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Liquid Organic Spent Solvents Co-processing in Cement Industries

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Abstract
The components and quantities of hazardous waste emissions have been reported to be the pollution indicator of large urban areas. The multiplicity and complexity of sources of pollutants in environment has put forward the need of use alternate fuels in industrial co-processing. The present study is focused on utilization of liquid organic spent solvents (which is hazardous waste produced by the pharma industries) co-processing in cement industries. Specific liquid organic solvents have been selected based on their calorific value and availability for co-processing in Cement industry. Co-processing has been performed by mixing with coal. It has been observed that there is no specific adverse effect on production in comparison with the industries where co-processing is not performing.
Keywords: Liquid organic spent solvents, Co-processing, Cement industries.

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INTRODUCTION

Cement is a gray gold of the concrete world. It sets, binds and stabilize the world of concrete construction. Cement has become top five most consumed materials in the lap nature. The high stability and binding nature with other construction metals has push forward the importance of Cement on the earth. The main cost involving process in cement industry is huge consumption of energy (fuel) in the cement manufacturing process. If we have performed any development to drag down the cost is an appreciation action. Co-processing is the highly suggestive and useful cost effective method in the manufacturing process of high temperature based processes. The major benefit is less consumption of natural sources of fossil fuel (Sengupta, 2014).

Liquid organic spent solvents co-processing is a useful and cost effective method, by using hazardous waste in cement manufacturing as a part fuel (Lamas *et al.,* 2013). Co-processing is a process where the two or more fuels with good calorific value participated in the production manufacturing without changing the quality of the product. We can say this is the very useful method for sustainable growth of energy and natural resources. The specific hazardous liquid and solid wastes which have calorific value more than 2500 K Cal are used as alternate fuels and raw materials (AFR) (Wehenpohl *et al.,* 2006).

Considering the situation of cement industry in constant expansion and the need to use cheaper fuels, co-processing has emerged as a great business opportunity for the sector. This alternative is even five to ten times cheaper than conventional forms of incineration. The price charged for incineration varies between US$ 1,000 and US$ 3,000 a tonne, depending on the type of waste. The disposal in landfills can cost US$ 150 a tonne. The burning in cement kilns ranges from US$ 100 to US$ 700 (Giugliano, 1999).

The cement industry solid waste co-processing has been studied by several authors in order to decrease environmental impacts, such as (Choy *et al.,* 2004; Tsiliyannis, 2012).

The present study is focusing on liquid waste (organic spent solvents) co-processing in cement kilns.

MATERIALS AND METHODS

We have selected two different units for our experiment in which one is using pure coal as a fuel and another one is using coal (95%) with Alternate Liquid Fuels (ALF 5%) which are generated waste from pharmaceutical waste and hazardous to the environment. The ALF is using in precalciner for co-processing. The calorific value of the ALF is 3000-5000 Kcal which is permitted for use at rate 0.95% (maximum) for co-processing in the cement industry.

To study the effect of the ALF on the clinker and Cement manufacturing we have collected samples from 3 different locations from the both industries and samples were sent to the laboratory for chemical analysis.

Elemental species and mineralogical characterization of the samples have been analyzed by using XRD (Thermo ARL EQUINOX 3000) and Cl- (Chloride ion), SO_3 (Suphates) were analyzed by wet chemical analysis. Physico-Chemical properties of the cement were identified for both coal and ALF produced cement in the cement industry lab.

RESULTS AND DISCUSSION

The chemical analysis (**Table 1**) of ALF has shown its eligibility and safe for the co-processing in cement kilns. It contains low ash (1.43%) and high calorific value (5850kcal) which suits for the clinkerization process. The values of Hydrogen, Nitrogen and low Sulfur has shown the effectiveness of the ALF in cement industry for clinkerization process. Further we have analyzed production samples for Cl^- (chlorides), SO_3 (Sulfites) and alkalis from both units (**Table 2 and 3**) to identify salts like Potassium Chloride, Potassium Sulfate, Sodium sulfate and calcium sulfate which can create the problem by making lines (cyclic phenomena) and rings in kiln which is so expensive to remove. ALF contains very low amount of sulfur which can reduce the cyclic phenomena in the kiln.

Table 1. Comparative proximate analysis of fuel.

Parameters	Alternate Liquid Fuel (ALF)	Pet-coke	Coal	TDF
Volatile Matter %	95.68	13.0	36.8	72
Ash %	1.43	7.1	14	7
Carbon %	43.94	82.6	80.6	84
Hydrogen %	7.31	3.4	4.6	5
Sulfur %	<0.1	4.9	0.7	2
Nitrogen %	5.59	1.75	0.3	1.75
Calorific Value	5850	6800	5800	-

Table 2. Chemical analysis of samples without ALF

Parameters	Kiln feed	RABH dust	Clinker
Loss on Ignition (%)	36.05	38.42	0.21
K2O (%)	0.30	0.51	0.52
Na2O (%)	0.06	0.04	0.03
SO3 (%)	0.04	0.03	0.40
Cl- (%)	0.00	0.01	0.00
SiO2	12.60	9.55	21.68
Al2O3	2.79	4.61	5.20
Fe2O3	2.75	2.57	4.03
Mn2O3	0.08	0.08	0.10
Lime Saturation Factor	109.79	138.91	94.81

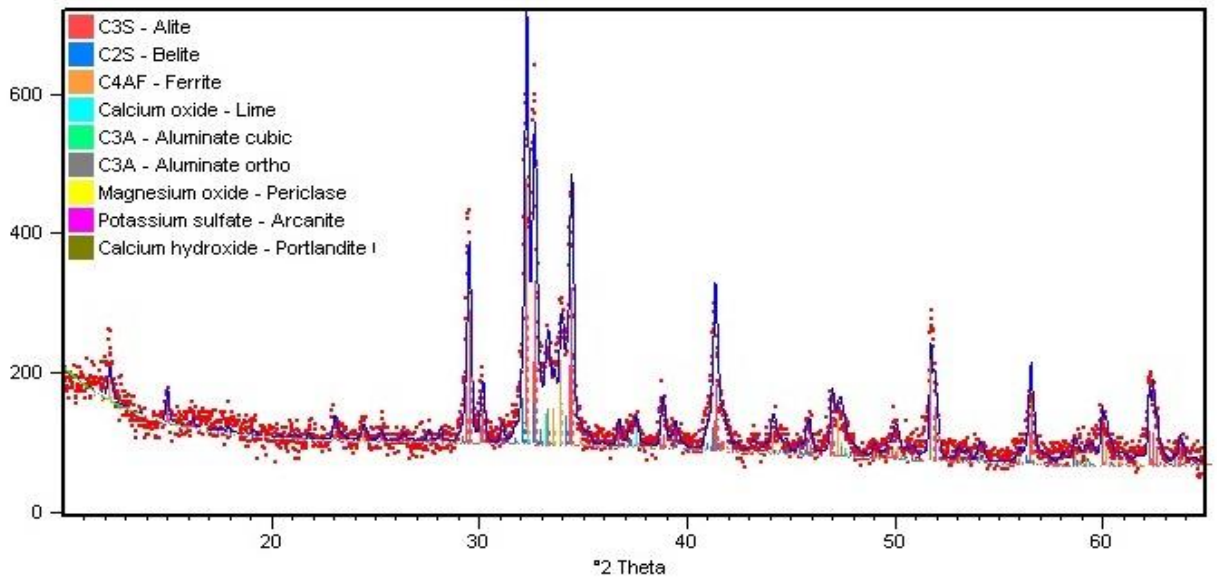
Table 3. Chemical analysis of samples with ALF

Parameters	Kiln feed	RABH dust	Clinker
Loss on Ignition (%)	35.81	38.26	0.28
K2O (%)	0.31	0.41	0.51
Na2O (%)	0.05	0.04	0.03
SO3 (%)	0.04	0.04	0.31
Cl- (%)	0.00	0.00	0.00
SiO2	12.66	9.87	21.34
Al2O3	2.94	4.24	5.29
Fe2O3	2.74	2.32	3.99
Mn2O3	0.09	0.08	0.13
Lime Saturation Factor	107.74	137.17	96.08

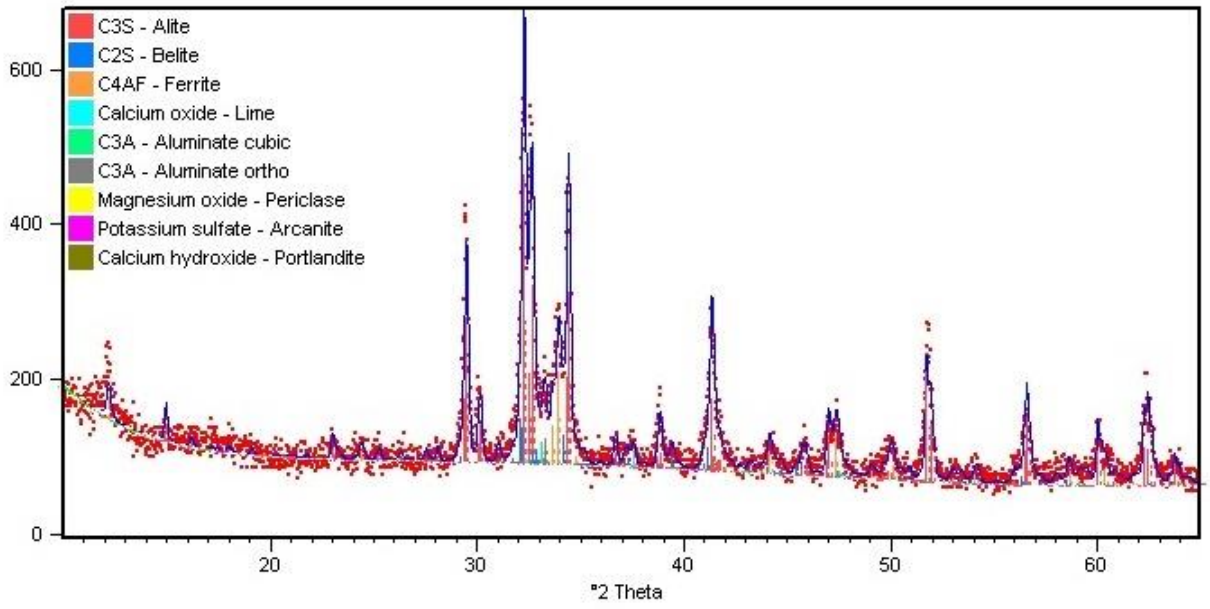
XRD analysis has shown the mineralogical composition of the clinker (Figure 1) which shows the main composition of the Alite (C3S), Belite (C2S), Ferrite (C4AF), Calcium Oxide (Lime), Aluminate (C3A), Aliminate Ortho (C3A), Magnesium Oxide (Periclase), Potassium Sulfate (Arcanite) and Calcium Hydroxide (Portlandite) were detected in both cases. XRD analysis has shown that the compound formation is similar in both cases. The peaks has showing that there is no specific difference between two XRD graphs and does not create any undesired compounds.

The product (Cement) property and comprehensive strength has shown the similar digits for both fuels without any big deviations. The setting time (age) has shown the similar property for both ALF and coal.

Air pollution emission strategy has shown interesting trend while comparison with conventional fuels. The trend of PM10 and PM2.5 have shown a different and low curvature for Alternate Liquid Fuels, whereas the plain coal as fuel has shown the high emission and curve in the graph (Figure 2). In a previous study, Anantham et al. (2011) documented the use of Alternative fuels as part of drive for sustainable development and resource conservation indicating the possibility of their use in cement processing.



(a)



(b)

Fig. 1. XRD analysis of clinker samples without ALF (a) and with ALF (b).

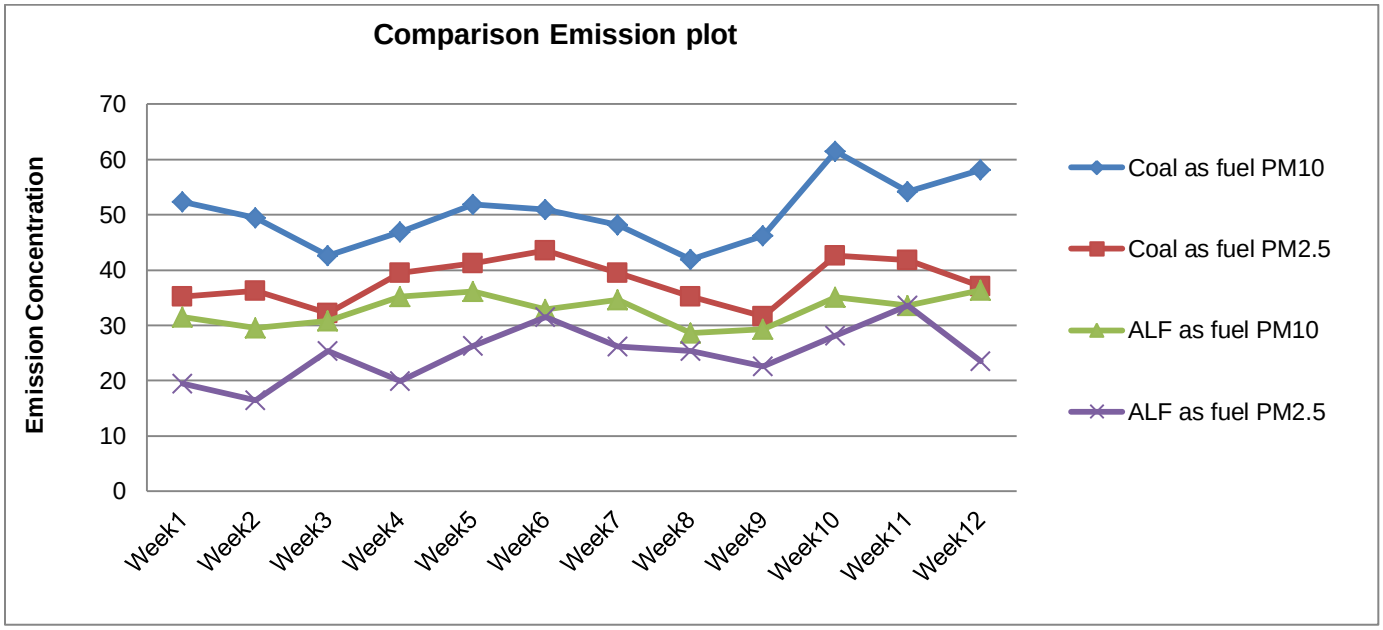


Fig. 2. Spatio-temporal variability of air emission in a Cement Industry

CONCLUSION

The present study concluded that, the use of alternative liquid fuels (ALF) in the industrial sintering process in rotary kiln in cement manufacturing is a environmental friendly and a waste minimization method. The use of ALF is a good cost effective method (operating facility at low cost) and a great substitution of conventional fuel; it reduces the tonnage of the coal use in the cement manufacturing.

Chemical analysis of the samples, cement properties and XRD analysis of the clinker has shown that there is no specific difference in the quality of the product in both with ALF and without ALF cases. By making these analyses, finally we found that the use of 5% of ALF has shown similar product efficiency and no adverse effects. The major benefit we have found that the air pollution emission is drastically low with comparison coal.

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CONFLICT OF INTEREST

The authors declare that no competing interests exist.

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