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Seperartion of Silica and Alumina from Fly Ash (Review)

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Abstract—*Fly ash is a mineral resource. It generally contains about 15-40% Al2O3 and mostly above 40% SiO2. Tones of fly ash is produced which is simply dumped in the environment which causes environmental hazard, also there is loss of such valuable compounds. So recovery of these compounds is an important. The method of recovering Al2O3 and SiO2 from fly ash can be divided into acid methods and alkali methods. Both the methods are efficient in recovering Al2O3 and SiO2. But Alkali methods has some advantages over acid methods like for acid methods there is high consumption of energy, it needs better acid-corrosion resistance equipment and it is inefficient in treating the soluble impurities present in the fly ash, so a pretreatment is required.*

The recovery of alumina and silica from fly ash using alkaline technology that made it possible to separate the main components of fly ash (SiO2, Al2O3) and utilize them separately, producing a large variety of useful products. One of the alkaline technologies is alkali leaching which involves the use of Sodium Hydroxide. The fly ash was added into sodium hydroxide solution, and then the suspension was heated to 115 to 125°C. After filtrated, the filtrate was collected and carbon dioxide was imported into the solution. Finally, the silica would precipitate from the solution. Separated silica can be further processed and used in various useful products like ceramics, glass, pigments etc. and the enriched alumina can be further used to make metallurgical grade aluminum by conventional process.

1. INTRODUCTION

The combustion of pulverized coal at high temperatures and pressures in power stations produces different types of ash. The 'fine' ash fraction is carried upwards with the flue gases and captured before reaching the atmosphere by highly efficient electro static precipitators. This material is known as Pulverized Fuel Ash (PFA) or 'fly ash'. It is composed mainly of extremely fine, glassy spheres and looks similar to cement. The 'coarse' ash fraction falls into the grates below the boilers, where it is mixed with water and pumped to lagoons. This material, known as Furnace Bottom Ash (FBA) has a gritty, sand-like texture. Fly ash closely resembles volcanic ashes used in production of the earliest known hydraulic cements about 2,300 years ago. Those cements were made near the small Italian town of Pozzuoli - which later gave its name to the term "pozzolan." A pozzolan is a siliceous or siliceous / aluminous material that, when mixed with lime and water, forms a cementitious compound. Fly ash is the best known, and one of the most commonly used, pozzolans in the world. Instead of volcanoes, today's fly ash comes primarily from coal-fired electricity generating power plants. These power plants grind coal to powder fineness before it is burned. Fly ash - the mineral residue produced by burning coal - is captured from the power plant's exhaust gases and collected for use. Fly ash is a fine, glass powder recovered from the gases of burning coal during the production of electricity. These micron-sized earth elements consist primarily of silica, alumina and iron. The difference between fly ash and portland cement becomes apparent under a microscope. Fly ash particles are almost totally spherical in shape, allowing them to flow and blend freely in mixtures. That capability is one of the properties making fly ash a desirable admixture for concrete.

Fly ash is one of the residues generated in the combustion of coal. Fly ash is generally captured from the chimneys of coal-fired power plants, whereas bottom ash is removed from the bottom of the furnace. In the past, fly ash was generally released into the atmosphere, but pollution control equipment mandated in recent decades now requires that it be captured prior to release. Depending upon the source and makeup of the coal being burned, the components of the fly ash produced vary considerably, but all fly ash includes substantial amounts of silicon dioxide (SiO2) (both amorphous and crystalline) and calcium oxide (CaO). Fly ash is commonly used to supplement Portland cement in concrete production, where it can bring both technological and economic benefits, and is increasingly finding use in the synthesis of geopolymers and zeolites.

2. PHYISICAL PROPERTIES OF FLY ASH:

Parameters	Fly Ash
Density	2.17 g/cm^3
Bulk density	1.26 g/cm^3
Moisture content	2%
Particle shape	Spherical/Irregular
Colour	Grey
pH	6.0-10.0
Specific gravity	1.66-2.55
Grain size distribution	Sandy silt to silty loam
Porosity	45%-55%
Water holding capacity	45%-60%
Electrical conductivity (dS/m)	0.15-0.45

3. METHODS FOR SEPERATION

1. ACID LEACHING

The Fly Ash sample is pulverized by mechanical method and concentrated sulfuric acid is added in proportion, heated with the heating jacket and agitated with an agitator. The overdosed sulfuric acid was separated from the solids with filtration and the intermediate product aluminum sulfate was on the surface of leached Fly Ash. The aluminium sulfate was dissolved by hot water and separated from the acid leaching residue with filtration. The aluminium sulfate crystals were obtained by concentrating the aluminum sulfate solution. The Al_2O_3 powder was obtained through sintering the aluminum sulfate crystals.

2. ALKALI LEACHING

Alkali leaching is a substitute process for separation of alumina from fly ash. We first take the pre pulverized fly ash mixture. This mixture is leached using a 80 % v/V concentrated NaOH. This mixture is then supplied with energy to heat upto temperature of 115-125C. The separation is carried out at atmospheric pressure in an inert environment. It is a spontaneous reaction and it doesn’t require any catalyst. It is led to react for 1 hr.

The reaction outcome gives Sodium Silicate and aluminium hydrate. Sodium silicate can be precipitated out on filteration. The filtrate contains dissolved aluminium hydrate which can further be recovered.

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4. SEPARATION OF FLYASH

The following gives the brief description of the process.

Digestion:

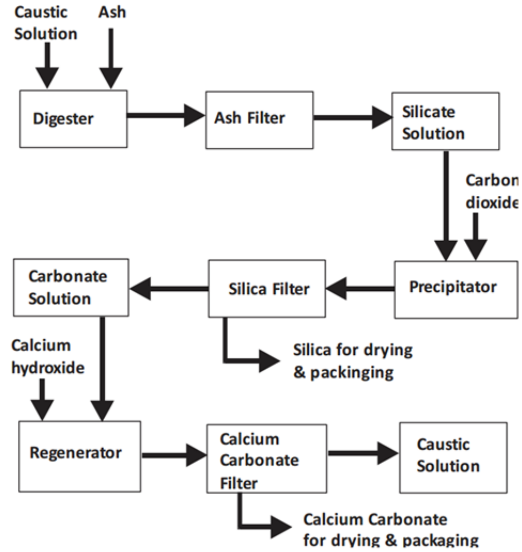
This involves the digestion of the fly ash with caustic at specific conditions. In this process the silica in the fly ash is gets extracted with caustic to form sodium silicate solution. After the completion of the digestion the solution is filtered for the residual undigested ash present in the solution.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

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.

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.



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