SCHOOL OF MATERIALS AND MINERAL RESOURCES ENGINEERING

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PROCESSING OF COARSE SAND FROM TERENGGANU SILICA SAND

By

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DECLARATION

I hereby declare that I have conducted, completed the research work and written the dissertation entitled “Processing of Coarse Silica Sand from Terengganu Silica Sand”. I also declare that it has not been previously submitted for the award for any degree or diploma or other similar title of this for any other examining body or University.

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PHYSICAL PROCESSING OF COARSE SILICA SAND

ABSTRACT

Coarse silica sand normally contains more impurities compared to the fine grain sand. Therefore, silica content in coarse sand is lower than fine grain. In this project, coarse silica sand was characterized with the tests of particle size distribution, grain scale, microscope analysis which can guide to the upgrading process by using common physical method that used in industry. The coarse sand was ground to reduce the size and liberate the impurities from the silica. Then, the silica content can be upgraded by remove or separate the impurities by spiral separator. The market of high grade silica sand is high due to the various applications can be done by using silica. The producer of silica has to be excited to rise the production. The increasing of silica content show it is a good method to apply. So, I believed that physical processing can upgrade the silica content and can produce high grade of silica for glass making industry.

PROSES FIZIKAL UNTUK PASIR SILIKA KASAR

ABSTRAK

Pasir silika kasar biasanya mengandungi kandungan mineral tidak perlu yg tinggi berbanding dengan pasir silika halus. Maka, kandungan silika di dalam pasir silika kasar adalah rendah daripada pasir halus. Dalam projek ini, pasir telah dicirikan dengan beberapa ujian seperti taburan saiz butiran, skala bijirin, analisis mikroskop yang boleh dirujuk untuk proses menaik taraf dengan menggunakan kaedah fizikal yang biasa digunakan dalam industri. Pasir kasar telah dikisar untuk mengurangkan saiz dan membebaskan mineral tidak perlu daripada silika. Seterusnya, kandungan silika boleh dinaik taraf dengan membuang atau mengasingkan bahan tidak perlu dengan mengunakan pemisah spiral. Pasaran pasir silika bertaraf tinggi juga tinggi disebabkan oleh pelbagai aplikasi boleh dihasilkan dengan menggunakan pasir silika. Peningkatan kandungan silika menunjukkan ianya satu kaedah yang baik untuk dijalankan. Maka, saya percaya bahawa proses fizikal boleh menaik taraf kandungan silika dan boleh menghasilkan silika bertaraf tinggi untuk kegunaan industri pembuatan kaca.

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CHAPTER 1

INTRODUCTION

1.1.Background

Silica, SiO^2, is the name of a group of minerals that composed by silicon and oxygen. Naturally, it form in various structures for example, quartz (crystalline), sandstone (sedimentary rocks that made out of little grains of quartz), quartzite (transformed subordinate of sandstone), and silica sand (weathered sandstone or quartzite improves in silica). It also occurs in an amorphous that formed from weathering.

Sand is a loose granular substance, typically pale yellowish brown, resulting from the erosion of siliceous and other rocks and forming a major constituent of beaches, river beds, the seabed, and deserts. It is also known as industrial sand, and is largely used in several construction applications.

Silica sand deposits are mostly mined as surface-mined in open pit mining, but dredging and underground mining are also applicable. The ore undergoes certain processing to increase the silica content and reduce the impurities. Silica sand can obtain from beach and ex-mine area. Beach sand is the sand that collected directly from the beach and normally highly silica content. The size of beach sand mostly in grain size which is about 80-90% grain size and the rest is coarse. Tailing sand is the sand collected from tailing dam in mining area. It was leave as tailing after the sizing process where

silica in grain size was taken for industries uses. Therefore, the remaining silica sand was considered as coarse sand. However, the coarse size still containing SiO^2.

For industrial and manufacturing applications, the silica content should be yield at least 95% of SiO^2. Silica is hard mineral. It is chemically inert and has a high melting point (1760^OC) due to the strength of the bond between the atoms. These are gave qualities in application like glass-making, metal casting, metal production and etc. The strength contribution and non-reactive properties make it a requisite for the production of the products.

Glass making is the main applications section that use silica sand and the major glass manufacturing industry in India and China act as main drivers for increase demand. The market has also been divided to a few countries that export the sand such as Japan, South Korea, Indonesia, Thailand, Malaysia, Singapore, Philippines, and Vietnam.

In glassmaking, silica sand is the main elements or materials for all types of standard and specialty glass production. The silica purity is the main factor that will give effect on color, clarity and strength. It is used to produce flat glass for building and automotive use, container glass for beverages, and tableware. For metal casting and production uses, the metal parts will be cast in a sand and clay mold to produce the external shape. This is due to the high fusion point of silica and low rate of thermal expansion produce stable cores and molds well-suited with all pouring temperature and alloy systems.

In Malaysia, Terengganu Silica that located at Setiu is a company that operates the largest silica resource in Asia. It is about 1000 hectar of lease land that contain more than 60 million ton of high purity grade silica. The product is about 99.55-99.9% of SiO^2

with low iron content. It will be the leading silica sand producer in Asia and Oceanic with an estimation of annual capacity is about 1,200,000 million ton. It produce high purify silica sand and flour, resin coated sand and frac sand. But, the production is almost application is to use the fine grain sand. The sand production there is about 50% fine grain, 30% medium grain and 20% coarse sand.

Silica sand contains quartz and other minerals in sand size. According to ISO 14688, the sand was graded as fine, medium, and coarse with ranges 0.063 mm to 0.2 mm to 0.63 mm to 2.0 mm. Sand is commonly divided into five sub-categories based on size: very fine sand (0.0625– 0.125 mm diameter), fine sand (0.125 mm – 0.250 mm), medium sand (0.250 mm – 0.500 mm), coarse sand (0.500 mm – 1 mm), and very coarse sand (1 mm – 2 mm). Therefore, the size of each particles of sand is important to be classified by the size.

The grade of silica sand is depending on SiO_2 content. The restricted minerals that does not needed in glass production that contain in raw silica sand are Rutile (TiO_2), Hematite (Fe_2O_3) and Corundum (Al_2O_3) and etc. These minerals need to separate from silica sand because it will give effect on colorless and transparency of glass such as give dotted color marks due to the present of Al and Fe and it has higher melting point that Si. Melting point for Zr is 1855^{o}C, Ti is 1668^{o}C, Fe is 1538^{o}C while Si is 1414^{o}C. Therefore, the impurities should be eliminate if not, it will affect the end-product of silica sand. That is why the silica based end-product required high grade of silica content with low grade of iron or impurities as low as possible.

1.2.Problem Statement

Nowadays, silica sand was uses widely for many applications. The supply of silica sand should meet the demand of industries. But, does the supply enough for industries demand? In industries, the coarse sand are eliminate from being uses because the application of silica sand required the fine grain of silica sand to produce products. So, what will happen to the coarse sand? It will be sell as coarse sand at lower price even it also content SiO^2 that can be used in industries.. The impurities such as Ilmenite, Rutile, and Zircon also formed in coarse sand. In fine grain also it formed but in low percentage compared to the coarse sand. In glassmaking industries, they are using fine silica sand in range <500µm or <600µm. The glassmaking industry is the biggest industries that apply the silica sand. Therefore, coarse sand will be sold as low grade sand due to unliberated impurities even it content about 90% of silica. A research should be done to investigate on how much silica content in coarse sand and does it profitable to re-mine.

As we know, the coarse sand content slightly high percentage of impurities even is it still containing silica about 90%. The ways to eliminate and remove the impurities should be applied. The method or technique to separate the impurities from silica should be identified. There are many techniques that can eliminate the impurities or upgrading the silica content. It can be done by chemically or physically. But, everything must be considered by cost. Generally, physical method is the suitable method to upgrade the silica content. It can be done by separating the minerals according to the density, magnetic behavior, and etc. So, suitable method and process should be selected to upgrade the silica content. Therefore, the coarse sand needed to be process.

1.3.Objective

1) To determine the characterization of the coarse silica sand
2) To upgrade the silica content from coarse silica sand by spiral separator

1.4.Scope Study

This study focuses about how to upgrade the silica content by using physical method. The physical processing such as grinding can be done to liberate the impurities and upgrade the silica content. The process of separation such as by using magnetic separator, mozley tables or spiral can be used to upgrade the silica content. The impurities such as iron (Fe) and aluminium (Al) have to be removed from the sand. Before any process of liberalization of impurities or upgrading silica content, characterization process should be done. Silica based product such as glass required high grade of silica. So, it is important to remove the impurities from the sand and meet the requirement of specification of the product needed. Every product has the specification to be produced. There are methods and procedures to reduce the size of the coarse sand and indirectly increase the grade of silica sand.

The process can be start by sieving the sand samples. It will separate the sand by the size and the size distribution of coarse sand from the sample can be analyzed. The samples will be separated by sieve shaker that provide force by shaking the sample that have been put in the machine. The sieve will be arranged from huge size of mesh to the small size of mesh. The grain size of sand will pass through the mesh of the sieve. From that, the sand that bigger in size can be separated from the grain size of sand. it is because,

this research is about to study the coarse sand. So, the coarse sand will be going to further process.

Normally, the bigger size of the sand content more impurities due to the interlocking or coating with silica. Another process must be carried out to liberate the impurities and silica. Attrition and scrubbing process is a process that can liberate the impurities from the sand. So, any impurities that coated or interlocked with silica can be liberate. After the process, the silica can be separate with the impurities by separation process. To occupy the requirement that generally needed from the glass making industry, the coarse sand will be grind to the size below 600µm. From that, we can decide whether the coarse silica sand worthy to be mine after the size reduction process.

As we all know, the density of silica is lower than other minerals. So, the separation process which is upgrading process can be done by separating the minerals based on the density. From grinding process, the size of sand became suitable with the industry requirement. But the impurities do not removed yet. The process will separate the minerals by giving pressure or force from the flow of water until the heavy mineral separated from light density minerals. From that, we can get high grade of silica sand that can achieve 99% of silica content.

For the mineral identification or analyzation process, X-Ray Fluorescence (XRF) test will be carried out. It will determine the percentage of each minerals containing in the sand. The iron content, silica content, zircon content can be determined by XRF test. From that, we can conclude whether the silica content upgraded or not.

Therefore, this project only focused on physical method of processing without using of any chemicals. The method used was using the common machine that being used in industry.

CHAPTER 2

LITERATURE REVIEW

Silica, or all the more effectively silicon dioxide SiO^2, is a standout amongst the most plentiful mixes on the surface of the Earth, being most evident as quartz and basic sand. Silica has a large number of applications relying upon the level of grade. Evaluations up to 99.5% SiO2 are utilized as a part of the produce of glass, optical filaments and earthenware production (Wills & Napier-munn, 2006).

Sand was utilized as right on time as 6000 B.C. to crush and clean stones to make tools or devices. The stones were rubbed on a bit of wetted sandstone to sharpen the forefront. At times, loose sand was scattered on a rock, and tools were rubbed against the sandy surface to smooth them. The principal beads with a glass coat showed up in Egypt in around 3,500-3,000 B.C. The glass was made by liquefying sand, albeit normally happening glass shaped by volcanic behavior was most likely known some time before that time.

There are different meanings of High Purity Quartz (HPQ) with respect to the total and elemental contamination. While present day processing strategies can evacuate a significant part of the contamination, it is the substitutional components, for example, aluminum, titanium and lithium which are inconceivable expel in the event that they are basically bound to the silica, that compel a definitive immaculateness of the silica. Normally happening ultra-pure SiO2 (more than 99.997%) which is reasonable for creation of high-immaculateness fillers, silicon metal and use in sun oriented boards and

semi-conductors is geologically uncommon and orders a critical premium over the cost of lower grader material.

2.1. Overview of Silica

According to N.R. Shaffer (2006), quartz sand is the last result of rock weathering which is a critical part of the stone cycle. The weathering of any quartz-bearing rock makes sand: igneous, sedimentary, or metamorphic. It is associated with a continue cycle of rock formation and disintegration that began with the World's arrangement and proceeds with today. Weathered grains end up isolated from between developed or solidified minerals that make up hard rock. Grains are transported for the most part by water and as they travel, weaker minerals are evacuated and safe grains become smaller in measure, turn out to be more adjusted fit as a fiddle, and their surfaces are altered by consistent scraped spot or substance assault. The more drawn out circumstances that grains venture to every part of the more develop they move toward becoming.

Numerous sand grains are extremely balanced showing a few cycles of testimony and transport. Researchers contemplate mineral creations, grain estimate appropriation, measures of grain roundness, insight of molecule arranging and different points of interest to unfold a sediments history. Extremely develop sands make the most artificially unadulterated, most in a perfect world round, and best arranged sand stores. Silica sand stores are generally develop or super-mature. Super develop sands frequently are over 95% quartz with some characteristic stores containing 98% quartz. These high-immaculateness sands have various financial applications and are required for glass making.

According to the report by Abdelrahman Ahmed Ali Abdelrahman (2013) titled, “Geological Overview of White Silica Sand”, he stated that, the sand was undergoes some processing process which is by physical or chemical process to upgrade the silica content and reducing the impurities content. Then, it dried and sized to produce the required sizes to fulfill the product requirement.

The sand was the product of mechanical and chemical weathering of quartz-bearing igneous and metamorphic rock such as granite and gneiss. Erosion and chemical weathering separate the less steady minerals, for example, feldspars and discharge the more steady ones, for example, quartz and zircon. The steady mineral parts are transported and stored in water. Wave and stream activity may additionally change the stores by arranging and washing until the point when a generally unadulterated store of silica sand remains. Figure 2.1 shows the pure deposit of silica sand.

Figure 2. 1: Silica sand deposit

Silica exists in nine diverse crystalline structures or polymorphs with the three primary structures being quartz, which is by a wide margin the most well-known, tridymite and cristobalite. It additionally happens in various cryptocrystalline frames.

Stringy structures have the general name chalcedony (microcrystalline quartz) and incorporate semi-valuable stone forms, for example, agate, onyx and carnelian. Granular assortments incorporate jasper and rock. There are additionally anhydrous structures - diatomite and opal.

Abdelrahman Ahmed Ali Abdelrahman (2013) also state about the quartz. Quartz is the second most normal mineral in the earth's crust. It is found in every one of the three of the world's rock types which is igneous, metamorphic and sedimentary. It is especially predominant in sedimentary rocks since it is to a great degree impervious to physical and concoction breakdown by the weathering procedure. Since it is so inexhaustible, quartz is available in about all mining tasks. It is available in the host shake, in the mineral being mined, and also in the dirt and surface materials over the bedrock, which are known as the overburden.

The greater part of the items sold for modern utilize are named silica sand. "Sand" indicates a material whose grain estimate dispersion falls inside the range 0.06-2.00 millimeters. The silica in the sand will typically be in the crystalline type of quartz. For modern utilize, unadulterated stores of silica able to do yielding results of no less than 95% SiO2 are required. Frequently significantly higher immaculateness esteems are required. Silica sand might be delivered from sandstones, quartzite and inexactly established or unconsolidated sand stores. Unconsolidated sand as shown in Figure 2.2.

Unconsolidated sand and rock aquifers can be assembled into four classifications: bowl fill aquifers, which additionally are called "valley-fill aquifers"; cover sand and rock aquifers; cold store aquifers; and stream-valley aquifers which are of for the most part

little degree and not mapped. Each of the four sorts have intergranular porosity, and all contain water fundamentally under unconfined or water-table conditions.

Figure 2.2: Unconsolidated silica sand

2.2. Market View and Demand

According to the report by IMARC Group titled, "Silica Sand Market: Global Industry Trends, Share, Size, Growth, Opportunity and Forecast 2017-2022", finds that the worldwide silica sand market achieved a volume of 116 Million Tons in 2016, developing at a CAGR of almost 8% amid 2009-2016. Silica sand, or industrial sand, is the most ordinarily accessible assortments of sand on earth. It is rich in quartz, a mineral, which is made out of silicon dioxide. Some different minerals are likewise present in silica sand in little amounts, for example, aluminum, feldspar and iron-bearing minerals. Silica sand utilized for a few mechanical purposes, other than development, must contain high extent of silica and less amount of impurities. Alongside this, the consistency of grains and physical attributes (grain measure, conveyance, grain shape, sphericity, grain quality and unmanageability) likewise assume a vital part in the mechanical utilizations of silica sand.

Features of the worldwide silica sand market:

- The market is driven by its growing applications over a few ventures.
- The Assembled States is the biggest market for silica sand, representing most of the offer.
- The market is relied upon to achieve a volume of around 231 Million Tons by 2022.

The market is fragmented based on end-use with a portion of its significant end-utilize enterprises being glass industry, foundry, water driven cracking, filtration and abrasive. In the glass business, silica sand is utilized as a part of the assembling of glass container, flat glass, insulation fiberglass, and specialty glass.

Based on "Silica sand supply and demand in Asia-Pacific market', by Murray Lines *et al,* World interest for flat glass will climbed in excess of 4 percent for each year to about 4 billion square meter in 2004, with a market estimation of over US$40 billion. In light of the present extent of glass made and utilized as a part of Asia the incentive in this locale would be around US$13 billion.

An extent of the high quality glass, and surely a portion of the rolled, is additionally handled by overlaying, toughening, covering and silvering. Some of this ends up in the form of protecting glass units or car windscreens and sidelights. Glass made in flat sheets (buoy, sheet and moved) which might be further handled. By and large 1 ton is roughly 125 square meter. The worldwide market for float/sheet glass (excluding rolled glass) is roughly 30 million tons p.a. This is commanded by Europe, China and North America, which together record for more than 70 for each penny of

interest. China is expanding in its worldwide significance as with numerous different items including steel and concrete, all driven by solid monetary development.

Prior to the quick development of hydraulic fracturing, sand was a generally small market. In 2005, for instance, U.S. Geographical Overview (USGS) information show 31 million metric tons of industrial sand were mined in 35 states. That sand was esteemed at $700 million, averaging generally $22.6 per metric ton. Around 35 percent was utilized for glass making, 19 percent at foundries, 12 percent in pressure driven breaking utilizing vertical penetrating systems, and 10 percent in the development business.

In 2014, 75 million metric tons amounts of sand and gravel were mined, almost 2.5 times something beyond a couple of years back. That sand was esteemed at $4.2 billion, averaging about $56 per metric ton. Hydraulic fracturing, not the glass making industry, is presently the main use for industrial sand as 72 percent of the sand mined in 2014 was used for hydraulic fracturing and well-packing. 13 percent of the sand mined in 2014 was utilized for glassmaking, 6 percent at foundries, and only 3 percent as whole grain fillers and for building products.4 Much of the development in industrial sand production has happened in the Midwest: 68 percent of the sand dug for hydraulic fracturing was mined in this area in 2012, and that figure has developed lately.

High flawlessness quartz has its own particular overall perspective using ventures is sure with improvement rate in the region of 3% and 5%, especially in certain lighting, semiconductor and photovoltic application. All sign show empower improvement in the coming a long time in sun controlled industry. Table 2.1 shows the production of silica sand around the world.

Table 2.1: Production of silica based on continents (%)

Continents	Production (%)
Asia	15.1
Europe	20.2
Africa	0.2
Australia	0.1
North America	64.2
South America	0.1

In 2007-2011 periods, it demonstrate that production of c (crystalline)-Si saw CAGR of 45% while in 2010-2014, Si-production is predict to ease back to CAGR in the 20-30% territory surpassing 300,00-400,00 tpa in 2014. Production of solar cell is increasing about 118% from 2009 to 2010. Crystalline silica is expected to be safe about 30% for next couple of the due to increasing in demand.

According to the "Malaysian Minerals Yearbook 2010" by Minerals and Geoscience Department Malaysia, stated that in 2010, the total sand and gravel production was 30.7 million tonnes with 1,049 operators compared with 17.4 million tonnes in 2009. The production has increased significantly by 76 per cent due to high demand in the construction industry and export to neighbour countries which lead to the increase in the number of sand and gravels operator in 2010.

The increase in production was observed in almost every states except for Terengganu and Kelantan recorded a decrease in production. The highest sand and gravel

producing states were Perak, Johor, Selangor, Sarawak, Negeri Sembilan, Kedah, Pahang, Terengganu, Sabah, Melaka and Kelantan. Table 2.2 shows the production of silica sand and gravel for each state in Malaysia from 2007 – 2010.

Malaysia also exported sand and gravel. In 2010, the total exports of sand and gravel registered a huge jump to 7,633 tonnes compared with 1,037 tonnes recorded in 2009. The main exports destination were Yemen and Australia. Similarly, the import volume of sand and gravel during the year increased by 41 per cent to 17,553 tonnes compared with 12,627 tonnes recorded in 2009. The main source of imported sand and gravel were from India and China. Table 2.3 shows the exported history of silica sand.

Table 2.2: Malaysia's production of sand and gravel

State	2007		2008		2009		2010	
	'000 tonnes	permit holders	'000 tonnes	permit holders	'000 tonnes	permit holders	'000 tonnes	permit holders
Perak	10,307	258	10,063	276	3,965	121	7,270	207
Selangor / KL	1,513	46	4,042	25	2,366	30	4,933	33
Sarawak	2,114	23	2,549	22	2,265	24	2,821	27
Terengganu	2,489	121	2,536	116	2,009	106	1,245	113
Johor	2,789	117	1,752	104	1,750	107	6,273	111
Pahang	1,039	90	856	68	1,627	81	2,198	131
Kedah	528	56	1,097	123	1,187	136	2,248	161
Sabah	673	48	678	41	810	47	923	45
Kelantan	236	73	240	N.A	623	118	323	125
Melaka	354	9	150	11	425	17	459	17
Negeri Sembilan	328	46	508	30	356	47	1,706	79
Perlis	–	–	–	–	–	–	–	–
Pulau Pinang	–	–	–	–	–	–	–	–
Total	**22,370**	**887**	**24,471**	**816**	**17,382**	**834**	**30,698**	**1,049**

Table 2.3: Exported of silica sand and gravel

Country	2008		2009		2010p	
	Quantity (tonnes)	Value (RM)	Quantity (tonnes)	Value (RM)	Quantity (tonnes)	Value (RM)
Sand & Gravel (HS: 2505.90.000)						
Singapore	1,831	722,000	799	666,000	801	502,000
Thailand	24	19,000	96	60,000	264	145,000
Philippines	24	17,000	51	37,000	5	15,000
Yemen	–	–	–	–	5,000	107,000
Australia	–	–	–	–	1,500	36,000
Others	51	307,000	91	60,000	63	61,000
Total	**1,930**	**1,065,000**	**1,037**	**823,000**	**7,633**	**866,000**

The import of silica sand from other country to Malaysia shows in table 2.4 Malaysia has import and export of the silica sand and gravel.

Table 2.4: Import's value of silica sand and gravel

Country	2008		2009		2010p	
	Quantity (tonnes)	Value (RM)	Quantity (tonnes)	Value (RM)	Quantity (tonnes)	Value (RM)
Sand & Gravel (HS: 2505.90.000)						
India	1,385	1,316,000	6,186	2,188,000	10,856	3,636,000
China	5,582	3,784,000	4,069	1,904,000	3,566	1,435,000
Germany	710	996,000	490	832,000	1,076	1,245,000
Australia	35	110,000	521	248,000	766	412,000
Taiwan	90	119,000	203	248,000	399	475,000
Others	867	1,607,000	1,158	2,248,000	890	1,971,000
Total	**8,669**	**7,932,000**	**12,627**	**7,668,000**	**17,553**	**9,174,000**

2.3. Properties and characteristic of Silica

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 encourage their own specialty. Table 2.5 shows the properties of pure silica.

Table 2.5: Properties of silica

Properties	Description
Density	2.0 – 2.7 gm/cm^3
Thermal conductivity	0.01 W/cm K
Thermal diffusivity	0.009 cm^2/sec
Coefficient of thermal expansion	0.5 ppm/K
Breakdown field	>1E7 V/cm
Electrical conductivity	Varied widely
Refractive index	1.46
Dielectric constant	3.9

There are different between quartz and fused silica. The different have shown in table 2.6.

Table 2.6: Differences between quartz and fused silica

Material	**Quartz**	**Fused silica**
Density (g/cm^3)	2.65	2.2
Thermal conductivity (Wm^{-1} K)	1.3	1.4
Thermal expansion coeff. (10^{-6} K^{-1})	12.3	0.4
Tensile strength (MPa)	55	110
Compressive strength (MPa)	2070	690-1380
Poisson's ratio	0.17	0.165
Fracture toughness (MPa)	-	0.79
Melting point (°C)	1830	1830
Modulus of elasticity (GPa)	70	73
Thermal shock resistance	Excellent	Excellent
Permittivity (ε') *	3.8-5.4	3.8
Tan (δ x 10^4) *	3	
Loss factor (ε'') *	0.0015	
Dielectric field strength (kV/mm) *	15.0-25.0	15.0-40.0
Resistivity (Ωm) *	10^{12}-10^{16}	$>10^{18}$

The physical particulars bargain only with particle size. The grain size of bunch materials emphatically influences the measure of energy required for melting. Glass producers lean toward a close uniform size to the bunch fixings to guarantee proficient softening; they commonly utilize material whose grains run from 0.59 to 0.149 mm. However, in textile and reinforcing fiber glass over 90% of the crude material grains are smaller than 0.045 mm (45 μm). There is thought to fix these cutoff points from 0.3 to 0.1 mm, particularly for sand since it is the most troublesome segment to liquefy. Grain state of the sand likewise influences softening. Angular grains offer more surface region and quicker liquefying than rounded grains.

Moreover, iced or pitted grains offer an expansion in surface territory that can improve dissolving. Uniform size among the greater part of the fixings likewise speeds liquefying, minimizes segregation during the batch handling, and homogenizes the dissolve. If there is coarser in size than the specified range, inadequate dissolving frequently happens, which brings about a low quality item. If very much of the batch is finer, tidying happens which makes housekeeping issues outside the heater due to the dusting. Inside the heater fines can hurt the heater refractories and warmth exchangers.

Size distribution represents a major processing function. Each glass creator may have somewhat different necessities for their gradation. However, they need raw materials to go from 0.59 to 0.149 mm. Subsequent to preparing to expel impurities and arranging the item to its legitimate size range, the last process is drying. Glass makers need the crude materials to contain below 0.1% moisture. It was stated in a journal "Silica sand supply and demand in Asia-Pacific market', by Murray Lines *et al.*

In a report by Abdelrahman Ahmed Ali Abdelrahman (2013) titled, "Geological Overview of White Silica Sand", he state that three noteworthy types of crystalline silica - quartz, tridymite and cristobalite, are steady at various temperatures and have subdivisions. For case, geologists recognize alpha and beta quartz. At the point when low temperature alpha quartz is warmed at air weight it changes to beta quartz at 573^{o}C. At 870^{o}C tridymite is shaped and cristobalite is framed at 1470^{o}C. The dissolving purpose of silica is 1610^{o}C, which is higher than iron, copper and aluminum, and is one motivation behind why it is utilized to deliver forms and centers for the creation of metal castings.

Quartz is typically dry or white however is regularly shaded by contaminations, for example, press, and may then be any shading. Quartz might be straightforward to translucent, henceforth its utilization in glassmaking, and have a vitreous radiance. Quartz is a hard mineral inferable from the quality of the bonds between the molecules and it will scratch glass. It is likewise generally idle and does not respond with weaken corrosive. These are prized characteristics in different mechanical employments. The crystalline structure of quartz depends on four oxygen particles connected together to frame a three-dimensional shape called a tetrahedron with one silicon atom at its middle.

Depending upon how the silica store was shaped, quartz grains might be sharp and angular, sub-angular, sub-rounded or rounded as shown in Figure 2.3. Foundry and filtration applications require sub adjusted or adjusted grains for best execution.

Figure 2.3: Quartz grain

2.4. Geological Impact

Sand mining is a global activity in both developed and developing countries. Exploiting sand from different sources has both multiple benefits (poverty reduction, economic growth, new habitats for plants and animals, new water reservoirs are created.)

and a series of negative impacts on the environment. Based on the research by Fo Kowalska and Sobczyk, several factors must be taken into account when the environmental impact of sand mining is analyzed:

- location of sand mine;

- size of mining area;

- time of exploitation;

- secondary mineralogy;

- habitats and vegetation diversity across the mining area;

- technical conditions for exploitation.

Until recently, sand has been mined predominantly from land quarries and riverbeds, but, due to intensive exploitation and because this practice has been banned in many regions and environmental regulations have become much more strict or no longer allow this, nowadays mining of marine sand is increasing significantly. Thus, due to the negative environmental impact, marine sand mining activities are nowadays regulated more strictly by global, regional and national legislation.

Even if in the past there were scientists that were concerned about environmental issues and brought them to the attention of public and authorities, only in the last years special attention was granted to all these negative environmental impacts. Nowadays, solving environmental problems is an essential objective, and experts are more aware that economic and social development needs to be correlated with environment protection.

2.5. Silica Applications

Regardless of its straightforward substance equation, SiO^2, silica exists in various shapes and crystalline structures. Found most generally in the crystalline state, it additionally happens in an indistinct frame coming about because of weathering or tiny fish fossilization.

For mechanical and fabricating applications, stores of silica yielding results of no less than 95% SiO^2 are favored. Silica is hard, synthetically idle and has a high liquefying direct, inferable toward the quality of the bonds between the iotas. These are prized characteristics in applications like foundries and filtration frameworks.

Quartz may be transparent to translucent and has a vitreous luster, hence its use in glassmaking and ceramics. Industrial sand's strength, silicon dioxide contribution and non-reactive properties make it an indispensable ingredient in the production of thousands of everyday products.

Some silica sand deposits may cater for the used primarily as metallurgical sand. The copper and zinc at some smelter uses the sand as a fluxing agent which, in the molten state, reacts with various impurities in the ore and produces a slag. The slag is drawn off with the impurities, leaving a more refined metal behind. The applications of the silica as followed:

- Production of glass
- Foundry sand
- Ceramics

- Sandblasting and other abrasives
- Building products
- Filler and extender
- Production of silicon and silicon carbide
- Pigments
- Hydraulic fracturing and propping in the oil industry
- Ultra-high silica products in the electronic and fiber optic industries, fused silica, silicone products
- Water filtration

Silica adds to the present data innovation upheaval being utilized as a part of the plastics of PC mouse and giving the crude material to silicon chips. Despite the fact that glassmaking and foundry utilizes prevail, various minor uses depend on either the substance virtue or physical properties of the sand, (for example, grain-estimate dissemination or grain shape). These incorporate pottery, water filtration, fluidized-bed heaters and synthetic make.

Attributable to the requesting particulars required for every application, silica sand for glassmaking is unmistakable from that utilized for different purposes. Notwithstanding glassmaking, its other real utilize is in molds for the foundry business.

U.S Silica is a company that produces silica in USA. Glassmaking requires silica sand items that are free from contaminants, clear in shading, steady in grain size, and low in press. U.S. Silica keeps up strict quality systems and details to enhance the execution of your glass items - and to empower generation efficiencies and cost investment funds