Precipitated Silica from Rice Husk Ash IPSIT

(Indian Institute of Science Precipitated Silica Technology)

Introduction:

Rice husk is an agricultural residue abundantly available in rice producing countries. The annual rice husk produce in India amounts is generally approximately 12 million tons. Rice husk is generally not recommended as cattle feed since its cellulose and other sugar contents are low. Furfural and rice bran oil are extracted from rice husk. Industries use rice husk as fuel in boilers and for power generation. Among the different types of biomass used for gasification, rice husk has a high ash content varying from 18 – 20 %. Silica is the major constituent of rice husk ash and the following tables gives typical composition of rice husk and rice husk ash. With such a large ash content and silica content in the ash it becomes economical to extract silica from the ash, which has wide market and also takes care of ash disposal.

Composition of Rice husk on dry basis.

Element	Mass Fraction %
Carbon	41.44
Hydrogen	4.94
Oxygen	37.32
Nitrogen	0.57
Silicon	14.66
Potassium	0.59
Sodium	0.035
Sulfur	0.3
Phosphorous	0.07
Calcium	0.06
Iron	0.006
Magnesium	0.003

Composition of Rice husk ash on dry basis.

Element	Mass Fraction %
Silica (SiO_2)	80 – 90 %
Alumina	1 –2.5 %
Ferric oxide	0.5 %
Titanium dioxide	Nil
Calcium oxide	1 – 2 %
Magnesium oxide	0.5 – 2.0 %
Sodium oxide	0.2 – 0.5 %
Potash	0.2 %
Loss on Ignition	10 – 20 %

From the table it is clear that silica is the major constituent of the rice husk ash. Experiments have been carried out successfully under lab scale to extract the silica from the rice husk ash. This not only provides value addition but also solves the problem of large amount of ash disposal.

Uses:

Precipitated silica can be tailor made to meet the requirements of various uses. Some of the applications are:

1. 1. Rubber industry – as a reinforcing agent
2. 2. Cosmetics
3. 3. Tooth pastes – as a cleansing agent
4. 4. Food industry – as an anti-caking agent.

Process:

The silica precipitation technology developed at CGPL, Indian Institute of Science, Bangalore is a novel method for silica precipitation where the chemicals used are regenerated making it a closed loop operation. Successful studies for extraction of silica on laboratory scale which meet the industrial requirements have been carried out. Also studies are being carried out for suitable application of the undigested ash obtained after extraction, in water treatment plants with or without further improving the activated carbon content of the ash. 70 % conversion is achieved on ash basis and around 90 – 95 % on silica in ash basis. The following gives the brief description of the process.

1. Digestion:

This involves the digestion of the rice husk ash with caustic at specific conditions. In this process the silica in the ash is gets extracted with caustic to form sodium silicate solution. After the completion of the digestion the solution is filtered for the residual undigested ash present in the solution. The clear filtrate is taken for precipitation.

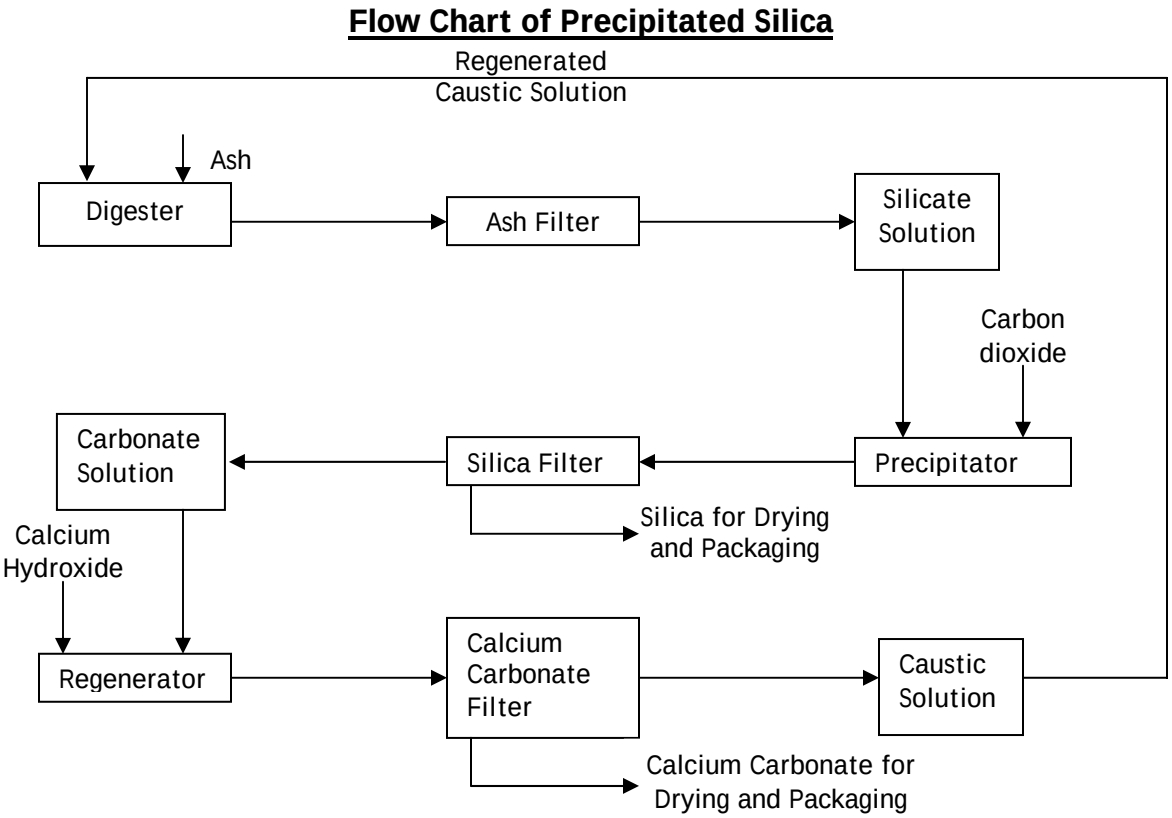
2. Precipitation:

This step involves precipitation of silica from the sodium silicate solution. Carbon dioxide at a specific flow rate is passed through the silicate solution at design conditions. Continuous stirring is employed during the operation. The precipitated silica is filtered, washed with water to remove the soluble salts and dried. The filtrate containing sodium carbonate is taken for regeneration.

3. Regeneration:

Regeneration is the step where calcium compound reacts with the sodium carbonate to form calcium carbonate and sodium hydroxide. The resulting solution is filtered to remove the solid calcium carbonate and the aqueous sodium hydroxide is used for digestion again. The calcium carbonate is washed with water and dried. The dried calcium carbonate can be either calcined to get calcium oxide, which is reused, for regeneration or the calcium carbonate is sold and fresh calcium hydroxide is used for regeneration which gives an option of one more value addition.

Block Diagram:



1. NaOH is regenerated upto 90 %.
2. Calcium carbonate is treated as a by product here.
3. No regeneration of calcium carbonate is attempted here.

Typical Properties of Silica Precipitated at C.G.P.L:

1. Nature: Amorphous powder
2. Appearance: White fluffy powder
3. Purity: > 98 %
4. Surface Area: 150 - 200 m2/gm
5. Bulk density: 120 – 200 g/liter
6. Loss on Iginition: 3.0 – 6.0 %
7. pH of 5 % slurry: 6.3 + 0.5
8. Heat loss: 4.0 – 7.0 % The properties like surface area, pH, Tap density can be tailor made for the requirement

Estimated Ash requirement for 1 ton of silica: 1.6 tons dry

Estimated Costing for Silica by *IPSIT* Process

		Silica Capacity -24 MT/day Investment - 240.0 Million Rs.	**Silica Capacity -5 MT/day Investment - 65.0 Million Rs.**
Sl. No	**Particulars**	**Cost in Rs. Per kg of silica**	**Cost in Rs. Per kg of silica**
1	Raw material	**7.1**	**7.1**
2	Cost of Man power/kg of Silica produced.	**2.00**	**2.50**
3	Packing & Handling cost per kg of silica.	**2.00**	**2.00**
4	Maintenance and repair cost/kg of silica	**0.5**	**0.7**
5	Maintenance and repair cost of biomass based energy plant/kg of silica	**1.60**	**1.60**
6	Power cost/kg of silica @ 4.0/kWh	**4.1**	**4.1**
7	Thermal energy cost	**6.08**	**6.08**
8	*Total production cost*	*23.28*	*24.08*
9	*Revenue generated* **per kg of silica** **Cost of Silica/kg** **Cost of CaCO3/kg**	**40** **6** **46**	**40** **6** **46**
10	*Profit without considering interest on investment & depreciation*	*22.72*	*21.92*
11	*Depreciation (10 Years)*	3	3.6
12	*Interest (10 %)*	3	3.6
13	*Net profit*	*16.72*	*14.72*

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