CHARACTERISTIC OF SILICA SAND FROM KUANTAN, PAHANG

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UNIVERSITI SAINS MALAYSIA

2022

SCHOOL OF MATERIALS AND MINERAL RESOURCES ENGINEERING
UNIVERSITI SAINS MALAYSIA

CHARACTERISTIC OF SILICA SAND FROM KUANTAN,PAHANG

by

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Dissertation submitted in partial fulfillment
of the requirements for the degree of Bachelor of Engineering with Honours
(Mineral Resources Engineering)

Universiti Sains Malaysia

AUGUST 2022

DECLARATION

I hereby declare that I have conducted, completed the research work and written the dissertation entitled ‘characteristic of silica sand from Kuantan, Pahang’. I also declare that it has not been previously submitted for the award of any degree and diploma or other similar title of this for any other examining body or University.

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Witness by

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ACKNOWLEDGEMENT

First, my gratefulness goes to Allah S.W.T. the Almighty. Without His blessing this project could not been complete. Biggest thank to my family especially my beloved parents for always supporting me while I am completing of my project and my thesis.

Second, I would like to give my greatest gratitude to my supervisor, Dr Zakaria bin Endut for the guidance and encouragement during the early starting this project, which is on January until the end of this project, on June. Without his help I would not able to complete this project successfully. I would like to delivery my thanks to School Of Materials and Mineral Resources Engineering of USM, which gave me a lot of knowledge and experiences to accomplish my project.

Moreover, millions of thanks dedicated to all the technical staffs of PPKBSM who have helped me in my laboratory work, running equipment, and analyzing data, especially Mr Junaidi, Mr Meor, Mr Shahrul Ami and others technical staffs for all their assistance and helps for me to complete my project. Your kindness is my utmost pleasure. Also to my friends who have supported me in my research work. I want to thank them for all their help, support, interest and valuable hints. Thank you again to everyone, either direct or indirect involved helping me throughout my project.

TABLE OF CONTENTS

LIST OF TABLES

Page

LIST OF FIGURES

Page

ABSTRAK

Tujuan kajian ini adalah untuk mencirikan sampel silika dan mendapatkan mineral berharga yang diperoleh daripada *YP Mining Sdn. Bhd*. Sampel diambil di dua bahagian yang berbeza serta kedalam bagi setiap bahagian adalah berbeza. Terdapat empat kaedah pencirian yang dilaksanakan dalam kajian ini seperti taburan saiz zarah, analisis komposisi unsur (menggunakan XRF dan *Micro* XRF), kaedah mikroskop(SEM/EDX). Daripada kajian ini, silika (SiO_2), rutile (TiO_2), korudum (Al_2O_3), dan hematite (Fe_2O_3) telah dijumpai di pasir silika YP Mining Sdn. Bhd. Saiz sampel yang digunakan untuk penyelidikan ini adalah di antara julat daripada 2.8 mm hingga kurang dari 0.053 mm. Merujuk kepada analisis komposisi, komposisi silika lebih tinggi di bahagian A berbanding bahagian B. Oleh itu, gred di bahagian A lebih tinggi dari bahagian B. Bahagian A mengandungi sedikit korundum dan rutile. Walau bagaimanapun, kandungan korundum dan rutile hanya mempengaruhi gred pasir silika tetapi tidak menggangu tujuan utama kajian ini dilakukan adalah untuk mendapatkan taburan saiz pasir silika di setiap kedalaman yang berbeza dan mineralogi sampel silika yang diambil di *YP Mining Sdn. Bhd.*

CHARACTERISTIC OF SILICA SAND FROM KUANTAN, PAHANG

ABSTRACT

The purpose of this research is to characterize silica sand sample and to recover the valuable minerals found in silica samples obtained from YP Mining Sdn. Bhd. The sample are taken at two different spot at different depth which are 1 to 4 meter depth. There are four method of characterization were implemented in this research such as Particle Size Distribution, X-ray Fluorescence (XRF), Micro X-ray Fluorescence, Microscopic Study(SEM/EDX). From this study, silica (SiO_2), R]rutile (TiO_2), corundum(Al_2O_3), and hematite (Fe_2O_3) were found in silica sand in Kuantan, Pahang. The size of the sample that was chosen for this research is the ranges from 2.8 mm to less than 0.053 mm. As the result, from composition analysis, the composition of Silica at spot A is higher compare to spot B. Therefore, grade at spot A is higher compare to spot B. At spot A contain less of corundum and rutile. However, the grade does not effect the research because the main objective of this research was know the size distribution of silica sand at different level and analyze the mineralogy of the bulk samples taken from YP Mining Sdn Bhd, Pahang.

CHAPTER 1

INTRODUCTION

1.1 Research Background

The phrase "silica sand" refers to sand or easily disaggregated sandstone that contains a high percentage of quartz (silica) grains. The most common silica crystal is quartz, which is also the second most abundant mineral on the planet's surface. It may be found in practically all types of rocks, including igneous, metamorphic, and sedimentary rocks. Quartz sand or white sand is the result of weathering rocks containing major minerals, such as quartz and rock ore. Quartz sand as a result of weathering that is naturally washed and carried by water or wind and settles on the banks of a river, lake, or sea. The composition of silica sand is highly variable, depending on the local rock sources and conditions. Silica exists in nine different crystalline forms or polymorphs but the three main forms being quartz, which is by far the most common, tridymite and cristobalite. It also occurs in a number of cryptocrystalline forms (Zira et al., 2018).

Deposits of silica that generate products with at least 95 percent SiO2 are favoured for industrial and manufacturing uses. Because of the strength of the connections between the atoms, silica is strong, chemically inert, and has a high melting temperature. In applications such as foundries and filtering systems, these are highly valued properties. Quartz is used in glassmaking and ceramics because it istransparent to translucent and has a vitreous shine. The strength, silicon dioxide contribution, and non-reactive properties of industrial sand make it an essential component in the production of thousands of everyday products. Some deposits of silica sand may be suitable for use as metallurgical sand.

1.2 Problem Statement

This study analyze the characteristics of silica sand from the selected small scale operation in Kuantan focusing the chemical composition, physical and impurities analysis. The better characterization of sand can optimized the resource and value of the sand deposit.

The most common forms of silica sand in Malaysia is made up of two types Natural sand deposits made up of beach sand and ridges, and Man-made deposits of tailing dumps from alluvial mining areas. Natural sand deposits fringe the peninsular almost continuously. Deposits of economical value however, are found as beach ridges mainly in Johor, Perak, Kelantan, Sabah and Sarawak. To date, more than 15 localities of natural silica sand, varying in geological age, reserves, grades, ways of assessment, and availability of infrastructure had been identified by the Minerals and Geoscience Department Malaysia (Jab. Mineral dan Geosains Malaysia, 1999).

Silica sand for industrial application in Malaysia is another new resource that contribute to the nation development. In 2015 the first development of silica sand has been in started in Setiu, Terengganu exploiting the silica sand near to the coastal area. Since then, several small scale development of the silica sand along the eastern coast. There is a lack of proper study about the quality and characteristics of this silica sand resources. Hence, the main problem is lack of proper study about the quality and characteristics of this silica sand resources.

1.3 Significant of research

The important of studying the mineralogy of the silica sand in YP Mining Sdn Bhd, Pahang is to give information about the mineralogical composition of the silica sand to study the optimization of grade and size of silica sand and achieve the maximum economic benefit from resource exploration.

1.4 Scope of research work

The sample in this research was obtained from YP Mining Sdn Bhd, Pahang. In early stage of this research involves moisture content of silica sand by wash the sample and dry in oven in particular time and temperature, Particle Size distribution using sieve in different size, Mozley table in separation of heavy mineral, and comminution using grinding. Mineralogical characterization analysis conducted included Micro X-ray Fluorescence, X-ray Fluorescence (XRF), Scanning Electron Microscopy (SEM).

1.5 Objective of research

The objectives of this research are to study the size distribution of every layer silica sand and analyze the mineralogy of the bulk samples taken from YP Mining Sdn Bhd, Pahang.

1.6 Thesis Outline

This thesis has been divided into five chapter, which is for the Chapter 1 is Introduction, Chapter 2 is Literature Review, Chapter 3 is Methodology, Chapter 4 is Result and Discussion and lastly for the final chapter which is chapter 5, is conclusion and recommendation

In the first chapter, it is about the research background, problem statement that involved in this research, followed by objective of this research, scope of research and the thesis outline.

Chapter 2 is about literature review. In this chapter explain about theoretical of the silica sand and its application in industries, geological impact and market value of silica sand.

For the following chapter, which is Chapter 3 is about methodology that is use in this research. It consist the steps and stages of work that already done to achieved the objective of the research.

For chapter 4, it is about the results and discussion of the overall study was done. In the discussion, it was explain about the reason why the result show like this and like that.

Last but not lease, chapter 5 is all about the conclusion and the recommendation of this study.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction to Sand

"Sand" is a term referred to loose granular material that covers the world's beaches, riverbeds, and deserts. Sand comes in a variety of colours, including white, black, green, and even pink, and is made up of many materials that vary based on location. Silicon dioxide in the form of quartz is the most common component of sand. Rocks and minerals, such as quartz, feldspar, and mica, make up the Earth's landmasses. The term 'silica sand,' which is commonly used interchangeably with 'industrial sand,' has some ambiguity, reflecting the traditional usage of high purity white sand in the glass, ceramics, foundry, and chemical industries. Sand is also utilised in a wide range of different goods, each with its own set of chemical and physical criteria. To avoid ambiguity, the term 'specialist sand' should be used to refer to processed or unprocessed sand marketed for a variety of specialist end uses, and the sand resources should be divided into specialist sand (industrial sand, non-construction aggregates) and construction aggregates. It is proposed that unprocessed sand is only referred to as "silica sand" if it is pure enough to be treated inexpensively to meet the needs of end users with stringent compositional and or colour requirements that cannot be met with other natural raw materials. The size of the reserve, available processing plant, practical, economic, and environmental feasibility of processing the sand, market conditions, and the operating company's strategic interests and requirements will all influence whether a silica sand resource's potential can be economically realised as the demand for sodium silicate is expected to continue to rise in the following year (GWP Consultant, 2010).

2.2 Overview of silica sand

Silica sand is one of the most widely used kind of sand in the world. It can be used for a variety of purposes. Sand is a broad name for broken down granules of minerals or rocks that are technically between one-sixteenth and two millimetres in diameter and fall between silt and gravel on the size scale. There are many different types of sand in the world, each having its own composition and characteristics.

Quartz is a specific lattice structure of silicon dioxide, SiO2. Silica is another term for SiO2. SiO2 refers to a group of minerals that include both silicon and oxygen. It is frequently found in a crystalline condition. Plankton fossilisation occurs as a result of weathering, resulting in SiO2 crystallisation. Mines can be found in almost every part of the world. In the industry, silica sand is usually used as wet and dry. Silica sand comes from a multitude of places. The colours are yellow, beige, and white.

The physical properties of silica sand, as well as its composition, influence its application. For example, silica gravel is used as filtration of water wells for drinking water, moreover in glass making process the chemical composition of the sand is of utmost importance. Besides, the presence of impurities in the silica sand is another crucial factor that must be taken into consideration (Abdelrahman, 2013).

In term of classification, most specialty end uses of silica sand demand a tighter grain size grading profile than building or concrete sand. However, aggregate sites may classify sand before reblending in order to keep product gradings constant. There are many different types of modern processing plants that can do this with differing degrees of precision and flexibility, but there are three main processes that can be combined which are screening, hydrocyclones, and hydrosizers. For the 0.5mm maximum grain size cut off necessary for glass sand, hydrosizers or screens can be utilised. Hydrosizer are sand slurry teetering devices that use a stream of water to expand the slurry into a teetering state. Heavy grains migrate to the bottom of the teeter, where the water velocity is higher, while lighter grains move to the top, where the water velocity is lower. In comparison to a hydrocyclone, the hydrosizer delivers good grading cut off and fewer particles in the sand. A range of well-controlled graded sands can be generated if employed in sequence (GWP Consultant, 2010).

As a result of variables other than characteristics and classification, theoretically low-grade silica sand may be dug and sold for lower-value purposes. The glass, chemical, and ceramics industries require very high grade, low iron silica sand, which can only be met if the iron concentration of the sand in the ground is naturally low or can be lowered adequately and affordably through processing. This trait is only found in a small number of locations. It is highly doubtful that ordinary building sand can be processed to produce high-quality glass sand at a cost that is both reasonable and environmentally friendly. However, if processing equipment were available, it is likely that sand currently used for other purposes might be treated to a grade appropriate for coloured glass. To assess a site's potential for high-grade sand production, extensive physical and chemical testing of sand is required (GWP Consultant, 2010).

2.3 Mineralogy of silica sand

Silica sand can be as describe grainy particles that are mostly contain quartz with a small number of impurities. The common impurities are other mineral or organic materials such as micas, clay mineral, feldspar and coal. In Malaysia, the main sources of silica sand are the beach and tailing sand deposits. Silica sand are contain dominant mineral which is quartz that has a specific gravity (S.G) of 2.7. mineralogy study is important because it will determine the quality of the silica sand. Silica sand itself has two types of impurities, which are the impurities that can be separated physically and eliminated chemically. Physical separation can be done using gravity separation and magnetic separation equipment. While, chemical separation using leaching with oxalic acid. Usually, the chemically separation are used when physical separation are failed to remove the impurities. The major impurities (more than 10 mg/kg) of the natural silica are: Al, K, Fe, Na, B, Ca, Mg, and P. The trace impurities (less than 1 mg/kg) of the base silica are Zn, Ni, Cu, Cd (M. Khalifa et al., 2012).

In silica sand, has heavy mineral and light mineral. This can be identified by using its own specific gravity (S.G). Heavy mineral are those minerals whose S.G is greater than 2.8 to 2.9. light mineral are those mineral whose S.G. is less than 2.8.

Table 2.1 specific gravity of common heavy and light elements in silica sand.

Heavy Element	Specific Gravity	Light Element	Specific Gravity
Iron	7.6-7.9	Aluminium	2.56-2.70
Calcium	4.58	Potassium	0.86
Zinc	7.00	Sodium	2.16
Nickel	8.90	Boron	2.34
Copper	8.95	Magnesium	1.74
Cadmium	8.65	Phosphorus	1.82

2.4 Properties of silica sand

As a mineral, silica or quartz has their own properties that make them different from other minerals. Every mineral have their own properties to be distinguish and their own specialty. Table 2.2 shows the properties of silica sand.

Table 1.2 Properties of silica sand

Properties	Description
Density	2.65 g/cm^3
Mohs hardness	7
Thermal conductivity	7.2 - 13.6 W/mK
Electric conductivity	10^{-14} - 10^{-16} S/cm
Dielectric constant	4

2.5 Geological impact

Sand mining is a global activity in both developed and developing countries. Exploiting sand from different sources has both multiple benefits such as economic growth and new water reservoirs. Its also has a negative impacts on the environment. Based on the research by (Fo Kowalska and Sobczyk, 2014) several factors must be considerwhen the environment impact of sand mining is done:

- location of sand mine;
- time of exploitation;

- size of mining area;
- habitats and vegetation diversity across the mining area;

Until now, sand has been mined predominantly from land quarries and riverbeds but due to intensive exploitation, this activity have become more strict or nolonger allow by environmental regulations. So, mining of marine sand is increasing significantly. Thus, this marine sand mining resulting to negative environmental impact, national and global legislation have made it more strict.

2.6 Silica Sand in Malaysia

The man-made deposits are found in tailing dumps resulting from the alluvial mining operations. They are located mostly in Perak, Negeri Sembilan, and Selangor. The current natural silica sand deposits stands at 148.6 Mt, of which 47 Mt is in Semenanjung, 44 Mt in Sabah and 57 Mt in Sarawak. Tailing sand with potential for construction sand totalled 491.5 Mt (Chu, 1988). Natural sand deposits fringe the peninsular almost continuously. However, natural deposits found as beach ridges of economic potential are found mainly in Johor, Perak, Kelantan, Sabah and Sarawak. The man-made deposits are found in tailing dumps resulting from the alluvial mining operations in Perak, Negeri Sembilan, and Selangor (Chu, 1988). Malaysia currently has about 640 Mt of defined resources of silica sand, of which 148 Mt 3comes in natural form and 492 Mt found as tin tailing dumps. These deposits possessed further potential with upgrading. The natural silica sand possess silica, Si02 grade ranging from 89.5% and 99.9%. Of the total amount of tailing sand recovered thus far, 305 Mt were reported to have Si02 content of more than 95%
In this industry can be upgrade by increased productivity by using advanced

technology, producing superior products to match and compete with global markets, research into new products and creating new markets.

2.7 Market view and demand

According to the report by IMARC Group titled, “Silica Sand Market: Global Industry Trends, Share, Size, Growth, Opportunity and Forecast 2022-2027”, finds that the The Asia Pacific silica sand market reached a value of US$ 5.42 Billion in 2021. Looking forward, IMARC Group expects the market to reach US$ 8.17 Billion by 2027, exhibiting a CAGR of 7.28% during 2022-2027. Keeping in mind the uncertainties of COVID-19, we are continuously tracking and evaluating the direct aswell as the indirect influence of the pandemic on different end use industries. These insights are included in the report as a major market contributor (IMARC group, 2021).

Asia Pacific is among the largest consumers of silica sand based on its increasing utilization in the glass and foundry industries. The rising demand for high purity silica sand in manufacturing photovoltaic panels and silicon-metal composite materials is also augmenting the market growth. The rapid development of solar infrastructures in the region is catalyzing the installation of glass-based photovoltaic modules. Additionally, the growing consumer electronics sector in the region has proliferated the use of silica sand in producing specialty glass. The increasing demand for foundry sand in the automobile industry is further fueling the market growth. Apart from this, the expanding construction industry has significantly increased the use of silica sand in manufacturing various building materials. Rapid urbanization has propelled the demand for high-grade construction materials in both residential and commercial sectors. Furthermore, the growing

infrastructural investments in various Asia Pacific countries, such as China, India, Japan, South Korea, Vietnam, etc., are also driving the market growth. Apart from this, silica sand is also utilized during hydraulic fracturing. Numerous shale gas exploration activities, particularly in China and Australia, are also bolstering the market for silica sand in the region.

The demand for high-grade construction materials in both residential and commercial sectors. Furthermore, the growing infrastructural investments in various Asia Pacific countries, such as China, India, Japan, South Korea, Vietnam, etc., are also driving the market growth. Apart from this, silica sand is also utilized during hydraulic fracturing. Numerous shale gas exploration activities, particularly in China and Australia, are also bolstering the market for silica sand in the region. Figure 2.1 shows the global silica sand market size, 2022-2027 (IMARC group, 2021).

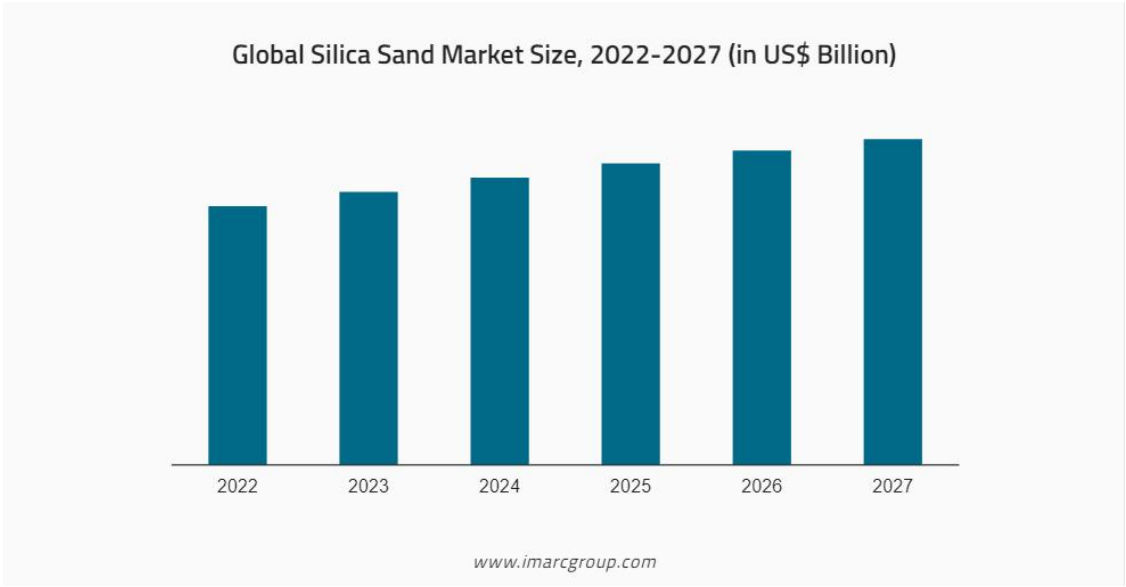

Figure 2.1 Global Silica Sand Market Size