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Separation of Silica from Local Clay

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Abstract

The work was done to separate silica from local clay by various separation methods such as washing and wet sieving. Two different types of local clay were used for this purpose. Washing method was done to separate the clay particles. During washing an electrolyte was added to keep the clay particles in suspension. After separation chemical analysis of the separated clay was done. It revealed the presence of 58% silica in clay. Separated silica was then characterized by scanning electron microscope (SEM). SEM showed the sharp edge and smooth surface of silica particles but silica and impurity particles could not be differentiated. In case of wet sieving, separated silica was characterized by Optical Microscopy (OM) and Polarized Light Microscopy (PLM). Optical and Polarized Light Microscopy helped to determine the mineralogy of silica. From OM mainly quartz particles were identified while Polarized Light Microscope helped to identify the other minerals like Muscovite, Biotite and Kyanite. From Optical Microscopy it was seen that oxides of iron formed a thin layer on the silica particles. So for purification of silica some sort of leaching will be necessary.

Keywords: *Wet sieving,Polarized Light Microscopy,Mineralogy, Electrolyte, SEM.*

1. Introduction

Silicon and oxygen are the earth's two most abundant elements and together they make silica, one of the earth's three most common rock forming minerals. The mass of the Earth's crust is 59 percent silica, the main constituent of more than 95 percent of the known rocks.

Silica occurs in three main crystalline forms. The principal occurrence is as the mineral quartz but it also occurs in other rarer mineral forms known as tridymite and cristobalite. It is a very durable mineral resistant to heat and chemical attack and it is these properties that have made it industrially interesting to man.

The first industrial uses of crystalline silica were probably related to metallurgical and glass making activities a few thousand years BC. It has continued to support human development throughout history, being a key raw material in the industrial revolution especially in the glass, foundry and ceramics industries. Silica contributes to today's information technology revolution being used in the plastics of computer mouse and providing the raw material for silicon chips.

For industrial use, pure deposits of silica sand capable of yielding products of at least 95 percent silica are required. Often much higher purity values are needed [1-2].

Washing is the most common separation process. Clay may contain quartz, feldspar, mica, colored minerals, sometimes soluble salts and occasionally organic matter. Washing process is so adjusted to separate clay and silica particles as far as possible. Washing process may, however, need some adjustment depending upon the individual characteristics of the clay under washing. The washing schedule has to be worked out taking into consideration the peculiarity of the clay to be washed and the impurities present [3].

Most sieve analyses are carried out dry. But there are some applications which can only be carried out by wet sieving. This is the case when the sample which has to be analyzed is e.g. a suspension which must not be dried; or when the sample is a very fine powder which tends to agglomerate (mostly < 45 µm) – in a dry sieving process this tendency would lead to a clogging of the sieve meshes and this would make a further sieving process impossible. A wet sieving process is set up like a dry process: the sieve stack is clamped onto the sieve shaker and the sample is placed on the top sieve. Above the top sieve a water-spray nozzle is placed which supports the sieving process additionally to the sieving motion. The rinsing is carried out until the liquid which is discharged through the receiver is clear [4].

2. Experimental procedure

Separation of silica by washing method

Around 4 grams of sample were mixed with 500 ml water. The mixture was stirred with the help of a stirring machine at a fixed speed (1000 rpm). After stirring, a settling time was given for the mixture. The settling time allowed the silica particles to settle down while the clay particles remained in the suspension. Then the silica and clay particles were separated. The silica particles were dried and after drying weight were measured. During the separation 0.3grams of an electrolyte [(0.1gram Na_2CO_3 + 0.2 gram $Na_2SiO_3.9H_2O$) +100 ml water] was added in the mixture. It aided the separation process.

Chemical analysis of clay

After separation chemical analysis of the separated clay was done. The determination of percentage of Silica (SiO_2), Ferrite (Fe_2O_3) and Alumina (Al_2O_3)of the separated clay was done according to the standard chemical analysis procedure.

SEM analysis

Finally, the separated silica particles were taken for SEM analysis. Silica samples were mounted on specimen stub and as silica is not electrically conductive, it was made electrically conductive by gold sputtering.

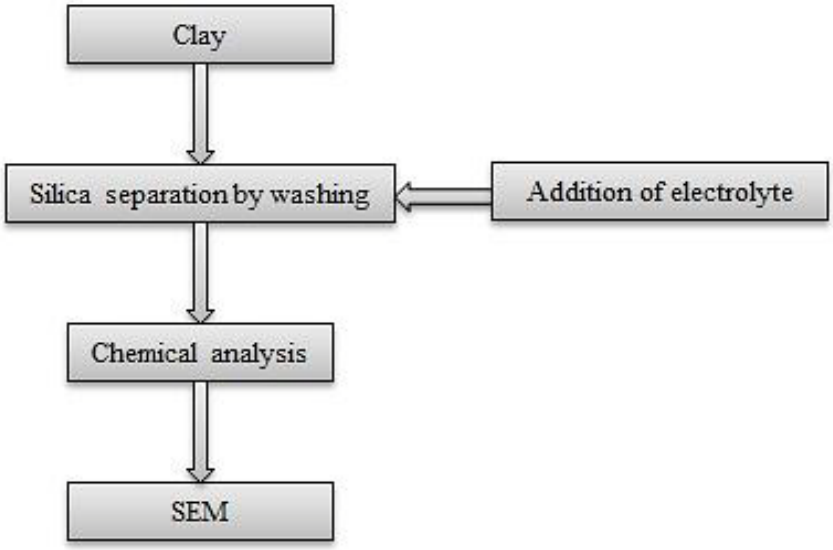


Fig. 1. Separation of silica from local clay by washing method

Separation of silica by wet sieving

At first sample was placed on a sieve having smallest opening, then distilled water was poured on it. Distilled water was used to avoid iron or some other impurities coming into the sample through water. The mixture was allowed to pass through sieve openings. Sand particles remained at the upper portion ofthe sieve. Washing continued until sand particle become free from clay. Obtained silica was then dried in the oven**.**

Microscopic analysis

After the separation of clay, silica samples were observed under optical and polarizing light microscope respectively**.**

Optical mineralogy

Finally Optical mineralogy was done on the basis of polarizing micrograph. Some mineral other than quartz was identified by this work.

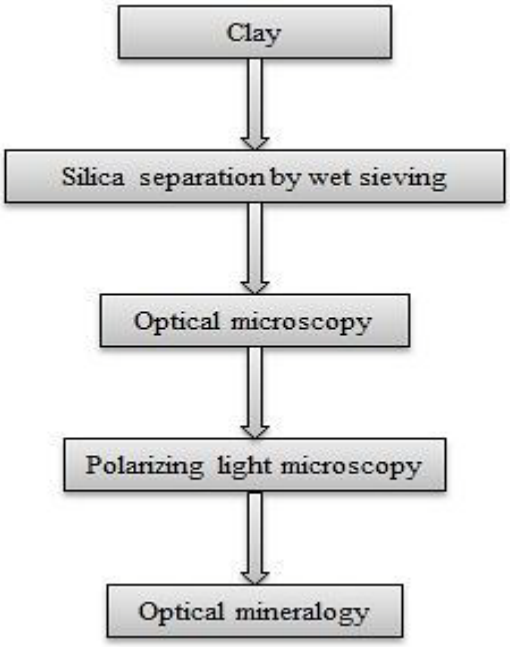


Fig. 2. Separation of silica from local clay by wet sieving method

3. Result and discussions

Effect of stirring and settling time

Table 1 and 2 shows the experimental data of obtained silica during washing method at different parameters. First, the stirring time was varied and the effect was observed.There was no significant change during this experiment (Fig. 3).

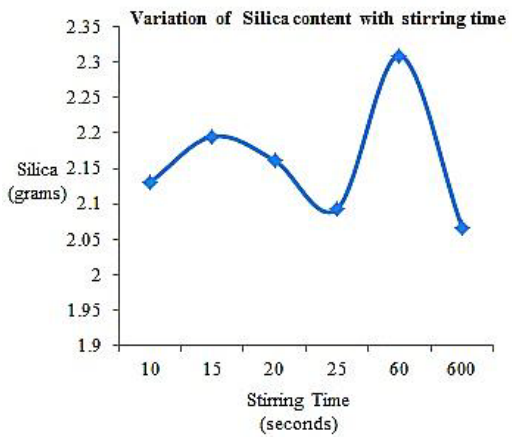
Table 1. Data of silica obtained with different stirring time

Sample (grams)	Water (ml)	Stirring time (seconds)	Stirring speed (rpm)	Silica obtained (grams)
4	500	10	1000	2.130
		15		2.195
		20		2.161
		25		2.093
		60		2.309
		600		2.066

Then, the settling time was varied to observe the change of silica content. The amount of silica was increased with increasing the settling time (Fig. 4).

Table 2. Data of silica obtained with different settling time

Sample (grams)	Water (ml)	Stirring time (seconds)	Stirring speed (rpm)	Settling time (seconds)	Silica obtained (grams)
4	500	300	1000	15	2.279
				30	2.251
				45	2.284
				60	2.235
				120	2.465
				180	2.484



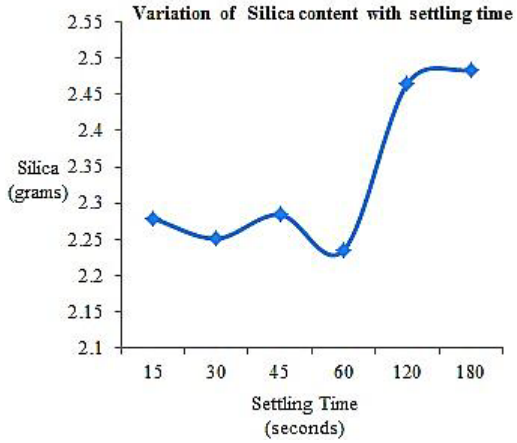


Fig. 3. Variation of silica obtained with stirring time

Fig. 4. Variation of silica obtained with settling time

Effect of electrolyte addition

Table 3 shows the effect of electrolyte addition on separation process. The effect was significant. As the amount of electrolyte increased the amount of separated silica also increased. But settling time had higher effect than electrolyte in this work.

Table 3. Data of silica obtained during electrolyte addition

Electrolyte (ml)	Clay (grams)	Water (ml)	Stirring time (seconds)	Stirring speed (rpm)	Silica obtained (grams)
5	4	500	10	1000	2.153
10					2.172
20					2.216
25					2.218
100 (0.3 g)					2.462
100(0.6 g)					2.481

Chemical analysis

Chemical analysis of the separated clay was done to know the percentage of silica. Around 58 percent silica was present in the separated clay (Fig. 5). It was clear from the analysis that most of the silica particles retained with clay. Washing method could not separate all the silica particles.So wet sieving was carried out. It gave higher percentage of separated silica than washing method.

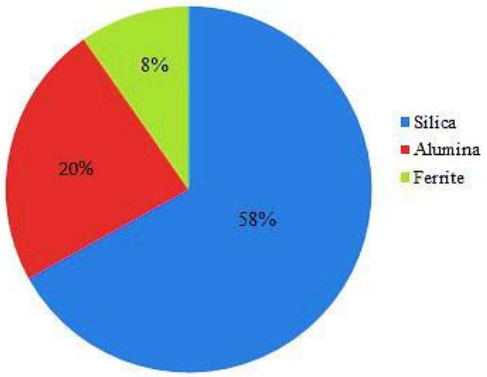


Fig. 5. Pie chart of chemical analysis report

SEM analysis

Fig. 6 shows the scanning electron micrographs of the separated silica particle has sharp edges and more or less smooth surface. By observing these micrographs silica particles could not be separated from impurity particles.

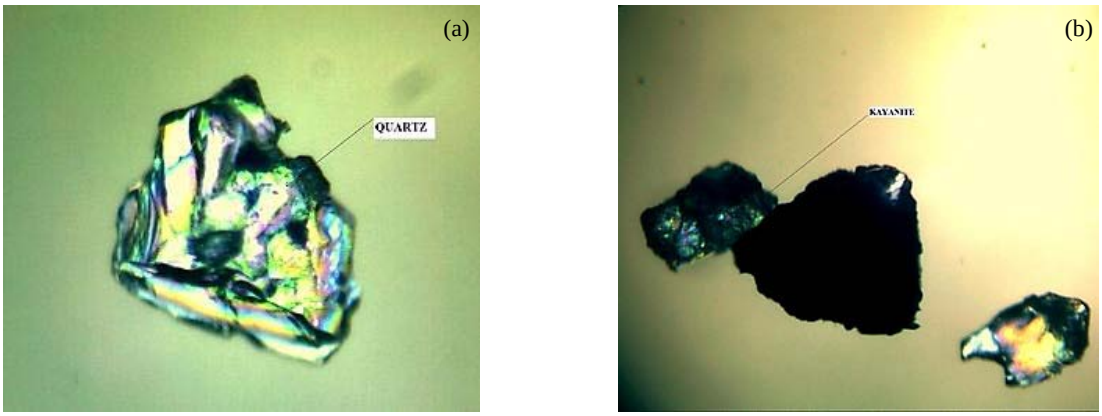
Fig. 6. SEM micrograph of silica obtained by washing method

Optical micrograph

Optical micrographscould differentiate the quartz particles from others. Fig. 7 shows the transparent particles of silica. The red colored particles were silica with thin layers of iron oxide. But OM could not identify the other impurities.

Fig. 7. OM micrograph of silica obtained by wet sieving

Polarized light microscopic analysis



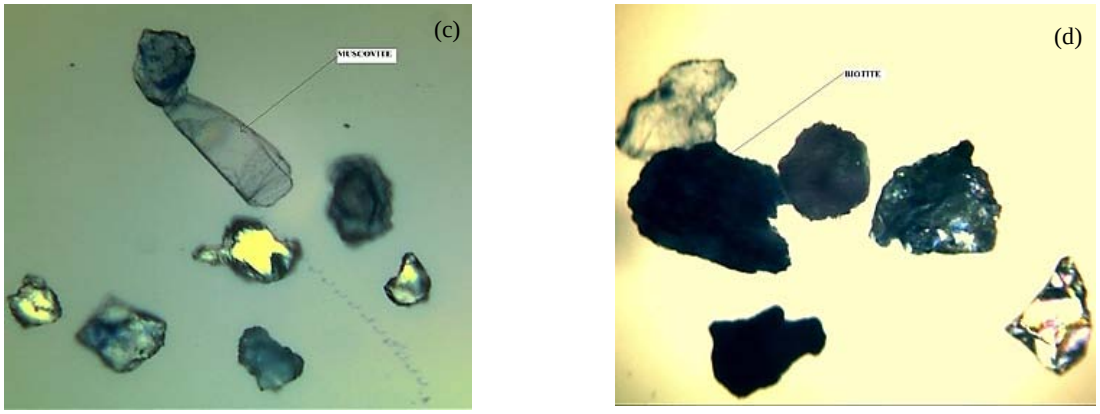


Fig. 8. Polarized light micrograph of (a) Quartz, (b) Kayanite, (c) Muscovite and (d) Biotite

Fig.8 shows the micrographs obtained from polarizing microscope where most of the minerals identified were quartz. Some muscovite, biotite and kayanite were also present. Minerals were identified by seeing their colors at cross polar and plane polar mode.

4. Conclusions

Washing method could not separate all silica particles. Most of the silica particles retained with clay. Moreover, large amount of impurities were present in the separated silica particles. On the other hand compared to washing method wet sieving method separated more silica particles. SEM didn't help to separate quartz minerals from others. It only showed the sharp edged particles with smooth surface. Optical and polarized light micrographs helped to identify the other minerals along with quartz. The micrographs showed the presence of thin layer of iron oxides on silica particles. So for purification of silica from iron oxide some sort of leaching will be necessary.

5. Acknowledgements

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6. References

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