

# Review Paper on Recent Trends in Utilization of Coal Fly Ash in India

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**Abstract-** Fly ash is a byproduct of burning coal in thermal power plants, and India is one of the largest producers of fly ash in the world. However, fly ash has been several uses, including construction materials, such as blocks, bricks, and cement, road construction, embankments, and mine filling. As the day by day demand of electricity is increasing in India, the utilization of fly ash has been a priority for the government, and several initiatives have been taken to promote its utilization. The Ministry of Environment, Forest, and Climate Change has notified the Fly Ash Utilization Rules, 2016, which mandates thermal power plants to ensure 100% utilization of fly ash generated by them within a certain timeframe. The Mission LiFE (Lithium Extraction from Fly Ash) programme was also launched by the Department of Science and Technology in collaboration with the Council of Scientific and Industrial Research (CSIR) to extract lithium from coal fly ash and reuse it for the production of batteries for electric vehicles and other applications. The Mission LiFE programme aims to promote the sustainable use of fly ash and the development of new technologies for the extraction of valuable materials from waste streams. Hence the present review aimed to brief out the generation and utilization of coal fly ash in India in line with the objective of Mission LiFE programme. The coal fly ash generated from thermal power plants can be reutilized in cement manufacturing, agriculture sector, filling of low-lying area, fly ash bricks generation, and construction of roads and embankments.

**Keywords:** Coal Fly Ash, Generation, Thermal Power Plant, Utilization.

## 1. INTRODUCTION

As the demand of electricity is increasing day by day, to achieve it, usage of coal is also increasing in thermal power plants. This leads to tremendous increases in coal fly ash content which is generated by burning of coal as fuel in power plants. The major power plants in India are using coal as fuel to generate the electricity; though alternatives are being searched since more than last 10 years but no feasible replacement of coal has found in India so far. Generally, coal combustion by products has 80% of coal fly ash so this has led to increase in fly ash generation year by year to meet increasing demand of electricity [1].

To promote the use of fly ash in construction, the government has also issued guidelines for the use of fly ash in various construction activities, such as roads, embankments, and building materials. The use of fly ash in construction not only reduces the demand for virgin materials but also reduces the environmental impact of disposing of fly ash in landfills. Fly ash is a fine powder generated during the burning of pulverized coal in thermal power plants. This industrial waste creates significant environmental problems when released into the atmosphere. Fly ash is a waste material predominantly generated in the production of electricity. A by-product after coal burning is known as Coal Fly Ash (CFA) deemed to be environmentally perilous. However, fly ash has been used in numerous zones since previous few centuries. Overall, this review survey highlights the research that fixates on the trends of utilization of coal fly generated in India for engineering applications such as cement, concrete, soil stabilization, road base/ embankment, land reclamation, agriculture and much more.

### 1.1. Year-wise trend of fly ash generation and utilization in India

As of now, in India 72% of the total electricity is produced by the coal-based electricity generation plants and this production rate and dependence on such plants is expected to remain the same in the coming years. The fly ash generation during 2018-19 is 217.04 million tons due to combustion of 667.43 million tons Coal/Lignite and fly ash utilization is around 168.40 million tones which suggest an effective usage of 77.59% respectively [2]. As per the report by Central Electricity Authority, the fly ash generation and utilization is increasing by the current annual production of fly ash. The authority has also reported that the generation of fly ash from coal-based thermal power plants in India was 217.04 million tons in 2019-20. The progressive fly ash generation and its utilization for the period from 1996-97 to 2019-20 is given in Fig. 1.

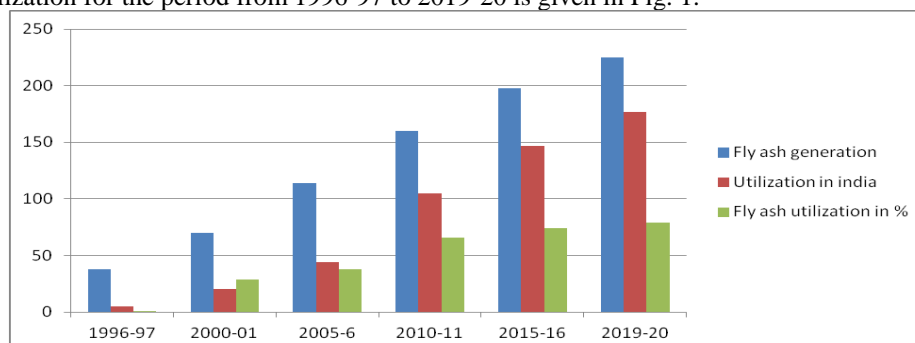


Fig. 1. Fly ash generation and its utilization for the period of 1996-97 and 2019-20

Source: Central Electricity Authority (CEA), Government of India (<https://cea.nic.in/wp-content/uploads/2021/01/Fly-Ash-2019-20.pdf>)

### 1.2. Ash generation & utilization during the 1st half of the year 2020-21

Fly ash generation & utilization data (Table 1) for the 1st half of the year 2020-21 (April 2020 to September 2020) has been received from 199 (One Hundred Ninety Nine) coal / lignite based Thermal Power Stations of various power utilities in the country. Data thus received has been analyzed to derive conclusions on present status of fly ash generation and its utilization in the country as a whole. A brief summary of status is given in Table 1.

Table 1. Ash generation and its utilization during the 1st half of the year 2020-21

Description	1st half year 2019-2020	1st half year 2020-2021
Nos. of Thermal Power Stations from which data was received	194	199
Installed capacity (MW)	195926.5	207220.5
Coal consumed (Million tons)	406.91	312.99
Fly Ash Generation (Million tons)	129.09	106.37
Fly Ash Utilization (Million tons)	100.94	84.22
Percentage Utilization of Fly Ash (%)	78.19	79.18
Percentage Average Ash Content (%)	31.73	33.98

Source: Central Electricity Authority, New Delhi, March-2021

## 2. MAJOR TYPES OF UTILIZATION

The most important utilization areas of fly ash are as follows:

### 2.1. Cement manufacturing

The fly ash contains substantial percentage of silica, alumina and lime and can be used as a partial replacement of Portland cement. The replacement rates normally run between 20% and 30% but can be higher. Fly ash reacts as a pozzolan with the lime in cement as it hydrates, creating more of the durable binder. As a result concrete made with fly ash is stronger and more durable than traditional concrete made with Portland cement. More over it is less susceptible to chemical attack and hence suitable for coastal atmosphere [2]. In India, the use of fly ash in cement manufacturing has been encouraged by the government through various policies and regulations. According to the Ministry of Power, the utilization of fly ash in the cement industry in India was 45.09% in 2019-20. This means that out of the total fly ash generated in the country, 45.09% was utilized by the cement industry [3]. The use of fly ash in cement manufacturing has several benefits, including reduced carbon emissions, reduced use of natural resources, and reduced waste disposal. Moreover, the use of fly ash in cement manufacturing has helped the cement industry to become more sustainable and environmentally friendly [4].

### 2.2. Filling of low lying area

Fly ash can be used in the filling of low lying areas as a sustainable and cost-effective alternative to traditional construction materials. Fly ash is a by-product of coal combustion and is typically produced by power plants, which burn coal to generate electricity. This material is often considered a waste product, but it can be repurposed for a variety of applications, including construction. Fly ash can be used in the filling of low lying areas as it is lightweight and has good compressibility properties. Additionally, it is readily available and inexpensive, making it a viable option for large-scale projects. When used in filling of low lying areas, fly ash can help to stabilize the soil, reduce settlement, and prevent erosion. However, it's important to consider the source of the fly ash before using it in construction projects. Fly ash obtained from coal-fired power plants may contain trace amounts of heavy metals and other contaminants that can leach into the environment over time. To avoid potential environmental contamination, it is crucial to use fly ash that has been tested and certified for safety.

Overall, it has been observed that fly ash can be a useful material in filling low lying areas, but before use it is important to ensure that the source of fly ash is free of contaminants and safe for use. During the transportation and handling of fly ash Proper safety measures should also be taken to minimize any potential risks.

### 2.3. Construction of road and embankment

Fly ash is a by-product of coal combustion and is typically produced by power plants, which burn coal to generate electricity. Fly ash can be used in the construction of roads and embankments as a sustainable and cost-effective alternative to traditional construction materials. This fly ash material is often considered as a waste product, but it can be repurposed for a variety of applications, including construction. When used in the construction of roads and embankments, fly ash can help to improve the durability and stability of the materials. The uses of fly ash in construction the need for traditional construction materials such as sand and cement have decreases, which can be costly and environmentally harmful.

### 2.4. Fly ash brick

Fly ash brick is a type of brick which is made from fly ash, a by-product of coal combustion. Fly ash is typically produced by power plants, which burn coal to generate electricity. The fly ash is collected from the flue gases and is then used as a raw material in the production of fly ash bricks. The use of fly ash in brick production has several benefits. Firstly, it helps to reduce the amount of waste produced by power plants, as the fly ash would otherwise be disposed of in landfills. Secondly, it provides a

sustainable and cost-effective alternative to traditional clay bricks, which require large amounts of natural resources and energy to produce. Fly ash bricks are also more durable and have better insulation properties compared to clay bricks [5-8].

### 2.5. Agriculture

Since fly ash contains micronutrients like potassium, calcium and phosphorus, which improves aeration and water holding capacity, for improving crop yield it can be suitably used in agriculture sector. Fly ash can also reclaim saline alkali soil resulting in saving of gypsum. The physical health of the soil also improves by using the Fly ash has. It also enhances the water retaining capacity and fertility of the soil. It serves as a soil modifier. It contains macro and micro nutrients and thus boosts the growth of plants and improves the crop yield 10-40%. Several reports are available related to the use of fly ash as a soil amendment for the benefit of a large number of field crops. The safe and sustainable use of sewage sludge/fly ash combination on agricultural soils is suggested to be a highly promising endeavor from environmental point of view [12].

### 3. CONCLUSION

In this review it has been concluded that the fly ash generation and utilization is increasing in every year. From this review it seems that coal-based electricity generation will increase in upcoming years. Fly ash has become an important raw material in various fields i.e. Agriculture, Cement Manufacturing, Road construction applications. It is widely used in construction of making fly ash bricks. Overall, there has been a steady increase in fly ash utilization in India over the years, and the country has been able to utilize a significant amount of the fly ash generated. However, there is still a considerable amount of fly ash that remains unutilized, and efforts are being made to increase its utilization further.

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