FLY ASH: AN ENVIRONMENT SAVIOUR @

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ABSTRACT

It is the action of human beings that determines the worth of any material. Materials having potential for gainful utilisation remain in the category of waste till its potential is understood and is put to right use. Fly ash is one of such examples, which has been treated as a waste material, in India, till a decade back, and has now emerged not only as a resource material, but also as an environment saviour. Use of fly ash in manufacture of cement, part substitution of cement in concrete/ mortar, manufacture of bricks etc, at current annual levels, saves generation of CO2 by 25 million tonne, good quality lime by 35 million tonne and coal by 15 million tonne a year. The potential that is yet to be tapped is multifold of the current levels. Conservation of mineral resources also reduces mining activity and the resultant degradation of environment. Other utilisations of fly ash like in construction of roads embankments (in lieu of soil), reclamation of low lying areas and mine filling etc. conserve 20 million m3 soil per year (5000 acres of land), precious river bed sand & river ecology. Fly ash also holds potential for cleaning the waste water and effluents.

Keywords: Effluent Treatment, Environment, Fly Ash, Global Warming Greenhouse Gases

1.0 INTRODUCTION

About 120 coal based thermal power stations in India are producing about 112 million tonne fly ash per year. With the increasing demand of power and coal being the major source of energy, more and more thermal power stations are expected to be commissioned / augment their capacities in near future. As per the estimates, fly ash generation is expected to increase to about 170 million tonne by 2012 and 225 million tonne by 2017. Fly ash has been considered as a “Polluting Industrial Waste” till about a decade back and was being disposed off in ash ponds occupying large areas of land. At present about 1,00,000 acres of land is buried under the ash ponds. Land being a scarce resource, indiscriminate disposal of fly ash has become a luxury in today’s context. Fly ash, as a material, which was being treated as waste and a source of air and water pollution till recent past, is in fact a resource material and has also proven its worth over a period of time.

Government of India, realizing the threat that unutilized fly ash can pose, commissioned focused efforts led by Fly Ash Mission (FAM), Technology Information, Forecasting & Assessment Council (TIFAC), Department of Science and Technology (DST), along with other stake holder agencies in 1994 towards confidence building for gainful utilisation & safe disposal of fly ash. The extensive work undertaken by all these agencies over a period of last 10 years has shown that fly ash if managed well is neither a polluting material nor a waste, rather it is a valuable resource material. It can be used for manufacture of cement, part replacement of cement in mortar and concrete, manufacture of bricks, blocks, tiles, roofing sheets and other building components, construction of roads / embankments, reclamation of low lying areas, back-filling of mines, agriculture and related application etc. In all these applications, fly ash has found to contribute positively on technical parameters as well as on environmental aspects. The focused thrust being provided by Fly Ash Mission (FAM) earlier is being continued as Fly Ash Utilisation Programme (FAUP), TIFAC, DST. As a result of mission mode efforts, the utilisation of the fly ash has increased from 1 million tonne per year in 1994 to about 45 million tonne per year during 2005.

@ The views expressed are that of the authors and not necessarily of the organisations to which the authors have affiliation.

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The contribution of fly ash to the environment is multi-fold, however, can broadly be classified in three categories.

1. A safe material in itself
2. Conservation of natural resources and
3. Reduction in green-house gas emission.

2.0 FLY ASH - A SAFE MATERIAL

Fly ashes from various thermal power stations in India have been tested at a number of National laboratories as well as academic institutes and industrial units as a part of FAM / FAUP projects or otherwise. It has been found that Indian fly ashes are very low on radioactivity and heavy metals counts. The tests on radioactivity of fly ash and fly ash based products have been carried out through Bhabha Atomic Research Centre (BARC) and Institute of Physics, Bhubneshwar, Department of Atomic Energy, Government of India. All investigations / tests certify that radioactivity in Indian fly ashes is almost in the same range as radioactivity in other building materials / normal soils available in India. When compared with the safety limits, the radioactivity values have been found to be around 1/10th of the permissible values (see our paper "Durability and Radio-activity of Fly Ash Bricks: A Safe Material" in the same proceeding).

Regarding the impact of heavy metals content in traces, in fly ash, more than 5,000 samples of dry hopper ash, pond ash, fly ash amended soils, surface water of fly ash treated fields, the crop produced from fly ash amended soils etc., have been analysed at different national / academic / R&D laboratories, which again indicate practically there is no significant impact of heavy metal content of Indian fly ashes. Further, as most of Indian fly ashes are alkaline in nature, hence, the leachable contents of heavy metals in them are even lower (see our paper "Fly Ash: a Material for Another Green Revolution" in the same proceedings)

3.0 CONSERVATION OF NATURAL RESOURCES

The Technology Demonstration Projects and large number of multiplier projects executed so far shows that fly ash is a very good substitute of soil for geo-technical applications, substitute of cement for mortar and concrete and substitute of clay for manufacture of bricks and various ceramic products etc.

Use of fly ash in cement, mortar and concrete as a pozzolanic material, saves the equal amount of cement, which otherwise would have been used. The production of cement apart from being quite energy intensive also uses about 1600 kg of lime stone and 400 kg. of coal per tonne of clinker. Replacement of cement by fly ash would save the corresponding amount of these natural mineral resources which already are in scarcity. As per the estimates, India is left with lime stone reserves, which are expected to last only for next 40 years. Further, reduction in usage of these minerals would also reduce the associated mining activity to the corresponding extent, hence the related environmental benefits.

With the lot of brick manufacturing activities going on everywhere, the mother earth is rapidly being stripped of its soil cover, which again is a serious environmental concern. The formation of soil takes thousands of years and if the indiscriminate use of this valuable natural resource is not stopped, we would definitely leave behind severe environmental problems for future generation. Though the use of fly ash in brick manufacturing has been in vogue for many decades, it did not get commercialized at significant levels, may be due to low understanding of technology as well as low level confidence in its durability. The technologies have now been developed and demonstrated for manufacture of fly ash bricks with or without firing and for production of the bricks of very high strength. The durability of these bricks has also been tested and is found to be comparable to conventional red bricks. The use of fly ash in brick manufacturing would save the precious top soil which otherwise is being used for brick manufacturing indiscriminately.

Fly ash can also effectively be used as a substitute of soil in almost all kinds of geo-technical applications. Use of fly ash for construction of roads / embankments, reclamation of low lying areas, construction of dykes etc. has been demonstrated and proved almost in all parts of the country. Use of fly ash as a soil replacement in all such applications would not only save the mother earth for our future generations but would also prevent creation of low lying areas which otherwise would be created by excavation of soil and would again have potential to become a source of environmental problem in future.

The technologies have also been developed for use of fly ash in ceramic applications. Such applications save about 30 to 40% of valuable mineral clays, which otherwise would have been used for manufacture of such products. Further, fly ash based wood substitute has been developed which is stronger than wood and is water proof, termite proof and has all other required properties of wood. It can be cut into pieces, sawed, nailed and screwed, hence can be used as timber replacement in most of the cases. The fly ash based panels and plywood have also been developed. All these applications if utilized to its full potential, can substitute timber to great extent in construction as well as in internal furnishing.

4.0 REDUCTION IN EMISSION OF GREEN HOUSE GASES

The scientists and the decision makers have been quite serious about global warming and its possible consequences for over last 20 years. Now with the effects of global warming becoming visible to common man, it has become a severe environmental concern. All national as well as international bodies are making all out efforts to promote the technologies that can mitigate green house gases emissions. Carbon dioxide has been identified the most prominent source of green house gas effect and efforts are on to minimize its emission from all possible quarters of life. Even trading of carbon dioxide emission has started in the form of carbon credits.

The use of fly ash for cementitious applications (manufacture of cement, mortar and concrete) contributes a lot in reducing green house gas emissions. The production of every tonne of cement releases equal amount of carbon dioxide gas in the atmosphere. Every tonne of fly ash utilized for manufacture of cement, mortar and concrete would reduce the consumption of cement to that extent and the resultant release of CO_2 of the same magnitude.

Further, use of fly ash in brick manufacturing would also reduce / eliminate the release of carbon dioxide and other harmful gases. For manufacture of bricks using fly ash / lime / gypsum / cement etc., no firing is required, which completely eliminates the emissions. Even in manufacturing of clay fly ash bricks it has been found that there is a fuel savings of 15 to 20%, which would again result in similar savings in emission of carbon dioxide and other gases.

In view of above, it can be said that fly ash can play a very important role in reducing the emission of carbon dioxide, which in today's context and scenario has become a very crucial international issue.

5.0 QUANTITATIVE ESTIMATES

As it has been seen in earlier paragraphs, fly ash has multifarious applications and in each application it helps to improve the quality of product, economise on the cost and saves environment. As of now about 45 million tonne of fly ash is being used in various applications per year (out of total generation of 112 million tonne per year).Out of this, about 22 million tonne fly ash is being used for cementitious applications and about 20 million tonne is being used for geo-technical applications (roads, embankments, reclamation of low lying areas, raising of ash dykes etc.) as a replacement of soil. Brick manufacturing utilizes about one million tonne fly ash & balance is going for agriculture, mine filling and other miscellaneous applications. A rough quantitative estimate of the economic and environmental benefits, which are being accrued in the present situation by the society through usage of fly ash, is as given below:

(i) Additional production of cement of 22 million tonne per year practically with very low investment and very less gestation period.

(ii) The value of economic wealth contributed by 22 million tonne of fly ash used in cement / concrete would be Rs. 1320 crores per year.

(iii) Annual saving of 35 million tonne lime and 15 million tonne coal per year that would have been used for manufacture of 22 million tonne clinker and about 1 billion bricks which are now fly ash based than from conventional inputs.

(iv) Conservation of 23 million tonne of CO2 that would have been produced if 22 million tonne of clinker and 1 billion bricks would have been produced through conventional route which is now being substituted by fly ash.

(v) Conservation of 20 million m3 of soil that would have otherwise been used for construction of road / embankment, reclamation of low lying areas, brick manufacturing and dyke raising, would have made barren 5000 acres of land by digging up to 1 m depth. In addition, fly ash that has been used would have required 1000 acres of land for ash pond for deposition (considering 5 m height), if it was not used.

(vi) The power stations are saving about Rs. 44 crores per year as dry fly ash is being collected in the power stations itself and it is not required to be pumped to ash ponds. The capital investment require for slurry disposal of 22 million tonne of ash is approximately Rs. 600 crores.

(vii) The path breaking work done in the area of fly ash in mining sector and agriculture also holds a large potential. The success achieved over last 10 years is exemplary and is opening up the gates for acceptance of fly ash for these applications. The mining sector would easily use 10 – 15 million tonne ash per year which would bring a saving of about Rs. 75 crores per year to the industry. In agriculture, even at the initial stage about 500 farmers using fly ash in vicinity of each power station with average field size of 5 acre would use 5 million tonne of fly ash per year and would give extra yield worth Rs. 25 crores per year. The potential in agriculture sector is at least 100 times of these figures.

6.0 CONCLUSION

With the combined efforts of all stake holder agencies over a period of last 10 years, utilisation of fly ash has been picked-up from a meager 1 million tonne per year in 1994 to about 45 million tonne per year in 2005. Enormous benefits are being accrued by the society by using fly ash in various applications. Estimates given in the previous section are indicative of the present situation only, the total potential of fly ash utilisation and the savings to the society would be manifold.

With the fly ash helping to preserve the environment through all its utilisations and the huge potential it has for the society and country, it can rightly be termed as an environment saviour. So let us pledge that fly ash, which is a resource, should be utilised to maximum possible extent in all walks of our life.

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Dr. Vimal Kumar, Adviser, Department of Science & Technology is the founder Mission Director of Fly Ash Mission, TIFAC, DST, Government of India. Fly Ash Mission conceived and implemented under his guidance has made a significant impact.

Dr. Vimal Kumar holds Bachelor Degree in Mechanical Engineering, MBA from Indian Institute of Management-Ahmedabad & Ph.D in Development and Commercialisation of New Technologies from Indian Institute of Technology-Delhi. Dr. Vimal Kumar has been instrumental for development and large scale utilisation of a number of technologies for use of fly ash in building / construction industry as well as many other technologies in other industrial sectors. He has published / presented more than 150 Technical Papers, Contributed / Co-Authored 6 books, widely travelled, Chairman & Member of Advisory Bodies / Research Council of a number of institutes / research bodies, visiting faculty to technology and management institutes and on the Editorial Board of International Journal of Technology Management, U.K.