Using Solid Waste & Alternate Fuel Raw (AFR) Material as a Fuel in Co-processing of Cement Kiln and Reduce Greenhouse Gaseous

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Abstract - Co-processing solid and other waste in cement kilns can both reduce the cement industry's growing fossil fuel use and carbon dioxide (CO2) emissions and help address the increasing need for safe and environmentally sensitive municipal waste treatment and disposal. The cement industry accounts for approximately 5 percent of current anthropogenic CO2 emissions worldwide. Given increasing cement demand and production, the industry's absolute energy use and CO2 emissions will continue to grow. Cement kilns typically burn fossil fuels, which are non-renewable and being depleted rapidly. Treating wastes in cement kilns, known as co-processing, can reduce the industry's reliance on fossil fuels and decrease associated CO2 emissions. The ashes from waste co-processing will be integrated into the clinker which can result in saving the virgin raw materials. In addition, treating wastes in cement production can help alleviate the problems associated with the increase in waste generation around the world, especially in developing countries experiencing rapid urbanization. Municipalities and governments in many urban areas, especially those with underdeveloped waste management systems, face growing difficulties disposing of MSW and sewage sludge in a manner that protects human and environmental health.

The high temperatures and sufficiently long residence time in cement kilns and other characteristics of cement production make co-processing of waste materials a viable strategy. Wastes have been coprocessed in cement kilns for more than 20 years. The purpose of this report is to describe international best practices for pre-processing and co-processing of waste in cement plants, for the benefit of countries that wish to develop coprocessing capacity.

INTRODUCTION

The use of AFR can decrease the environmental impacts of wastes, safely dispose of hazardous wastes, decrease greenhouse gas emissions, decrease waste handling costs and save money in the cement industry. However, there are some basic rules and principles that should be observed. AFR use should respect the waste hierarchy, be integrated into waste management programs, support strategies for resource efficiency and not hamper waste reduction efforts. Following certain basic rules assures that the use of AFR does not have negative impacts on cement kiln emissions. Co-processing should not harm the quality of the cement produced. Countries considering coprocessing need appropriate legislative and regulatory frameworks. National laws should define the basic principles under which co-processing takes place and define the requirements and standards for co-processing. Regulators and operators should conduct baseline tests with conventional fuels and materials so they can compare AFR results to these. Some wastes should never be co-processed; these range from unsorted municipal garbage and certain hospital wastes to explosives and radioactive waste. Other wastes will need pre-processing before they can be used, and approaches to AFR use should take account of the need to effectively regulate and manage these pre-processing plants.

Following certain basic rules assures that the use of AFR does not change the emissions of a cement kiln stack. These include feeding alternative fuels into the most suitable zones of the kiln, feeding materials that contain a lot of volatile matter into the high temperature zone only, and avoiding materials that contain pollutants kilns cannot retain, such as mercury. Emissions must be monitored, some only once a year and others continuously. Environmental impact assessments (EIA) should be done to confirm compliance with environmental standards; risk assessments can identify any weaknesses in the system, and material flux and energy flow analyses help to optimize the use of resources. Cement plant operators using AFR shall ensure their traceability from reception up to final treatment. Transport of wastes and AFR must comply with regulations. Plants must have developed, implemented and communicated to employees adequate spill response and emergency plans. For start-up, shut-down and conditions in between, strategies for dealing with AFR must be documented and available to plant operators. Plants need well-planned and functioning quality control systems, as well as monitoring and auditing protocols. Risks can be minimized by properly locating plants in terms of environmental setting, proximity to populations and settlements, and the impact of logistics and transport. Plants will require good infrastructure in terms of technical solutions for vapors, odors, dust, infiltration into ground or surface waters, and fire protection. All aspects of using AFR must be well documented, as documentation and information are the basis for openness and transparency about health and safety measures, inside and outside the plant.

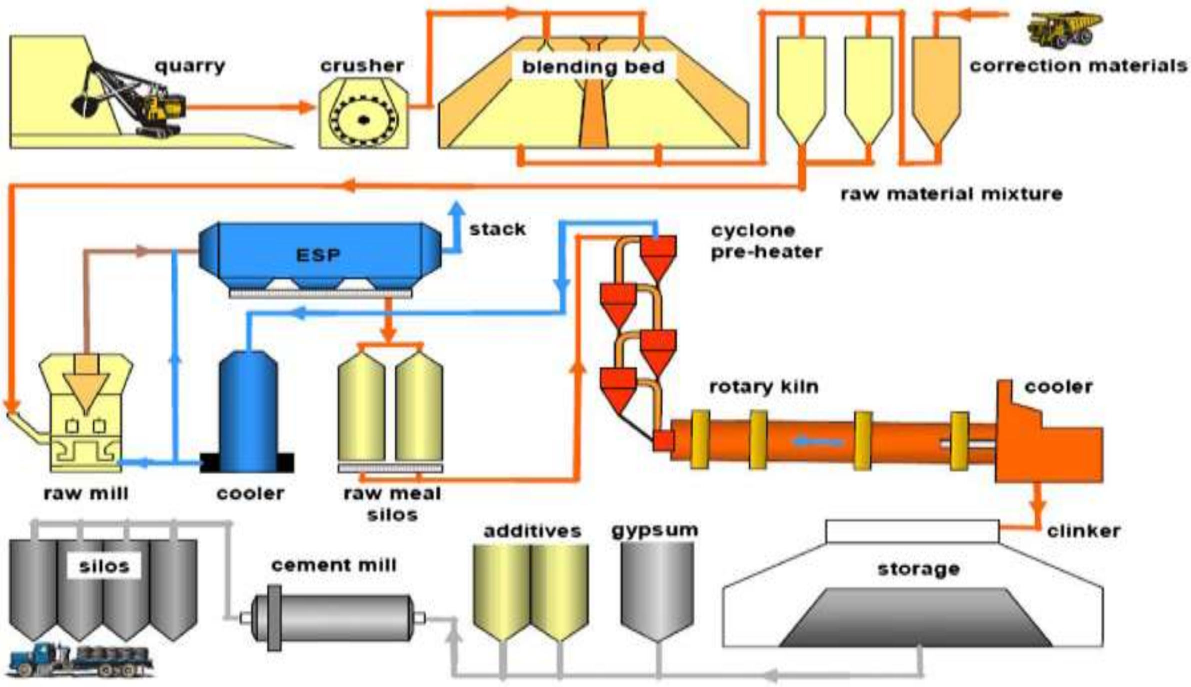


Figure: Schematic representation of Cement production process

Producing 1 metric ton (t) of cement releases an estimated 0.73 to 0.99 t CO2 depending on the clinker per-cement ratio and other factors. A major difference between the cement industry and most other industries is that fuel consumption is not the dominant driver of CO2 emissions. More than 50 percent of the CO2 released during cement manufacture, or approximately 540 kilograms (kg) CO2 per t of clinker (WBCSD 2009), is from calcination, in which CaCO3 is transformed into lime (CaO) in the following reaction:

$CaCO_3 \rightarrow CaO + CO_2$

Direct CO_2 emissions from the production of cement are attributed to:

(1) Calcination process - the process of transforming raw materials into clinker which is the main component of cement;

(2) Fuel combustion - fuels (oil, coal, petrol coal etc.) burn in the kilns and produce CO_2 as a result of the chemical reaction between carbon and oxygen. Indirect emissions of CO_2 are released during the generation of electricity required for the production of clinker and cement, as well as during the transportation of raw materials, fuel and final products. There are several measures in the cement industry, which can reduce CO_2 emissions significantly.

(A) Waste : defines waste as "any substance or object, which (a) the holder discards or intends or is required to discard or (b) has to be treated in order to protect the public health or the environment." Waste material can be solid, liquid, or pasty. Any waste material can be defined by its origin (industry, agriculture, mining etc), hence a proper list should always be established at national level to help create a common understanding and define a legal framework.

(B) Hazardous and non-hazardous waste: Hazardous Waste defines hazardous waste by reference to two Annexes that evaluate the level of danger of a material (harmful, irritating, combustible…). However, legislation can vary greatly between countries (except within the EU), leading to differences in determining whether a waste is hazardous or not. For countries where no classification of waste exists,

(C) Co-processing: This refers to the use of waste materials in industrial processes, such as cement, lime, or steel production and power stations or any other large combustion plants. Even though the EU calls this process co-incineration, for the purpose of these Guidelines, co-processing means the substitution of primary fuel and raw material by waste. It is a recovery of energy and material from waste.

(D) AFR (Alternative Fuel and Raw Materials): This refers to waste materials used for co-processing. Such wastes typically include plastics and paper/card from commercial and industrial activities (e.g. packaging waste or rejects from manufacturing), waste tires, waste oils, biomass waste (e.g. straw, untreated waste wood, dried sewage sludge), waste textiles, residues from car dismantling operations (automative shredder residues - ASR), hazardous industrial waste (e.g. certain industrial sludges, impregnated sawdust, spent solvents) as well as obsolete pesticides, outdated drugs, chemicals and pharmaceuticals.

(E) Pre-processing: Transforming waste to AFR requires certain standards. AFR does not always consist of a specific waste stream (such as tires or solvents) but must be prepared from different waste sources before being used as fuel or raw material in the cement plant. The preparation process is needed to produce an AFR stream that complies with the technical and administrative specifications of cement production and to guarantee that environmental standards are met.

Alternative Fuels which can be used to increase thermal substitution rate (TSR) in cement industry (use of CV of waste as fuel in cement kiln)

Fuel	Calorific Value (kcal / kg)
1. RDF from Municipal Solid Waste	2800-3800
2. Used Tires	6700-7700
3. Hazardous Waste	4000-9500
4. Industrial Plastic Waste	4070-6620
5. Biomass	2500-3800
6. Slaughter House Waste	700-1400
7. Poultry Litter	2700-3800
8. Dried Sewage Sludge	1700-1900

Source: Holtech & CPCB

Impact of co-processing on kiln emissions

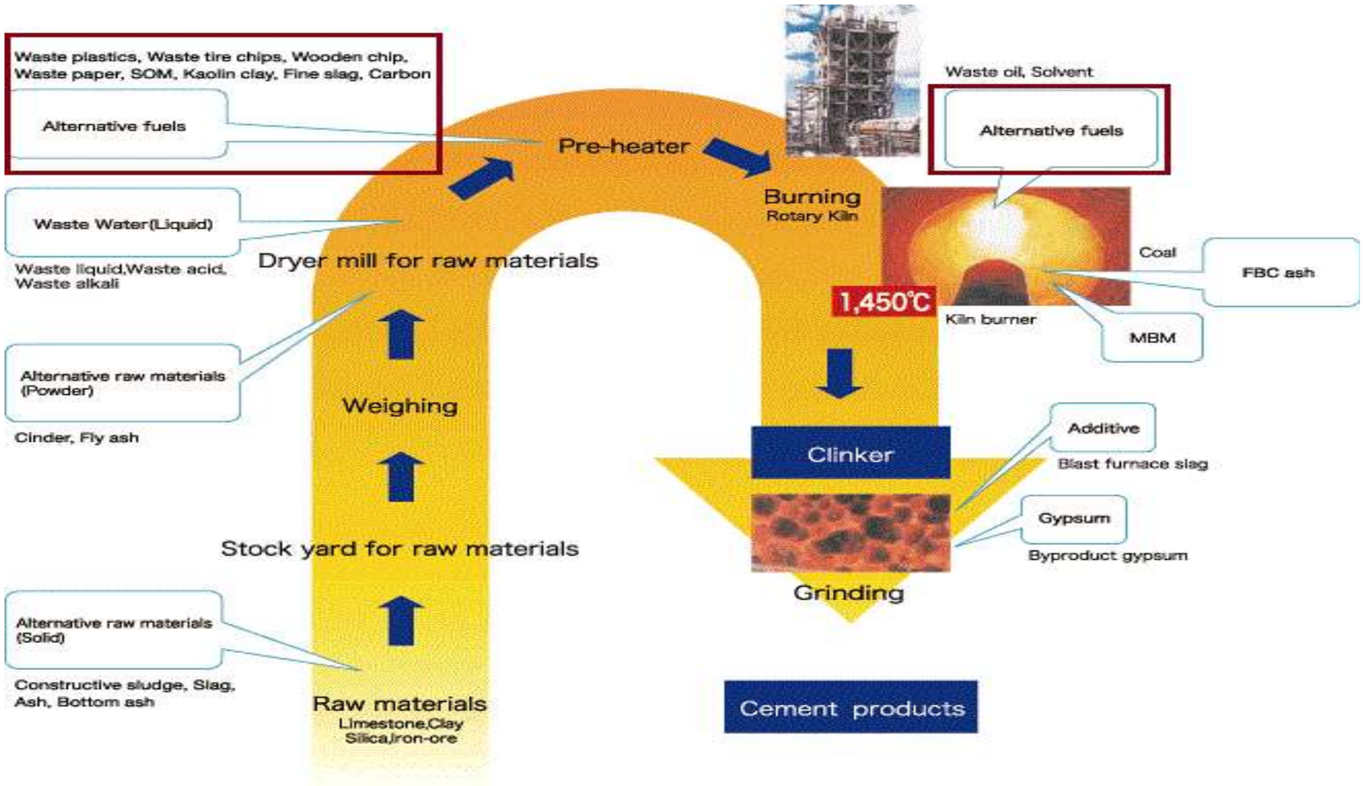
The impact of waste co-processing on emissions from cement manufacturing is relatively minor if co processing is done correctly and in compliance with strict regulations. Nonetheless, it is important to compare the presence of nitrogen, sulphur, chlorine, and other elements in the waste fuel with the concentrations of these elements in fossil fuels. The subsections below discuss some of these important elements in more detail.

Sulphur: Because clinker has an alkaline matrix, the presence of sulphur in waste fuels does not result in critical levels of sulphur gas emissions. However, the possibility that sulphur might react with different metals in raw meal must be considered. The concentration of sulphur in substitute fuels is generally much lower than the reference value in conventional fossil fuels (0.1-0.2 percent in RDF, 3-5 percent in fossil fuels). Therefore, there is no problem of precipitation or clogging from sulphur in alternative fuels.

NOx : Nitrogen is responsible for the formation of NOx. In general, formation of NOx is related to the amount of nitrogen in the fuel, the temperatures in the kiln, the residence times, and the types of burners (Genon and Brizio 2008). RDF has low nitrogen content (0.3-0.5 percent) in comparison with fossil fuels (1.5-2 percent). Overall, alternative fuels do not lead to higher NOx emissions and, in some cases, NOx emissions can even be lower when waste fuels are used (Genon and Brizio 2008). A rotary kiln in which raw materials are sintered at a temperature of 1,450°C using fossil fuel emits a large volume of NOx gas. When dewatered sludge is injected into the kiln, ammonia contained in the dewatered sludge decomposes NOx as follows:

2 NH 3 + 2 NO + 1/2 O

2 → 2 N 2 + 3 H2O



Advantages of co-processing in cement kiln

1. Due to the high temperature in cement kiln 1250-1450°C, all types of wastes can be effectively disposed.

2. Residence time of 4-5 sec in cement kilns

3. oxygen rich atmosphere, which aids complete combustions of the waste material and better efficiency then incinerators

4. The thermal stability due to temperature and long residence time, makes complete destruction of the waste material

5. Waste materials in the kiln are in contact with a large flow of alkaline (basic) materials that neutralize potential acid off-gases from combustion. destruction of the waste material

6. No ash left over after co-processing, minerals are trapped in the matrix of the clinker

7. Cement kiln co-processing technology is accepted by Basel convention for disposal of hazardous wastes

8. The cement kiln co-processing technology is accepted by Montreal protocol for disposal of POPs

9. Reduces the overall Greenhouse gas emissions and Conservation of fossil fuel resources.

10. Integrated solutions to waste management.

11. Immobilisation of toxic and heavy metals.

Parameters to be documented during trial period

1. Physical and chemical of Hazardous waste utilized for co-processing

2. Output of all equipment's in Kiln section during co-processing

3. Detailed write up on process, system, facilities and technologies in the co-processing unit

4. Screen shots of all equipment's in the co-processing unit during the trial

5. Thermal energy and electrical energy consumption

6. Physical and chemical testing results of clinker manufactured

7. Physical and chemical testing of cement produce from clinker manufactured with waste material

8. Physical and chemical analysis of raw material Sustainable Recycling Industries (SRI) India 24

9. Records on process parameters monitored during the trial

10. Records of Stack emissions monitoring

11. Records of Ambient air quality monitoring

12. Write up on storage, handling and feeding of waste in the process

13. Write up and records on safety, environment and product quality

14. Kiln stoppages with time duration, frequency and reasons

15. Problems faced during the trial of waste co-processing

16. Daily log sheets from Control room, quality assurance and environment department

17. Quantity of waste consumed, cement produced and reduction in conventional fuel

Conclusion

From this study, the following conclusion can be drawn. The main aim of this research is to use of solid or Alternative & fuel raw (AFR) material using and reduce cost of fossil fuel also reduce emission of $CO2$, NOx from fuel combustion. Also it's proven sustainable development concept that reduces demands on natural resources, reduces pollution and landfill space , thus contributing to reducing the environmental footprint, Reduces the overall Greenhouse gas emissions and Conservation of fossil fuel resources.

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