

## *Brief write-up on S&T (Mines) completed projects*

**Project Title:** S-31: Bench scale study on extraction of pure Silica and smelter grade Aluminium Fluoride from Coal Fly Ash (CFA)

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**Objective:**

- To develop a bench scale process (0.5-1.0 kg CFA) for extraction of pure silica (fumed silica) and aluminium fluoride from coal fly ash (CFA).
- Study of various parameters such as pressure, temperature, precipitation of aluminium fluoride, removal of silica and recycling of mineral acid.

**Abstract:**

The coal fly ash (CFA) generation in INDIA is about 200 million tons per annum containing ~30% alumina and ~60% silica. Hence it is estimated that the current demand of pure silica required for various applications and aluminium fluoride required for Indian aluminium smelters will be fulfilled by treatment of coal fly ash alone. This will help in saving the natural resources (bauxite, sand) and ensure proper utilization of coal fly ash. Pure silica is used in structural materials, microelectronics (as an electrical insulator, semiconductors etc.), and as components in the food and pharmaceutical industries. In this project work efforts were carried out to study bench scale (0.5-1 kg CFA) for extraction of pure silica and aluminium fluoride by treating CFA with appropriate mineral acid.

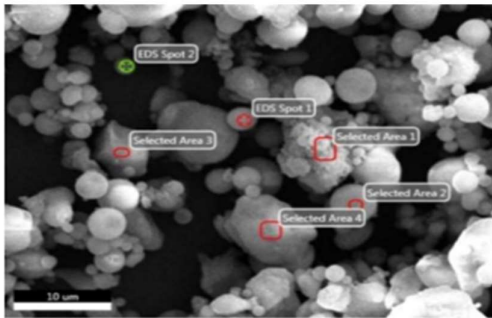
A laboratory study of extraction using mineral acid with 20 g of CFA from Koradi Thermal Power plant, Nagpur indicated that the total (>98%) silica and alumina get extracted in digested liquor. During digestion with HF, silica gets converted to Hydrofluosilicic acid ( $\text{H}_2\text{SiF}_6$ ) and alumina to aluminium fluoride ( $\text{AlF}_3$ ). Due to the large difference in boiling point, Hydrofluosilicic acid gets evaporated and reacts with water in the condenser to produce pure silica ( $\text{SiO}_2$ ), whereas, Aluminium fluoride remains in the evaporator which precipitates to hydrated Aluminium fluoride ( $\text{AlF}_3 \cdot 3\text{H}_2\text{O}$ ). After studies with 50 g CFA, a bench scale setup was fabricated., which can use up to 1 kg of CFA. A photograph of the Bench scale setup for processing CFA up to -- 1Kg is shown below. In the bench scale unit, the products obtained are pure fumed silica ( $\text{SiO}_2$ ) and Aluminium Fluoride hydrate ( $\text{AlF}_3 \cdot 3\text{H}_2\text{O}$ ). Pure Fume silica is amorphous in nature, hydrophobic, light in weight has a bulk density of 0.05 g/cc, and purity >99.79 %. If volatile (fluoride) is removed by heating, then the purity would increase to >99.90 %. Another product "Aluminium fluoride trihydrate" also has a purity of more than 98 %. It is white in colour and has a bulk density of 1.46 g/cc. Apart from products, the study generated

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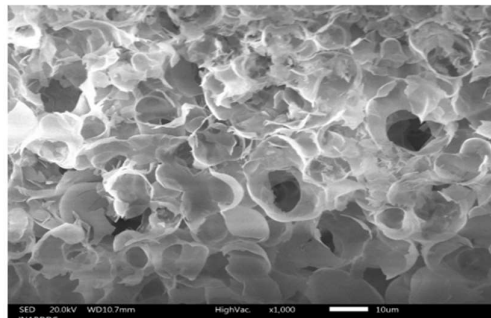
the knowledge for extraction of pure silica and aluminium fluoride and the concept of the process and most of the parameters of the process were well understood. The process can be commercialized, if further study is carried out on a pilot scale to come over the unit operations on a large scale.



Photograph of Bench scale setup for processing CFA up to -- 1Kg



SEM Micrograph of coal fly ash



SEM Micrograph of Fumed Silica

### **Findings:**

- Successful completion of bench scale trials (0.5-1 kg CFA) for extraction of pure silica and aluminium fluoride by treating Coal fly ash (CFA) with appropriate mineral acid.
- The process was found to be technically feasible.
- The process is economically viable, as the quality of silica that is produced has a high selling price (500-1000 Rs/kg) c)
- Precipitated Aluminium fluoride is useful in Aluminium smelters or in other industries.

### **Recommendations:**

- Before going to commercialization of the process, it is recommended that the pilot study (at least 100 kg CFA) should be carried out from a technological point of view in association with a technology consultant or engineering firm.