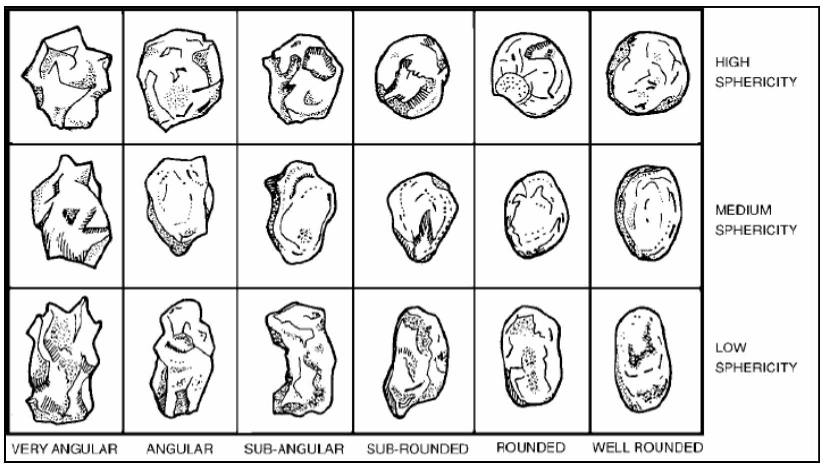


FIGURE 4 - Classification of Grain Shape (Turkeli, A., 2012)

Sand particle shapes have a significant influence on the sand production performance. According to Edward (2012), shape can be expressed in the mean of angularity and sphericity. He also mentioned that sand grains vary from well-rounded to rounded, sub-rounded, sub-angular, angular and very angular. Sphericity is often used to measure how close a particle is to a perfect sphere (Cheel, R., 2005). The angularity of sand is estimated by visual examination with a low power microscope and comparing with published charts, as show in figure 3.

2.3.1.2 Mineral Compositions

Sandstone minerals are classified in three main groups: 1) Detrital residue, 2) Secondary detrital, and 3) Chemical precipitates. According to Webster, C. (2005) detrital residues are the minerals from a source rock that have been mechanically transported and deposited. On the other hand, chemical precipitates are deposition of minerals from solution through chemical or biochemical processes.

Quartz is the principal mineral constituent of sandstones and although usually in the concentration range of 50 - 70% can form up to 99% of the rock. At concentrations of up to 12%, the feldspar group are the next most common sandstone minerals after quartz. There are four distinct types of feldspar: potassium, sodium, calcium and the rare barium feldspars. Also commonly found in sandstone rocks are the micas and small amounts of "heavy mineral" constituents due to their higher specific gravity.

In order to bind loose grains into sandstone rock, it is a necessity to have a cementing material. Among the common types are dolomitic, siliceous, hematite, shales and mudstones and anhydrite.

2.3.1.3 Sand Particle Sorting

According to Bashir, A. (2007), sorting, the measure of degree of scatter, also can be defined as the distribution of grain size of sediments, either in unconsolidated deposits or in sedimentary rocks. It is a ratio of the grain sizes between largest and smallest. Very poorly sorted formation indicates that the sediment sizes are mixed (large variance); whereas well sorted formation indicates that the sediment sizes are similar (low variance).

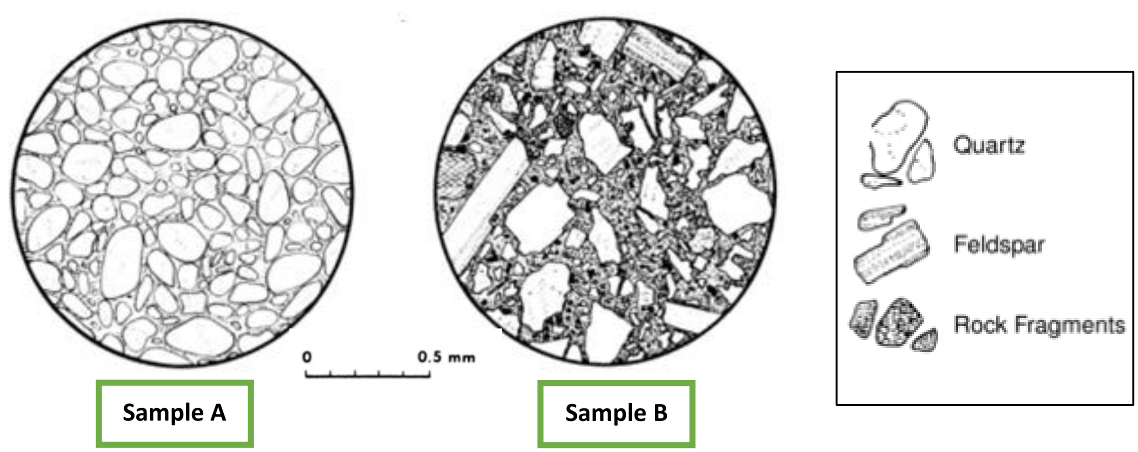


FIGURE 5 - Sample A is poorly sorted while sample B is well sorted.
(Turkeli, A., 2009)

2.4 LASER PARTICLE SIZE ANALYSIS (LPSA)

Laser Particle Size Analysis or as known as LPSA is one of particle distribution analysis method. LPSA works electronically by measuring the intensity of light scattered as a laser beam passes through a dispersed particulate sample (Ke, Z., Rejesh, A. C., Mondal, S., Wu, C., Sharma, M. and Ayoub, J. A., 2014). The angle of scatter of the laser is inversely proportional to the particle size and the angular intensity of light scattered is captured by a series of photosensitive detectors. In order to calculate the particle size, the data are then processed and analyzes through the instrument software.

Ballard, T. and Beare, S., in their paper 'Particle Size Analysis for Sand Control Applications' mentioned that the whole analysis by using LPSA takes approximately 5 minutes. The general procedure is as follows. A sample dispersed in a suitable fluid, usually water, is passed through a beam from a monochromatic light source, usually a laser. The light scattered by the particles at various angle is focused by the Fourier lens onto a specific spot irrespective of the particle's position or velocity. Therefore a single, composite diffraction pattern is formed containing a contribution from all the particles in the measurement cell. The diffraction pattern is measured by multi element detectors placed in appropriate positions. Numerical values relating to the scattering pattern are recorded and then transformed using an appropriate optical model and mathematical procedure in to a volumetric size distribution related to grain sized by assuming the particle to be spheres.

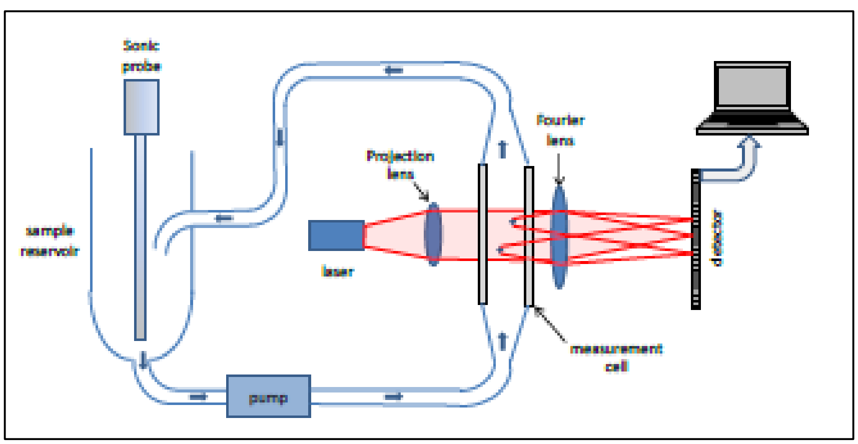


Figure 6 - Schematic diagram of LPSA measurement system
(Ballard, T. and Beare, S., 2013)

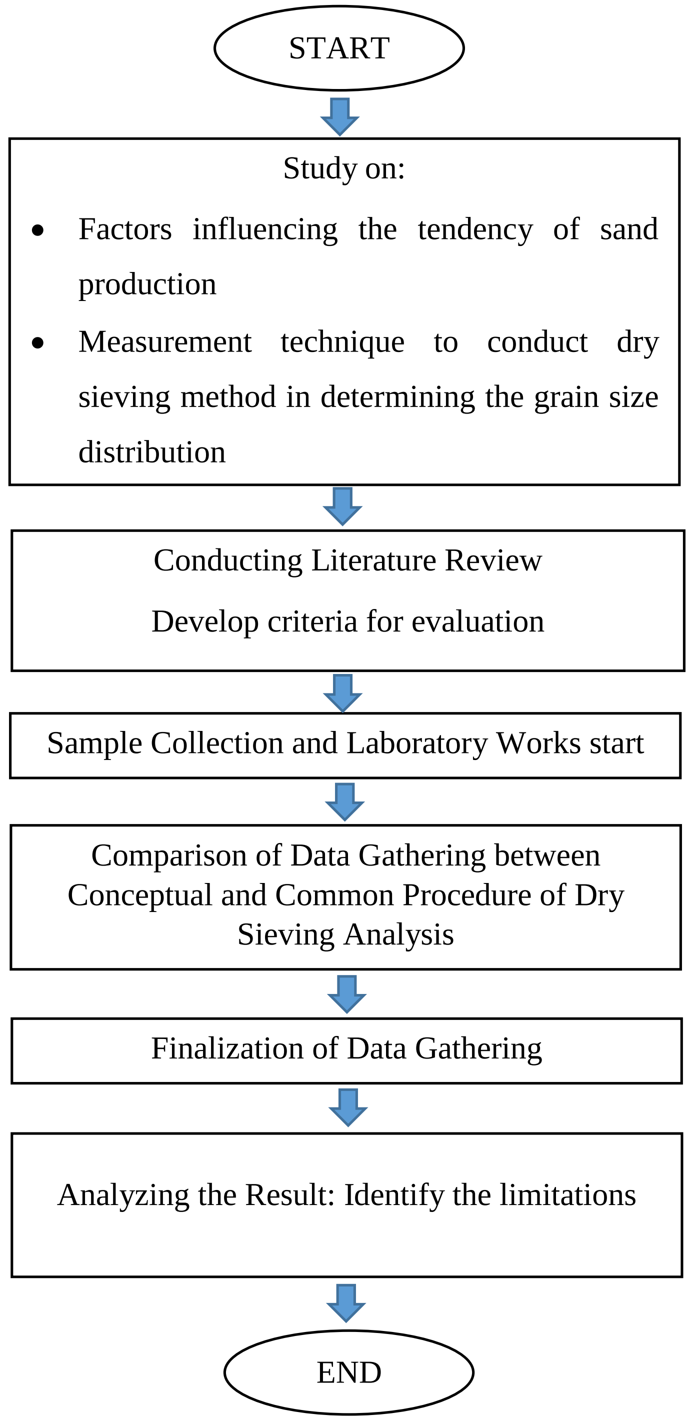
CHAPTER 3

METHODOLOGY

3.1 RESEARCH METHODOLOGY AND PROJECT ACTIVITIES

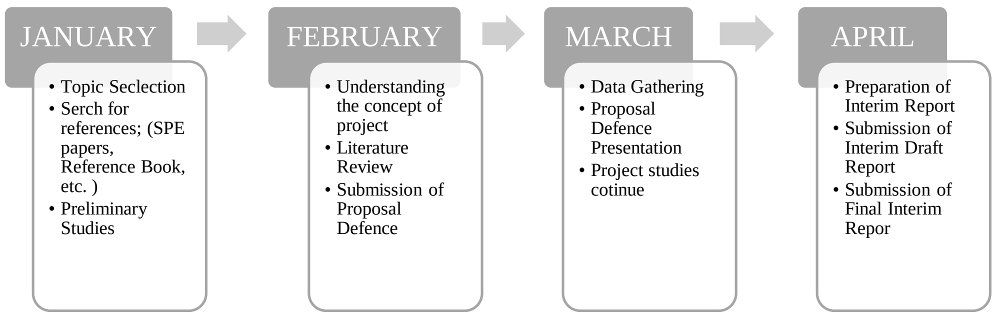
In this project, a thorough understanding of the proposed project title was needed as a starting point. A comprehensive study on the factors that influenced the tendency of sand production in oil and gas wells, an in-depth understanding of dry sieving procedures and the basic concept of sand particle measurements have to be covered in order to understand the background of this project. Hence, information gathering related to sand particle size analysis and dry sieving method from internet, journals, SPE papers and books were required.

The initial step is to prepare a literature review based on the fundamental of sand production factors and its relation to dry sieving analysis. The next step was the development of criteria for evaluation based on the reading and data gathering. All the laboratory works were conducted during Final Year Project (FYP) 2. Sand sample was taken from Pantai Dungun, Terengganu and the analysis of its particle sand distribution will be used to analyze the outcome of this project. Finally, the limitations of dry sieving method in particle size analysis for sand control application has been identified. A final organization of the findings has been carried out and some recommendation has been outlined. The overall project work follows the flow chart as below:

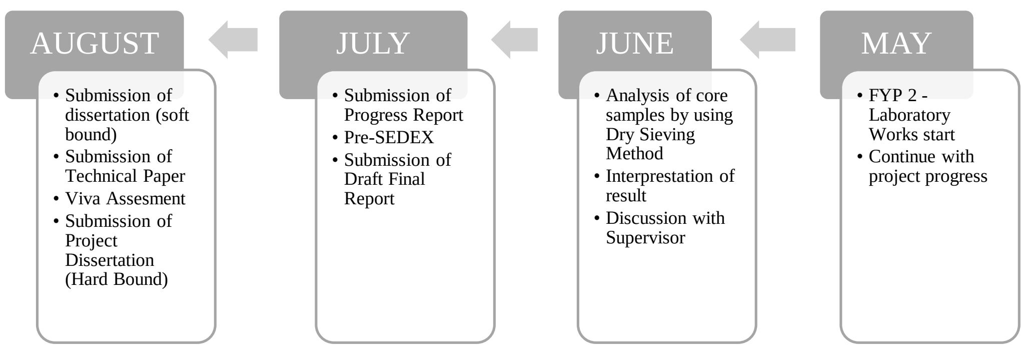

START
Study on:
Factors influencing the tendency of sand production
Measurement technique to conduct dry sieving method in determining the grain size distribution
Conducting Literature Review
Develop criteria for evaluation
Sample Collection and Laboratory Works start
Comparison of Data Gathering between Conceptual and Common Procedure of Dry Sieving Analysis
Finalization of Data Gathering
Analyzing the Result: Identify the limitations
END

3.2 PROJECT KEY MILESTONE

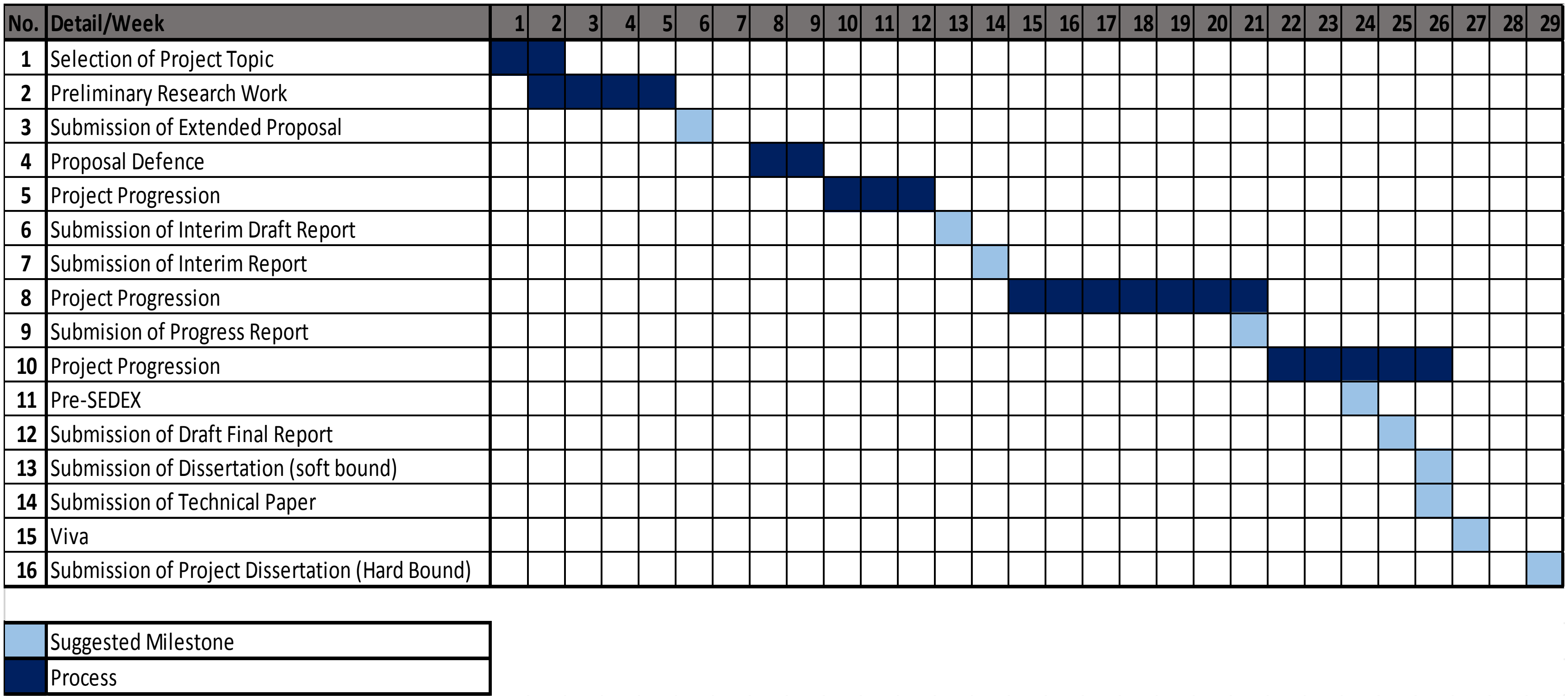
3.2.1 Final Year Project (FYP) 1 Milestone



3.2.2 Final Year Project (FYP) 2 Milestone



3.3 PROJECT TIMELINE (GANTT CHART)



3.4 EXPERIMENT METHODOLOGY

In order to conduct dry sieving analysis by using sieving facilities, several steps have to be identified. First, identification of samples to be used in the experiment has to be done. Then, tools and equipment list needed and in-depth knowledge on the procedure of sieving experiment have to be covered.

3.4.1 Sand Samples

Several runs of the experiment by using dry sieving method were conducted to strengthen the knowledge on its procedure. An in-depth analysis on dry sieving method was obtained through the understanding of how this method works.

However, produced sand samples from producing wells were not able to be used in this experiment because of time constraint and limited sources. Hence, throughout this project, sand sample used was taken from Pantai Dungun, Terengganu. Since beach sands is best to describe the characteristics of sand produced from the wells, hence, the sample used for analysis on this method is acceptable.

3.4.2 Tools and Equipment

The tools and equipment needed in conducting dry sieving analysis experiment are:

- Balances of suitable capacities and accuracies to determine all masses referred to in this test to within an accuracy of 0.1 percent of the initial mass of sub-sample.
- A set of US Standard Sieve.
- An oven capable of maintaining a temperature of 45 to 50℃
- Dishes and trays.
- Sieve brushes and a wire or other stiff bristle brush.
- Mechanical sieve shaker.
- Large tray suitable for hand proving.

3.4.3 Experiment Procedure

Dry sieving analysis was done following below procedures:

i. All sieves that were used in this experiment was ensured clean.

ii. The weight of each sieves were taken and recorded.

iii. The sieves then were assembled in ascending order of sieve numbers.

iv. A pan was placed below the #200 sieve.

v. The soil sample was carefully poured into the top sieve.

vi. The sieve stack was placed in the mechanical shaker and was shaken for 10 minutes.

vii. The stack was removed from the shaker.

viii. Each sieves and pan were then carefully weighed and the weight of each sieves with its retained soil were recorded.

CHAPTER 4

RESULT AND DISCUSSION

4.1 DRY SIEVING ANALYSIS RESULT

The volume of sand that were sieved was set to be fixed, in term of weight, which is 591.72 grams. All runs were conducted with a fixed sieved time, which is 5 minutes. In term of sieving facilities, all the apparatus used are following the American Petroleum Institute (API) standard. Below are the results for all three runs done throughout this project:

TABLE 3 - Dry Sieving Analysis Result Run #1

U.S Mesh Sieve	**Sieve Opening**	**Sieve Weight Before**	**Sieve Weight After**	**Sand Weight**	**Cumulative Sand Weight**	**Cumulative Sand Weight**
	(mm)	**(grams)**	**(grams)**	**(grams)**	**(grams)**	**(percent)**
10	2	**469.10**	**470.35**	**1.25**	**1.25**	**0.21**
14	1.18	**433.00**	**444.04**	**11.04**	**12.29**	**2.08**
30	0.6	**339.47**	**464.30**	**124.83**	**137.12**	**23.17**
40	0.425	**386.01**	**621.92**	**235.91**	**373.03**	**63.04**
50	0.3	**280.02**	**455.20**	**175.18**	**548.21**	**92.65**
100	0.15	**337.02**	**380.34**	**43.32**	**591.53**	**99.97**
230	0.063	**261.59**	**261.76**	**0.17**	**591.70**	**100.00**
Pan	**-**	**244.15**	**244.17**	**0.02**	**591.72**	**100.00**

TABLE 4 - Dry Sieving Analysis Result Run #2

U.S Mesh Sieve	Sieve Opening	Sieve Weight Before	Sieve Weight After	Sand Weight	Cumulative Sand Weight	Cumulative Sand Weight
	(mm)	(grams)	(grams)	(grams)	(grams)	(percent)
10	2	**468.64**	**470.21**	**1.57**	**1.57**	**0.27**
14	1.18	**432.86**	**444.20**	**11.34**	**12.91**	**2.18**
30	0.6	**339.59**	**462.64**	**123.05**	**135.96**	**22.98**
40	0.425	**386.21**	**624.15**	**237.94**	**373.90**	**63.19**
50	0.3	**280.25**	**454.37**	**174.12**	**548.02**	**92.61**
100	0.15	**337.00**	**380.19**	**43.19**	**591.21**	**99.91**
230	0.063	**261.46**	**261.79**	**0.33**	**591.54**	**99.97**
Pan	**-**	**244.10**	**244.28**	**0.18**	**591.72**	**100.00**

TABLE 5 - Dry Sieving Analysis Result Run #3

U.S Mesh Sieve	Sieve Opening	Sieve Weight Before	Sieve Weight After	Sand Weight	Cumulative Sand Weight	Cumulative Sand Weight
	(mm)	(grams)	(grams)	(grams)	(grams)	(percent)
10	2	**468.78**	**470.29**	**1.51**	**1.51**	**0.26**
14	1.18	**432.95**	**445.59**	**12.64**	**14.15**	**2.39**
30	0.6	**339.52**	**462.46**	**122.94**	**137.09**	**23.17**
40	0.425	**386.52**	**626.09**	**239.57**	**376.66**	**63.66**
50	0.3	**279.97**	**450.53**	**170.56**	**547.22**	**92.48**
100	0.15	**336.98**	**381.32**	**44.34**	**591.56**	**99.97**
230	0.063	**261.37**	**261.41**	**0.04**	**591.60**	**99.98**
Pan	**-**	**244.12**	**244.24**	**0.12**	**591.72**	**100.00**

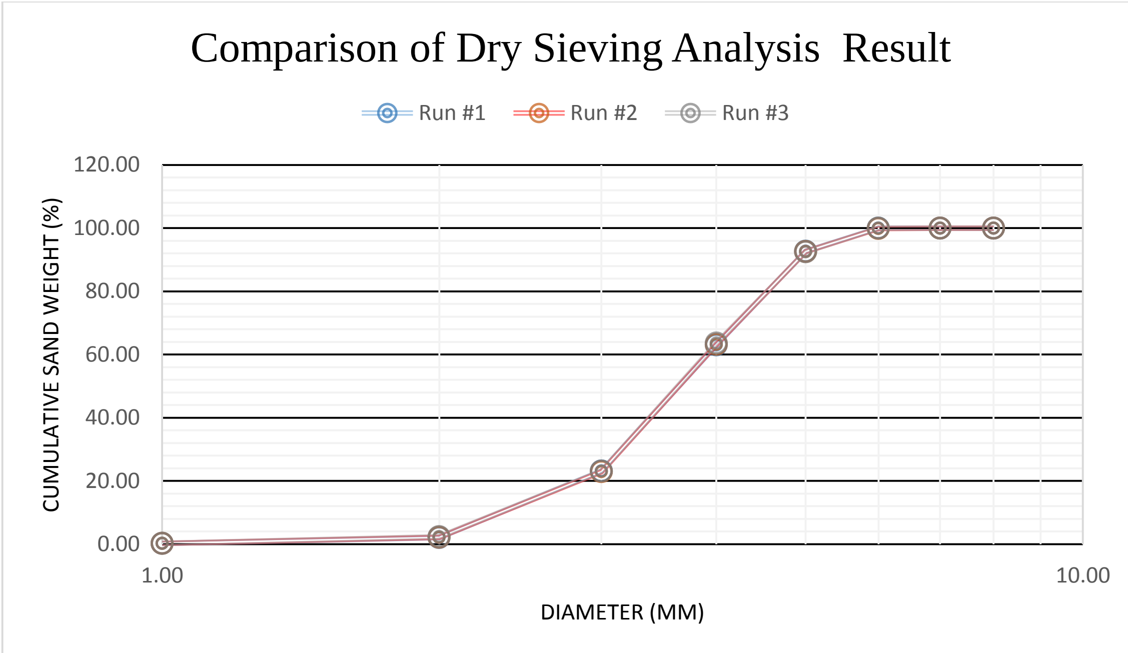


FIGURE 7 - Comparison of Dry Sieving Analysis Result for Three Runs

Figure 5 shows the comparison of sieve analysis plot of three different runs by using the same sand samples from Pantai Dungun, Terengganu. From the result of all three runs, the sieved sand's weight distribution in each mesh was observed not to be repeatable. Each run produces different value of sand weight in every mesh. However, this value differences was comparatively small and it is believed not affecting the whole result of particle size distribution analysis of this sand samples.

4.2 DRY SIEVING DATA ANALYSIS

As discussed in Literature Review section, there are several parameters can be used in interpreting the dry sieving data obtained. By using Run #1 result in Table3, below are there (3) analysis done by using histogram graph and cumulative probability curve to obtained mode, median and standard deviation of sand particle distribution.

4.2.1 Mode of Sand Particle Distribution Result

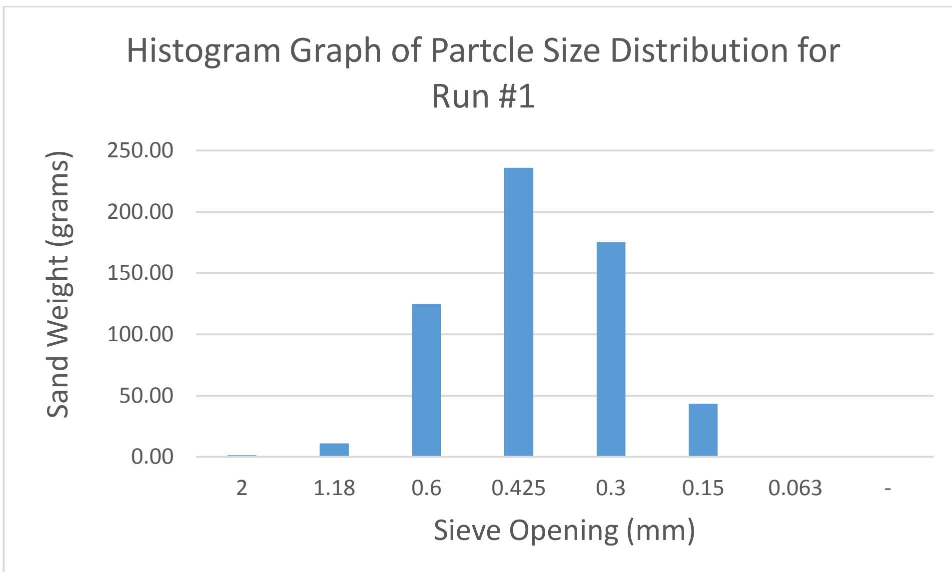


FIGURE 8- Histogram Graph of Particle Size Distribution for Run#1Result

Mode is the most frequent occurring particle class in the size distribution analysis. From the histogram graph of particle size distribution for Run #1 in Figure 6, mode of this run is sieved by mesh #40 with opening of 0.425mm. This shows that the most frequent occurring particle in this sample is not smaller than 0.425mm and not larger than 0.6mm.

4.2.2 Median of Sand Particle Distribution Result

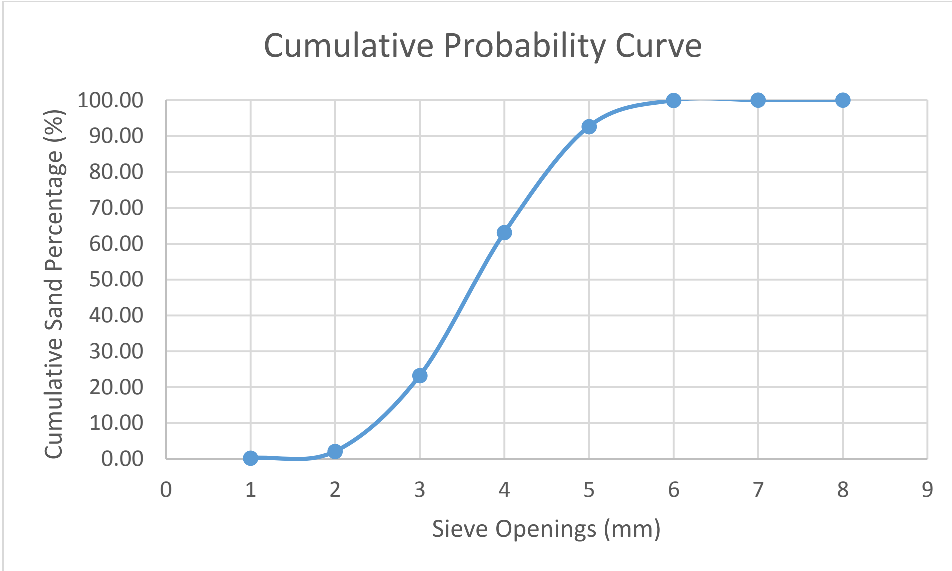


FIGURE 9- Cumulative Probability Curve for Run #1

From the cumulative probability curve in Figure 7, the median of Run #1, at which diameter in the cumulative curve intersects the 50% line, falls in between 0.3 and 0.425 mm sieve openings. At this point, the diameter is having 50% courser particles and 50% finer particles.

4.2.3 Standard Deviation of Sand Particle Distribution Result

By using the same cumulative probability curve in Figure 7, the standard deviation of Run #1 can be used to determine the sorting of sand samples. A better sorted formation will have closer curve approaches the vertical – major percentage of sediment occur in one class. Significant percentages of coarse and fine end-members show up as horizontal limbs at the ends of the curve. However, comparison on which sample is having better sorting cannot be made because we are using the same sample from same lithological area.

4.3 FINDING AND DISCUSSION

4.3.1 Sand Particle Size

Dry sieving facilities provide the minimum sieve openings of 0.063mm. In this case, any sand particle sizes that is lower than this value will not be sieved by this mesh. The sand leftover will be accumulated in pan below the 0.063mm opening mesh.

Based on the result of dry sieving analysis in Table 3, the sand weight that was left in pan is 0.18 grams. This is about 0.03% of total sand sample weight that being used in this experiment (591.72 grams). However, when looking into a bigger scale of sand production in a well, this 0.03% of sand might give a big impact on our production system.

In addition to this matter, the leftover sand that was not being identified its sizes might be the major reason why the well keep producing sand even if it has been installed with sand control completions. Hence, dry sieving analysis is not a suitable method to be used in determining sand particle size distribution for wells that is having major sand sizes which is smaller than 0.063mm.

4.3.1 Sand Particle Characteristics

By looking at all data and parameters obtained in this experiment, it can be discussed that the result of particle sand distribution of sand samples has catered mostly the physical sand particle characteristics. This mean that, from this result, the sand particle sizes, sand particle shapes, sand particle sorting, mineral compositions, and sand particle hardness can be further studied and classified into its own classes.

4.3.2 Fluid Flow Effects

Fluid flow effect is a very important parameter when discussing on how the sand grains settled through the installed sand control completion. In this case, fluid flow effect refers to the velocity and viscosity of the fluid. In dry sieving procedure, it was observed that there was no effect of these parameters throughout the experiment. This is one of the major drawback when using this method.

As discussed in literature review, fluid velocity plays subsequent role in sand production. As the fluid velocity increases, the production rate will also increases. Subsequently, the tendency of sand to move together with the fluid is also higher. Installing sand control completion in high velocity well might solve the sanding problem for a short period of time. If the production rate is high, the frictional drag force of the sands might exceed the strength of the completion. Hence, erosion might occur.

Same goes to fluid viscosity. The major drawback that is related to fluid viscosity is the frictional drag force of the sand. Having a high fluid viscosity might lead to erosion of the sand completion.

Since each producing well are having different type of fluid being produced, hence the velocity and viscosity of the fluid will also differs. Therefore, the usage of dry sieving method in analyzing sand particle size distribution is not preferable if the fluid viscosity and velocity of the producing well are above average.

CHAPTER 5
CONCLUSION

In this project, it has been clearly discussed on the factors that influenced the tendency of sand production in oil and gas wells. An in-depth understanding of dry sieving procedures and the basic concept of sand particle measurements also has been deliberated thoroughly in this report.

Based on the result and discussion of dry sieving method experiment, it is believed that this analysis has its own limitations. Dry sieving analysis is not a suitable method to be used in determining sand particle size distribution for wells that is having major sand sizes which is smaller than 0.044mm. In addition, this method is also not catering any fluid flow effect throughout its analysis. Therefore, the usage of this method in analyzing sand particle size distribution is not preferable if the fluid viscosity and velocity of the producing well are above average (William, K., et al., n.d.).

However, regardless of these limitations, dry sieving method is still desirable in determining the particle sand distribution because of its easiness and cheaper as compared to other method.

CHAPTER 6
RECOMMENDATIONS

6.1 COMPARATIVE STUDY

For future studies, a comparative study is suggested to be done to strengthen the result and findings of this project. There are two (2) suggestion on how to conduct the comparative study. First is by comparing dry sieving method results with another particle size distribution method results. Another suggestion is to compare dry sieving method to mathematical modelling result.

6.1.1 Comparative Study between Dry Sieving Method with another Particle Size Distribution Method

Apart from dry sieving analysis, there are several others method in determining the particle size distribution of sand samples. One of it is Laser Particle Size (LPS) method. A comparative study between dry sieving analysis and LPS will broaden the findings and more criteria of evaluation can be done. Advantages and disadvantages of each methods and when the best to use these methods also can be clearly observed.

6.1.2 Comparative Study between Dry Sieving Results with Mathematical Modelling Result

Another comparative study that can be recommended for this project is to associate the result of dry sieving method to any mathematical modelling result. The intention is to study on the accurateness of dry sieving result based in analyzing the particle size distribution. One of the commonly used particle size distribution mathematical modelling is Rosin-Rammler Model. This model can be done by using MatLab to describe particle size distributions. It is still widely used in mineral processing to describe particle size distributions in combination processes. By comparing these two results, a quantitative comparison can be distinguished.

6.2 COMBINATION OF EXPERIMENTAL PROCEDURE

From result and discussion, it has been mentioned that dry sieving method only cater the physical characteristics of sand particles by using the particle sand distribution data obtained. The sand particle sizes, sand particle shapes, sand particle sorting, mineral compositions, and sand particle hardness can be further studied and classified into its own classes. However, it was observed that there was no effect of fluid flow effects throughout the experiment. This is one of the major drawback when using dry sieving method.

For future study, it is recommended that dry sieving analysis has to combine with air elutriation analysis, a method of particle sand distribution as a function of settling velocity in liquid stream, and sedimentation techniques, an analysis that determines particle size distribution as a function of viscosity and velocity, in order to tackle the flow effects towards the sand sample [13].

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