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Process Technology Silica Sand Into Microsilica and Nanosilica For Construction Material

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Abstract. Nanotechnology has experienced rapid growth, it can be seen the emergence of products and high interest researchers associated with nanotechnology.
The implication process natural resources management is no longer limited to generating value addition, but were able to perform value creation. One potential source is the natural silica sand. Silica sand reserves in Indonesia, among others are, South Kalimantan, West Java, East Java and Papua. Utilization of silica sand has been used as a filler only on the construction materials at a price of 20 - 50 IDR/kg, while microsilica: 12,000 – 15,000 IDR/kg and nanosilica: 100,000-150,000 IDR/kg.
This study develops the potential of silica sand in Indonesia through testing, XRF, XRD, SEM and PSA. Then further process by nanosilica's equipment in Indonesia, resulting microsilica and nano silica Indonesia. The end result made comparisons with microsilica and commercial nanosilica.
The results showed that the Planetary Ball Mill (PBM), High Energy Milling (HEM) can be used to generate microsilica. Polishing Liquid Milling Technology (PLMT) can be used to make nanosilica of Indonesia's natural resources, which is equivalent to nanosilica have traded commercial.

Introduction

Indonesia offers some potential to participate in the era of nanotechnology. Its vast natural resources such as petroleum, metal, minerals, coal and other natural materials are available for further explorations[1]. Opportunities in addition to abundant natural resources would have availability of technology that can be used in processing raw materials into finished materials wherever possible existing technologies that exist in their own country to be more independent, not hanging with foreign parties. Indonesia has developed several tools to support the process, among others Planetary Ball Mill (PBM), High Energy Milling (HEM), Sonification, Polishing Liquid Milling Technology (PLMT).
Creation of value can be accomplished through processing of natural silica to become microsilica and nanosilica. Silica sand are chosen from locations famous for silica reserves and quarries such as Bangka Belitung, South Kalimantan , West Kalimantan and some other areas in Kalimantan .
The purposes and goals of the study was obtained potential silica sand, the composition of the chemical content, the process becomes microsilica and nanosilica with existing technology. The results were expected to value creation existing silica sand.

Literature References

Recent researches on the use of nanosilica in mortar and concrete indicated a trend of improved and enchanced performance of mortar and concrete [2, 3, 5, 6]. Silicon Dioxide (SiO_2) is often used in concrete mixtures to increase strength and reduce permeability [4]. There are two reasons to use of SiO_2 in mixture of concrete, the first chemical interaction between silicon dioxide and calcium hydroxide released during cement hydration process, the second is due to an increase in mechanical continuity of distribution of fine particles of silicon dioxide into the substance of the matrix [4].

Methodology

The process of making microsilica and nanosilica with a top down approach by grinding large particles into microsilica and nanometer-sized particles. Silica sand from Bangka Belitung was choosen for further processing into microsilica and nanosilica Indonesia using Planetary Ball Milling (PBM), High Energy Milling (HEM), Sonification and Polishing Liquid Milling Technology (PLMT). PLMT is a method developed a process to produce nano powder from Indonesia Center of Ceramics, as shown in Figure 1.

Figure.1 Flow Diagram of Microsilica and Nanosilica Synthesis
[*Courtesy of Center for Ceramics and MNI*]

Silica sand was obtained from: Bangka Belitung, South Kalimantan, and some areas in West Kalimantan. Then the silica sand is done through testing screening with *X-Ray Fluorescence* (XRF), *Scanning Electron Miscroscope* (SEM) *X-Ray Diffraction* (XRD) and testing with *Particle Sizer Analyzer* (PSA), XRF result can be seen in Table 1.

Tabel 1 XRF Method Chemistry Analysis Result

Source of silica sand	Oksida in %				
	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	CaO
Bangka Belitung	99.24	0.0747	0.143	0.107	0.0302
South Kalimantan	95.40	0.172	2.65	0.740	0.0403
West Kalimantan	99.55	0.0501	0.0513	0.0352	0.0107
Desa Tanjung Gundul 1	97.70	0.0448	0.523	1.04	0.113
Desa Tanjung Gundul 2	96.89	0.0546	0.789	1.22	0.301
Desa Pasir Panjang 1	98.65	0.0584	0.0905	0.747	0.0392
Desa Pasir panjang 2	87.95	0.0766	4.06	5.01	0.297
Sanggau	89.87	0.133	3.80	3.07	0.369
Sekadau	85.62	0.118	7.83	2.05	0.843

According to the schematic description of the technology, the raw material is first blended and washed before being ball milled for a period of time. Then silica sand is separated, filtered, and ovendried. What is somewhat unique is that prior to being separated the sand is sedimented in a reactor. The next step is ball milling for the second time to allow dispersion followed by sieving to obtain the nano size particles or nanosilica. The produced nanosilica is tested for characterization using XRF-EDS, SEM, XRD, and PSA. The produced nanosilica is then compared with commercially available nanosilica, namely Jiangsu, Aerosil HDKN 20 and silicafume from Sika.

Result and Discussions

Produced nanosilica has been analysed for particle size distribution using the particle size analyser. The result shows that nanosilica Indonesia has more than 50% particles of measuring 70 nm, visual characterization using SEM having 60,000 x magnification, some particles are in fact larger than 100 nm, as confirmed by SEM. The result of XRF in Table 2. simply suggests that the produced nanosilica contains 99.60% SiO_2. Meanwhile, Jiangsu nano silica contains 99.94% SiO_2 and Aerosil HDKN 20 contains 99.99% SiO_2.

Results of PSA for silica sand Bangka with through a variety of processes as given in table 3.

Table 2 Results of XRF Nanosilica Commercial, nanosilica Indonesia, and Microsilica

[in weight percent]

Oxida in %	Type of nanosilica			Microsilica
	NS Jiangsu	Aerosil	Nano silica Indonesia	Silica fume
Al_2O_3	-	-	-	0.720
SiO_2	99.94	99.99	99.60	87.74
CaO	-	-	-	0.520
ZnO	0.02	-		
TiO_2	0.04	-		0.0092
CuO	-	0.01		
Fe_2O_3	-	-	0.08	1.63

Table 3 The results of the PSA for silica sand Bangka

Process	Size diameter silica sand Bangka in nanometers (nm)				
	before	5 hours	10 hours	20 hours	30 hours
PBM	809.4	502	772	1046.5	1264.9
HEM	809.4	457.4	618	775.6	608.2
Sonification	457.4	332.5	433.8	370.8	301.7
PMLT	70				

Summary

Planetary Ball Mill (PBM), High Energy Milling (HEM) can be used to generate microsilica Milling and Polishing Liquid Technology (PLMT) can be used to make nanosilica of Indonesia's natural resources, which is equivalent to nanosilica have traded commercially.

For silica sand with SiO_2 content of less than 90% should be processed into microsilica, while for SiO_2 content of more than 90% can be processed into nanosilica

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