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Effect of Variation in the Chemical Constituents of Wastes on the Co-processing Performance of the Cement Kilns

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Abstract

Cement kiln co-processing is a globally practiced technology for management of different kinds of wastes in an environmentally sound and ecologically sustaining manner. Different types of wastes e.g. agro-wastes, hazardous & non-hazardous industrial wastes, combustible fractions from MSW etc are disposed off in large quantities in many cement kilns in different countries all over the world. During the treatment of wastes through co-processing, wastes get utilised as Alternative Fuels and Raw materials (AFRs) in the cement kilns. In India, cement plants have initiated co-processing of wastes and to prove the acceptability of cement kilns for their environmentally sound disposal, cement plants have implemented large number of demonstration trials on different kinds of waste streams as per the protocol prescribed by Central Pollution Control Board. Based on the critical evaluation of the results of these trials, Central Pollution Control Board endorses the acceptability for their co-processing in cement kilns. In this paper, results of such 22 demonstration co-processing trials – which were endorsed as successful by CPCB - are evaluated to understand the extent of variation present in the chemical constituents of these waste streams. It was also concluded through this evaluation that different waste streams having large variation in the chemical characteristics can be managed in an environmentally sound manner in the cement kilns.

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1. Introduction

Co-processing technology is practiced in cement kilns world over for management of different kinds of hazardous and non-hazardous wastes. Being a recovery technology, the entire material and energy value present in the waste gets gainfully utilised in the cement process. Further, due to this recovery process, it substitutes the use of traditional raw materials and fuels thereby conserving natural resources. Since, the waste material gets utilised as an alternative fuels and raw material in the cement production process, it reduces the GHG emissions substantially by reducing the use of virgin fuel. In order to demonstrate suitability of co-processing technology in cement kiln for the management of both hazardous and non-hazardous wastes generated in India and to prove that this technology occupies the Best Available Technology (BAT) status for disposal of Indian wastes also, ACC conducted several co-processing trials of different kinds of wastes the results of which were evaluated by Central Pollution Control Board of India. Central Pollution Control Board reviewed the inputs, process, emissions and the product quality achieved in these trials and then approved them as acceptable co-processing trial and the wastes utilised in these trials was approved as co-process able.

There was a concern being raised by some of the stake holders that waste approved through co-processing trial and waste to be taken up for regular co-processing should have similar chemical constituent levels to ensure that the emissions from the cement kiln stack and the product quality are sustained at the acceptable levels. Thus the objective of the study was to understand the relevance of the stake holder concerns, the concerns were evaluated based on the review of the results of 22 co-processing trials that have been approved by Central Pollution Control Board, based on the review of inputs, process, emissions and product quality, the variation were observed for the chemical constituents of the waste streams. The organization of the paper is as follows: section 2 deals with the detail literature review of the co-processing of waste and its impact on various parameters of cement plant. Section 3 explains the methodology adopted for this study. Section 4 discusses the results based on the 22 trial which have been carried out in number of different cement plants of ACC across India. Section 5 concludes the papers.

2. Literature Review

Cement manufacturing consists of raw meal grinding, blending, pre-calcining, clinker burning and cement grinding. Limestone and other materials containing calcium, silicon, aluminium and iron oxides are crushed and milled into a raw meal. This raw meal is blended and is then heated in the pre-heating system to initiate the dissociation of carbonate to calcium oxide and carbon dioxide. A secondary fuel is fed into the preheating system to keep the temperature sufficiently high. The meal then proceeds to the kiln for heating and reaction between calcium oxide and other elements to form calcium silicates and aluminates at a temperature up to 1450°C. Primary fuel is used to keep the temperature high enough in the burning zone for the chemical reactions to take place. The reaction products leave the kiln as a nodular material called clinker. The clinker will be inter-ground with gypsum, limestone and/or ashes to a fine product called cement (Alsop, 1998). The energy- intensiveness of cement production processes and increasing fuel prices, combined with fuel deficit, force the cement industry to search for technologies based on waste-derived and alternative fuels.

The process of clinker burning in a rotary kiln creates favorable conditions for the use of alternative fuels. These include high temperature, alkaline environment, oxidizing atmosphere, the lack of incineration wastes as all metallic and non-metallic incineration products undergo a complete absorption, large heat-exchange surface, good mixture of gases and products, and sufficient time (over 2 s) for the disposal of hazardous wastes (Mokrzycki and Uliasz-Bocheńczyk, 2003). Alternative fuels are the solid, liquid, municipal or industrial wastes used in industrial and power plants as a substitute for conventional fuels. Alternative fuels have been in use for more than 10 years now and are gaining an increasing share in the global energy market Syrek & Nowak, (1993). The range of fuels is extremely wide. Traditional kiln fuels are gas, oil or coal. Materials like waste oils, plastics, auto shredded residues, waste tyres and sewage sludge (SS) are often proposed as alternative fuels for the cement industry. Also, all kinds of slaughterhouse residues are offered as fuel nowadays. To be able to use any of these fuels in a cement factory, it is