INVESTIGATION ON THE SEPARATION OF UNBURNT CARBON CONTENTS PRESENT IN FLY ASH BY FROTH FLOATATIONPROCESS

Prof. Sandeep Sharma[1]Mohit Gaba[2], Karmveer Singh[3]

1 Professor, Mechanical Engineering Department, Asra College of Engg.& Technology, Bhawanigarh (India)
2Assistant Professor, Mechanical Engineering Department, Asra College of Engg.& Technology, Bhawanigarh (India)
3Research Scholar, Mechanical Engineering Department,Asra College of Engg.& Technology, Bhawanigarh

ABSTRACT

Fly ash, generated during the combustion of coal for energy production, is an industrial by-product which is recognized as an environmental pollutant. Because of the environmental problems presented by the fly ash, considerable research has been undertaken on the subject worldwide. An industrial fly ash sample was separated by different processes, which were triboelectrostatic separation, ultrasonic column agglomeration, and column flotation, froth flotation, air classifier, magnetic separation and gravity separation. In the present study the percentage of unburnt carbon present in fly ash is calculated by froth flotation process. The forth flotation process is a good technique to separate unburnt carbon contents in fly ash. This unburnt carbon will create the pollution in environment also decrease the efficiency of thermal plant. So must be kept within the permissible limits.

1. Introduction

The combustion of coal and biomass fuel 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.

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 (SiO_2) and calcium oxide (CaO).

1.1 Classification of Fly Ash

Class C fly ash:-Fly ash produced from the burning of younger lignite or sub bituminous coal, in addition to having pozzolanic properties, also has some self-cementing properties. In the presence of 10water, Class C fly ash will harden and gain strength over time. Class C fly ash generally contains more than 20% lime (CaO). Unlike Class F, self-cementing Class C fly ash does not require an activator. Alkali and sulfate (SO_4) contents are generally higher in Class C fly ashes.

Class F fly ash:-The burning of harder, older anthracite and bituminous coal typically produces Class F fly ash. This fly ash is pozzolanic in nature, and contains less than 10% lime (CaO). Possessing pozzolanic properties, the glassy silica and alumina of Class F fly ash requires a cementing agent, such as Portland cement, quicklime, or hydrated lime, with the presence of water in order to react and produce cementitious compounds. Alternatively, the addition of a chemical activator such as sodium silicate (water glass) to a Class F ash can lead to the formation of a geopolymer.

Figure 1 Class C fly ash

Figure 2 Class F fly ash

1.3 Fly ash utilization:-The reuse of fly ash as an engineering material primarily stems from its pozzolanic nature, spherical shape, and relative uniformity. Fly ash recycling, in descending frequency, includes usage in: Portland cement and grout, embankments and structural fill, waste stabilization and solidification, raw feed for cement clinkers, mine reclamation, stabilization of soft soils, road sub base, aggregate, flow able fill, mineral filler in asphaltic concrete. Other applications include cellular concrete, geopolymers, roofing tiles, paints, metal castings, and filler in wood and plastic products.

2.Literature Review

N. Bouzoubaa et.al.(1997)in the study , the specific gravity and the fineness of the fly ashes increased with an increase in the grinding time. The morphology of the fly ashes was changed by grinding. Most of the plerospheres and large, irregular-shaped particles were crushed. However, the number of the spherical particles reduced with increased grinding

Heng Ban et.al.(1997), studied that dry triboelectrostatic separation of fly ash has the potential to be an effective method of separating unburned carbon from fly ash. Laboratory tests on a simple parallel flow **separator** showed that 60-80% of ash could be recovered at carbon contents below 5%, and 50% of carbon could be recovered at carbon concentrations over 50%. Additional studies should be initiated to evaluate the effects of ash properties on separation with the goal of optimizing the beneficiation process. In the study, when a gas, such as air, flows upward through a container filled with particles, some of the gas flows through the bed in the form of voids of gas or bubbles if the gas flow rate is high enough. As the bubbles move upward through the bed, they cause agitation and motion of the solid particles and circulation of bed material in the vertical direction. This leads to transport of low density particles to the top of the bed and high density particles to the region of the distributor at the bottom of the bed. In the case of fly ash, the relatively low density carbon particles segregate towards the top of the bed, permitting a separation between the unburned carbon and the inert portion of the fly ash

M.L.Gray et.al.(2001), described the oil agglomeration process and gave the optimum operating conditions for the recovery of unburned carbon. The experimental setup consisted of a 6 ft by 4 in. Plexiglas column equipped with a variable speed electrical motor, a slurry tank equipped with a variable air motor, a solvent recovery tank and 60-mesh stainless steel screen. Initially, the solvent and fly ash slurry was prepared at about a 5:1 weight ratio and conditioned for two minutes before it was pumped into the column at the feed rate of 930 ml/min. During the course of these tests the agitation speed was maintained at 400 rpm with airflow of 189 ml/min. The overflow unburned carbon product was collected on a 60-mesh screen, air-dried and analyzed to determine its purity. All of the carbon recoveries were calculated on a total weight carbon basis present in the feed fly ash. These conditions were predetermined during the initial developmental stages of this process.

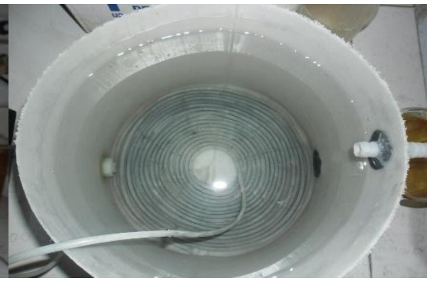
Gray et.al. (2002)an industrial fly ash sample was cleaned by three different processes , which were triboelectrostatic separation, ultrasonic column agglomeration, and column flotation. The unburned carbon concentrates were collected at purities ranging up to 62% . Column flotation was determined to be the most effective process for the collection of carbon concentrates at a LOI value of 61% and a carbon recovery of 62% with 90% of the ash reporting to the tails with LOI values <8% for the Shawville fly ash. Authors concluded that, in all cases, there is room for significant improvement in the cleaning performance of these separation processes.

3. Experimental Procedure

Froth flotation cell

3.1 Fabrication :-A low cost floatation cell design was conceived and the floatation cell was self fabricated as described below.

Step 1



Step 2

Step 3

Step 1:- A plastic container was taken.

Step 2:- A rubber pipe was coiled at the base of the container and an arrangement for the outflow collection was provided

Step 3:- Air pump was connected at other end of the coiled pipe for air bubbling

3.2 *Fabrication of froth flotation cell*

Experimental procedure:

Step 1:- A mixture of fly ash and collector is prepared in a beaker, mixture was agitated to ensure uniformity. Carbon rich fraction is collected from the top and ash settled at the bottom.

Step 2 :- The top and bottom particles were filtered for analysis.

Step 1

Step 2

The following standard procedure was used for the flotation experiments:

1. Collector (kerosene oil) was added at the desired dosage in 30 g fly ash. The sample was then agitated in 1L beaker filled with water for some time to thoroughly mix the collector with the suspended fly ash.
2. The air pump was switched on, and the slurry was added into the cell .
3. The products from flotation were filtered, dried, weighed, and analyzed. Percentage of loss-on-ignition (% LOI) was determined.

4. Results and Discussion

The fly ash sample, obtained from GNDTP Bhathinda, Punjab was taken for LOI determination. All the fly ash was well mixed before subjecting to LOI determination and beneficiation. The well mixed sample of fly ash showed good reproducibility for LOI determination as shown in Table 1. These results show that the LOI of the fly ash is 14.9± 0.2 (wt%).

Trail no.	LOI (wt%)
1	15.08
2	14.79
3	14.72

Table 1. LOI of fly ash sample Collected

Froth flotation process:-The froth flotation process is shown to be very promising for fly ash LOI reduction . However, the success of the process depends on the doses of collector/frother. In the present study, few initial experiments were done without the use of collector.

Trail no.	LOI of top fraction(%)	LOI of bottom fraction(%)
1.	48.30	10.51
2.	48.87	10.47
3.	46.91	9.68

Table 2. LOI of top and bottom fraction of froth flotation cell

Collector dose:-A set of experiments were carried out and the collector dose was optimized.

Collector dose (ml)	Fly ash sample (g)	LOI of top fraction (wt%)	LOI of bottom fraction (wt%)
4	30	46.04	10.42
3	30	42.35	10.77
2	30	47.73	9.91
1	30	46.21	10.09
0.5	30	51.62	10.13
0.25	30	48.72	13.71

Table 3 LOI of froth flotation fractions with and varying collector dose

5. Conclusions

The main purpose of separating unburned carbon from fly ash is to obtain high quality fly ash for concrete applications. Another incentive for a well-established separation technology is that, to efficiently utilize fly ash, high value products must be generated from raw ashes to counter balance the transportation cost of the material.

1. Separation efficiency of the processes based on size and shape is generally low. Gravity separation, air classifier, fluidized bed separation, and oil agglomeration processes are based on density. These processes are better than the processes based on size and shape. Triboelectrostatic and froth flotation process is based on surface properties. These processes are having high separation efficiency.

2. Efficiency of wet separation processes is higher than the dry separation processes. wet-separation processes have some disadvantages. wet-separation processes, consume large amounts of water and add to water pollution due to leaching of toxic materials from fly ash. The other possible disadvantage is the need for a wide operational area, which is unsuitable for densely populated countries.

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