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Fly ash in Bangladesh- An Overview

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Abstract— Fly ash is one of the common residues produced from combustion of coal. In past, fly ash was unconditionally released into the atmosphere. Recent concerns about environmental pollution led to prohibition of its atmospheric release and mandated the use of various mechanisms to trap it before release. Subsequently, the storage and recycling of this huge quantity of fly ash has become a new concern. Presently in Bangladesh, it is estimated that 1.3 million cubic feet of fly ash is produced per annum for dumping from thermal power plants alone, and is estimated to reach an alarming crescendo of 9.5 million cubic feet by 2018. The environmental degradation due to dumping of fly ash aggravates the situation. Together, they pose an imminent threat in a densely populated country like Bangladesh, which needs to be addressed urgently.

Index Terms— Fly ash, coal, combustion, environmental pollution, thermal power plant, dumping area.

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1 Introduction

Fly ash is produced after combustion of coal (both bituminous and lignite) and is naturally a by-product of coal based industries [1]. It has been into production ever since industrialisation set in, when it was freely released into air, but became a source of concern only after it was identified as an industrial waste in early 90s. Since then, various techniques have been adopted to separate them from industrial emissions.[2] This led to the problem of storage, disposal and management of huge quantity of fly ash produced every year from thermal power plants and other coal based industries. Especially in densely populated countries like Bangladesh, the storage and disposal of fly ash is a major concern due to land scarcity for disposal. In this paper, we try to investigate the problem posed by fly ash produced from thermal power plants in Bangladesh from relevant available data and assess its impact. Fly ash produced from other coal based industries (brick field etc.) is beyond the scope of this discussion.

2 . Fly ash composition:

Fly ash is a fine grained material consisting of spherical, glassy particles .The chemical composition of fly ash varies depending upon source and use. It chiefly consists of oxides of different elements, namely SiO_2, Al_2O_3,CaO, Fe_2O_3 and SO_3, to name a few .It is nearly insoluble in water. Negligible amount of heavy metals (less than 1%) is also found bonded to the fly ash. Due to the presence of these heavy metals, fly ash is often suspected to be a cause of metal leeching [3],[4]. However, the latter claim is often refuted and there is a persistent demand for fly ash to be classified as a non-hazardous industrial waste [1].

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3 Fly ash in Bangladesh:

3.1 Qualitative and Quantitative Analysis:

As already stated, we will concern ourselves with the fly ash produced in Bangladesh by thermal power plants only.

3.1.1 Quantitative Analysis:

In Bangladesh, 6 potential coal fields have been identified till date, out of which only one, Barapukuria coal field is in production. Barapukuria Coal field has been operating officially since 2004, with a coal reserve of 390 Million Tonnes. The yearly production is 1 million tonnes, out of which 65% is supplied to the Barapukuria Coal fired Thermal Power Plant, the only operating thermal power plant of Bangladesh, with a capacity of 250 MW[5]. According to the data available, ash produced is approximately 10% by mass of the coal burnt [5]. Out of this ash, 80% is estimated to be fly ash and the rest is bottom ash. The following calculations are then necessitated to estimate the amount of fly ash produced from thermal power plants in Bangladesh per annum:

Calculations for Fly ash estimation:

Coal used in Thermal Power Plant per year
=65% of 1000000 MT
= 650000 MT

Total Ash production after the combustion of coal
= 10% of total coal
= 10% of 650000 MT
= 65000 MT

80% of the ash is Fly ash & 20% of ash is bottom ash.

Total Fly ash produced from the coal combustion (per year) = 80% of 65000 MT
= 52000 MT
= 52000*1000 kg = $52*10^6$ kg

1 cubic feet of fly ash = 40 kg of fly ash (loose condition) [6]

Fly ash production per cft per year = $52*10^6/40$ cft = $1.3*10^6$ cft

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So, 52000 MT of fly ash is presently produced in Bangladesh per annum.

3.1.2 Qualitative Analysis:

Fly ash is broadly classified into two categories, Class C fly ash and Class F fly ash. The main difference between these two classes lies in their calcium content. While Class C fly ash generally contains more than 20% lime, Class F contains less than 20% [2].

The ash analysis of Fly ash obtained from Barapukuria Power Plant is as follows:

Oxides	Percentage
SiO_2	54.4
Al_2O_3	35.6
Fe_2O_3	2.9
TiO_2	3.2
Mn_3O_4	0.11
CaO	0.56
K_2O	0.66
Na_2O	0.06
MgO	0.18
P_2O_5	0.46
SO_3	0.13
Wardell Armstrong 1991	

The above Qualitative analysis clearly establishes the fly ash in Bangladesh as Class F Fly ash [2][7].

3.2 Fly ash Disposal:

Fly ash disposal is carried out by two techniques, namely Dry disposal scheme and Wet disposal scheme.

In dry disposal, the produced fly ash is transported from site by various methods (truck, conveyor belt etc.) and disposed into a dry embankment. In wet disposal, the fly ash is mixed with water to form a slurry, which is transported by pipes to be disposed off in a confinement called the 'ash pond'.[8]

In Bangladesh, the dry disposal scheme is incorporated. Produced fly ash (52000 MT per annum) is dumped off in a dry embankment (dyke). The capacity of the dyke stands at 183000 MT, which, alarmingly, is supposed to be two-third filled by 2012.

3.3 Law and Legislation Regarding Fly ash:

In Bangladesh, there is no direct law restricting emission of fly ash into atmosphere and its proper disposal. However, The Environmental Conservation Rules, 1997 lists power plants in the red category based on location and impact to the environment. It also limits the emission of Suspended Particulate Matter (SPM) within 100-500 microgram/cusec meter, depending upon area sensitivity. Fly ash, being a type of SPM, is also covered under this broad heading.

4 Fly ash in Bangladesh – Source of concern:

In Bangladesh, as we discussed previously, the total fly ash produced by thermal power plants is still concentrated to Barapukuria Thermal Power plant due to its lone existence. Fly ash produced is dumped in a dry embankment of capacity 183,000 MT, which is already two-third filled by 2012. Each passing year, an additional 52,000 MT of fly ash is being added. But this is only the present scenario.

The Government of Bangladesh plans to build 6 more Thermal power Plants, out of which two have already gained momentum. While the 250 MW Barapukuria power plant (phase-2) is in tendering stage, the 1300 MW Rampal Power Plant in Khulna is under construction. The Barapukuria Power plant (phase-2) will run on coal from Barapukuria Coal field extracts, whereas the proposed Rampal Thermal Power plant will derive its fuel from coal imported from India (joint collaboration with NTPC) [9]. If the available fly ash data is linearly interpolated, the annual production of fly ash will rise to 377000 MT per annum from 2018 onwards, considering that only a total of 3 specified power plants will be in production. 377000 MT of fly ash will occupy nearly 9.5 million cft volume under loose condition.

For a densely populated country like Bangladesh, where on an average 1142 people reside per square kilometers[10], this volume of fly ash (approximately 9.5 million cft) is an astronomical amount to dispose off. Analogically, 9.5 million cft translates to filling 11 international standard football fields one story (3 metre) high per year. Already the dry embankment used as a dumping site for fly ash is two-third full and procurement of a new disposal site is a necessity.

Inadequate laws to govern fly ash disposal aggravates the situation. No specific law governs criterions for fly ash disposal. In contrast, our neighbouring country, India, is quite concerned about this potential problem. The Ministry of Environment and Forest (MoEF) issued a regulation for progressive utilization of fly ash. According to this law, all coal based thermal power plants must utilize 100% of fly ash produced within a stipulated time limit, which varies from 9 years to 15 years depending on the tenure of operation of the power plant [11].Unfortunately, such type of legislation is still absent in Bangladesh, causing neglect of power plant authorities to initiate fly ash utilization strategies.

5 Recommendations and remedial Measures:

5.1 Enactment of appropriate legislation:

The problem of fly ash is common to all the industrial nations of the world. But they have successfully tackled the problem of fly ash disposal due to enactment of law. Many countries, including our neighbour India, have executed laws limiting the period of storage of fly ash [11].This has led the industries

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to consider utilization of fly ash seriously. As a result, the fly ash utilization rates are progressively increasing in India, increasing from 1 million tonnes in 1994 to 45 million tonnes by 2005 [12]. Similar trends are observed worldwide [2].

But due to lack of such legislation in Bangladesh, no such alternatives are yet being considered and the dry storage of fly ash is constantly threatening the environment. Appropriate legislation to regulate fly ash emission and utilization should be the top most priority in industrial sector, as it will force the industries to reorient and recognise this imminent threat.

5.2 Embankments:

Road and fly over embankments are potential areas for utilization of fly ash. Recent embankment constructions in India with fly ash establishes an economy of Rs. 50 to 75 per MT of Earthwork cost due to excavation and transportation cost savings[13].Apart from economy, use of fly ash in road embankment will encase the fly ash into earth, isolating it from rainwater and terminating the possibility of metal leeching. Hence, use of fly ash in embankments will reduce pollution. [14].

5.3 Utilization in Cement and concrete:

Fly ash, being pozzolanic in nature, is a substitute of cement in concrete. Fly ash minimizes the problem posed by free lime in concrete and makes the concrete durable [15]. Additionally, it acts as a substitute of cement in concrete, saving cost and making concrete greener by cutting down CO_2 production. The practice of using fly ash in concrete should be encouraged in Bangladesh without hesitation.

5.4 Manufacture of Bricks:

Fly ash bricks can prove to be an important remedy. Almost all bricks manufactured in Bangladesh employs conventional method of using clay, which is environmentally very harmful. Fly ash bricks are advantageous in many forms from conventional bricks. Firstly, the unburnt carbon of fly ash provides fuel for burning, saving 25-30% energy cost by adding 25-40% fly ash [16]. Other advantages include higher strength, lower penetration of water etc. [17].

6 Summary and Conclusion:

The points discussed in the paper are summarised below:

- There is only one Thermal power plant in Bangladesh, responsible for production of fly ash. But by 2018, at least two more expected to be in production.
- Current fly ash production of Bangladesh stands at 52000 MT per annum, which is expected to soar to 377000 MT per annum by 2018.
- The fly ash produced in Bangladesh is essentially class F fly ash. The fly ash produced is dumped off in a dry embankment by trucks, conveyor belts etc.
- As of yet, there are no dedicated laws to regulate the emission and utilization of fly ash in Bangladesh, in contrast to many other nations. This dearth of legislation id deterring any effective initiative to be taken by the authorities for fly ash utilization.
- Fly ash is recognised as a potential by product for many specialised uses, like brick manufacturing, cement substitute etc. There is a rise of fly ash utilization all over the globe.
- Despite many avenues of utilization, fly ash is still considered to be a wasteful by-product of thermal power plants in Bangladesh and continues to be dumped in the dykes only, without any plans of utilization. The dumped fly ash continues to pollute the adjoining areas.

Fly ash is being recognised as a boon in many parts of the world. But it continues to be neglected in Bangladesh, may be due to poor foresight of the future threats. It continues to be a constant source of pollution and land problem. This problem should be addressed immediately, with appropriate legislation of fly ash utilization and research and implementation of fly ash use in all possible sectors of Bangladesh.

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