



Confederation of Indian Industry
CII-Sohrabji Godrej Green Business Centre



CASE STUDY MANUAL on Alternative Fuels & Raw Materials Utilization in Indian Cement Industry



May 2011

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FOREWORD

The fast growth Indian Cement industry has witnessed over the last decade will certainly result in increased consumption natural resources. In an effort to assist the Indian cement industry grow in an ecologically sustainable path, CII – Godrej Green Business Centre has taken up many initiatives in making Indian cement industry World Class in Green.

CII's 'Low Carbon Roadmap for Indian cement industry' released in Green Cementech 2010 highlighted two broad areas where significant opportunity for improvement exists for the Indian cement industry to tap on:

1. Utilization of Waste Heat Recovery (WHR) &
2. Utilization of Alternative Fuel and Raw material (AFR)


CII has released a Manual on Waste Heat Recovery Systems earlier highlighting various technologies, case studies, etc to give an impetus to the adoption of WHR in the Indian industry. It is heartening to note that several Indian cement manufacturers have either gone ahead or on the verge of going ahead with WHR in their facilities. I am confident that in the next few years, WHR would become an integral part of cement manufacturing process in India.

We still have a long way to go as far as alternate fuel & raw material usage is concerned. Notwithstanding several policy, regulatory or technological barriers that we face, I strongly believe that this is the opportune time for the Indian cement industry to focus all its efforts in furthering AFR utilization in its processes.

CII's studies indicate that the GHG emission reduction potential through waste utilization in cement kilns is extremely high. International experiences highlight large opportunities for such AFR usage with Japanese cement industry utilizing over 450kg Waste/Ton of cement manufactured and European cement plants having thermal substitution rate as high as 40%. If these initiatives and experiences could increase thermal substitution in Indian cement industry to just 5% replacement of thermal substitution, GHG emissions could reduce by over 1,700,000 MT CO₂ annually. This is a very large emission reduction opportunity; so large that it could make a difference in the overall country's emissions.

Indian cement industry has several successful case studies of AFR utilization and this manual is a small effort to recognize such good efforts & to serve as a reference for other cement manufacturers to emulate.

I wish success for all initiatives towards this objective and hope to see Indian cement industry achieve world class levels in greener tomorrow.



G Jayaraman

Chairman, Green Cementech 2011, CII- Godrej GBC &
Executive President, Birla Corporation Ltd.



MESSAGE

India is rapidly developing into a giant force with GDP rising consistently at more than 8% year after year and the cement demand and therefore the cement industry capacity is also increasing at the similar rate. It is projected that by 2020 the cement demand would rise to more than half a billion TPA in the country. On the other hand, the natural resources that are used as raw materials and fuel by the cement industry are depleting fast and acquiring new reserves is becoming more and more difficult.

More than 6 million T of hazardous waste, about 40-50 million Tonnes of non-hazardous & municipal solid wastes and large quantum of agro-wastes generated in the country is posing a sizeable threat to the eco-system of the country due to lack of adequate infrastructure to deal with it in an ecologically sustaining manner.

Co-processing of different types of wastes in cement kiln as alternative raw materials and fuels is one of the globally demonstrated solutions through which the waste management challenge faced in the country can be mitigated to a large extent and also the cement industry can reduce the concern faced by it due to depleting resources. This is certainly a win-win option for both cement industry and the society at large.

The cement industry in the country has already initiated few steps towards implementing co processing which is evident from the various case studies presented in this manual and the industry is looking forward to attaining the substitution levels that are prevalent in the developing countries quickly so that it can support the poised growth of the country respecting fully the triple bottom line.

There is, therefore, an urgent need to implement appropriate policies and practices in favour of co processing in the country so that co processing can contribute reasonably towards the waste management needs of the country and also help industry in substituting alternative resources in the cement manufacturing process. This implementation would be requiring substantial capacity building in the relevant stakeholder community - particularly the policy makers, authorities, waste generators, facility providers and the cement plants.

This "case study manual on utilisation of wastes as AFRs in Indian cement Industry" being brought out by CII would certainly be facilitating all these stake holders in moving the cement kiln co processing approach in the right direction in the country.



Ulhas V Parlikar

Chairman - CII Initiative on Increasing AFR Usage in Cement Industry &
Director - AFR Business, ACC Limited

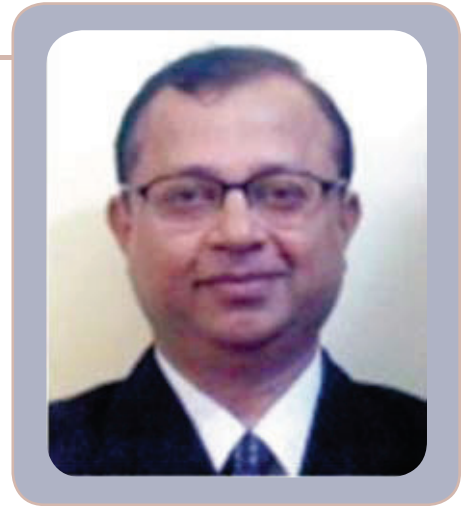


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1.0 EXECUTIVE SUMMARY

India is the 2nd largest producer of cement in the world with total installed capacity of about 260 Million MTPA as on March 2010. Cement industry in India is a fast growing sector and is expected to add an additional capacity of 92.3 MT by the year 2013¹. As a result, the cement industry would have a total installed capacity of 383.5 MTPA by March 2013.

Indian Cement Industry produces about 7 percent of the world cement production. The present per capita consumption of cement in India is about 186 kg², which is still way below compared to several other countries in the world. India's GDP is likely to grow by an impressive 9.2 percent in FY 11 and infrastructure industries such as cement would also grow at almost the same pace as that of national GDP.

The cement industry is a Resource Intensive Industry (RII) with use of large quantity of natural resources as Raw materials and Fuels. The energy consumption by the global cement industry is about 3.84% of the global primary energy consumption, or almost 5% of the total global industrial energy consumption³. While the known fossil fuels, and more importantly Coal, which is the primary fuel for Indian cement industry is fast depleting, it is imperative to look for alternatives. At the same time, it is also essential for all corporations to fulfill their social commitment towards sustainability by reducing the consumption of fossil fuels and reducing greenhouse gas emissions.

Further, availability of natural raw materials also is reducing substantially and acquiring land of the mineral deposits required in the production of cement is becoming increasingly difficult. With increasing demand of cement in the country, exploring alternative resources as fuels and Raw materials is an important imperative that cement industry has to look for. On other side, waste management in India is an increasing concern. The increasing urbanization and rapid industrial growth in the country is leading to large quantum generation of Municipal Solid Waste (MSW) and Industrial Wastes (both hazardous and non-hazardous), posing substantial difficulties in the management of the same due to paucity of the infrastructure available in the country for the management of the same. Prime Minister's NAPCC – NMSH⁴ has also identified Urban Waste Management as a major component for ecologically sustainable economic development.

1. Cement Manufacturers Association (www.cmaindia.org) & India Business Equity Fund (www.ibef.org)
2. Cement Manufacturers Association (www.cmaindia.org)
3. Bureau of Energy Efficiency (www.bee-india.nic.in)
4. National Action Plan on Climate Change – National Mission on Sustainable Habitat

Therefore, implementation of effective waste management practices become imperative for the sustainable growth of the country and the cement industry, having demonstrated capability of providing safe, ecological sustaining and environmentally sound solution for the management of both Municipal and Industrial wastes - can supplement this requirement waste management in the country in an effective manner.

The cement industry is capable to co process wastes as alternative fuels and raw materials to reinforce its competitiveness and at the same time contribute to solutions to some of society's waste problems in a way which valorizes the waste and is beneficial to the environment.

Cement kilns have a number of characteristics which make them ideal installations for disposal of wastes through co processing route in an environmentally sound manner.

- High temperatures (Flame temperature $>1800^{\circ}\text{C}$ and material temperature up to 1400°C)
- Long residence time
- Oxidizing atmosphere
- High thermal inertia
- Alkaline environment
- Ash retention in clinker

The use of waste as alternative fuels and raw materials in the cement industry has numerous environmental benefits such as:

- Reduced the use of mined natural materials such as limestone, bauxite, Iron ore etc and non-renewable fossil fuels such as coal. This also reduces the environmental impacts associated with mining of these natural materials
- Contributes towards a lowering of emissions such as greenhouse gases by replacing the use of fossil fuels with materials that would otherwise have to be incinerated with corresponding emissions and final residues
- Reduced requirement of land required for land fill option thereby reducing the emissions and also liability associated with the landfills.



- Maximizes the recovery of resources present in the waste. All the energy is used directly in the kiln for clinker production and the non-combustible part of the waste becomes part of clinker

The co processing of waste as AFR in the cement kiln therefore disposes the waste completely and thereby eliminates fully the societal concerns associated with it.

In Indian cement industry, if these initiatives could increase thermal substitution to the level of European countries – say 40% thermal substitution of fossil fuel (on heat basis), cement industry can reduce its GHG emission by over 13,771,000 MT CO₂ reductions annually. This is a very large emission reduction opportunity; so large that it could make a sizable difference in the overall country's GHG emissions.



2.0 PURPOSE OF THIS MANUAL

The objective of this manual is to act as catalyst for promoting increased use of alternate fuel & raw materials in Indian Cement Industry through co processing of wastes and reducing cost of clinker production, thereby improving performance competitiveness of individual cement plants. The objective also is to promote a much needed ecologically sustaining solution to the waste management problem in the country through co processing in cement kiln.

This manual also serves as a reference document for utilization of waste (or) best waste disposal options in the cement industry.

This manual will cover/examine the following:

- Various types of waste currently being used in cement industry
- Best practices for utilization of waste in cement kilns
- CO2 emission reduction opportunities through alternate fuel utilization

The primary goal of this manual on use of Waste as AFRs through co processing in cement kiln is to share experiences in reducing GHG emissions and also improving efficiency in the cement kiln operations in India. Additional considerations are following.

- To set a clear goal for reducing cost of production or improving the performance and moving towards the world class standards, unique case studies/experiences on co processing learnt over the last few years have been included in this manual
- These case studies/ best practices in utilization of waste through co processing may be considered for implementation after suitably fine tuning them to meet the requirement of individual units
- Suitable latest technologies may be considered for implementation in existing and future cement plants for co processing of waste. Further investigation and statutory requirements need to be verified for the suitability of these technologies for Indian cement plants

Therefore, Indian cement plants should view this manual positively and utilize the opportunity to improve the performance and to achieve world class resource efficiency while extending the environmentally sound solution of cement kiln co processing for the disposal of waste.

3.0 BACKGROUND

3.1 URBAN WASTE

Waste management in India is an increasing concern. India's urban population grew from 290 Million reported in the 2001 census to an estimated 340 Million in 2008, and is projected to go up to 590 Million by 2030⁵. While India's urban population grew by 230 Million in about 40 years (from 1971 to 2008), the next 20 years would see an increase by about 250 Million; emphasizing the rapid urbanization in India at unprecedented rate. This increased urbanization would create higher demand for effective Municipal Solid Waste (MSW) management, considering increasing income levels and changing lifestyle choices. Therefore, effective waste management practices become imperative for the sustainable growth of the country.

Prime Minister's NAPCC – NMSH⁶ has also identified Urban Waste Management as a major component for ecologically sustainable economic development.

3.2 INDUSTRIAL WASTE

India generates about 6.2 Million Tons of hazardous wastes annually, out of which around 3.09 Million tonnes is recyclable, 0.41 Million Tons is incinerable and 2.73 Million tonnes is land-fillable⁷. With this kind of increasing quantum of hazardous waste generation, local administration, civic bodies and policy makers are posed with a serious concern of its effective & safe disposal. This categorization of hazardous wastes into 3 classes is based on the hazard potential and its characteristics guiding its ultimate disposal, in accordance with the Hazardous wastes (Management and Handling & Trans boundary Movement) Rules, 2008.

CPCB has also noted that most of these wastes have characteristics suited to their utilization as resource material either for recovery of energy or materials like metals etc., or their utility in construction, manufacture of low-grade articles or recovery of the product itself, which after processing can be utilized as a resource material. Hence a new mind-set for treating the hazardous & non-hazardous waste as a resource material rather than a difficult disposable material is the need of the hour.

5. India's Urban Awakening, McKinsey Global Institute, April 2010

6. National Action Plan on Climate Change (NAPCC) – National Mission on Sustainable Habitat (NMSH)

7. Central Pollution Control Board (www.cpcb.nic.in)

3.3. WASTE DISPOSAL

Safe & easy options available for the local governments is to land fill or incinerate the hazardous waste. However, the capital & operating costs involved in these exercises are significant and prohibitive in several cases. The cost of providing incinerator would depend on its capacity ranging from Rs 10 Crores to 30 Crores⁸. Assuming disposal cost of Incinerable hazardous waste is about Rs. 16,000/- per MT, it would create an additional burden of about Rs. 640 Crores annually for incinerating hazardous waste in India. Besides, incinerator if not operated optimally may contribute to emissions including toxic Dioxins and Furans. The land availability for land fill is becoming scarce and the liabilities associated with the same during its operation and also for years after their closure remains as a major and continuous cause of concern to both society and administration.

This coupled with resource conservation and reduced carbon emissions make a strong case for considering co-processing as a sound and better alternative for wastes disposal in the country.

Advantages of Co-Processing in Cement Kilns
Significantly higher operating temperatures > 1400°C
Sufficiently large residence time
Inorganic content gets fixed in Clinker
Energy content in waste fully utilized
No residue left, unlike incinerator ash which should be land-filled

3.4 CO-PROCESSING IN CEMENT KILNS

All developed nations globally have utilized cement kilns in their countries as an effective option for industrial, municipal and hazardous waste disposal. This creates a WIN-WIN situation for all the relevant stakeholders, viz, the waste generator, the local administration, the society and the cement plants; the waste generator getting an environmentally sound and economically attractive disposal option without any concerns about future liabilities, the administration utilizing the infrastructure already available

Characteristics	Temperature and time
Temperature at main burner	>1450°C: material >1800°C: flame temperature.
Residence time at main burner	>12-15 sec and >1200°C >5-6 sec and >1800°C
Temperature at Precalciner	>850°C: material >1000°C: flame temperature
Residence time at Precalciner	>2 - 6 sec and >800°C

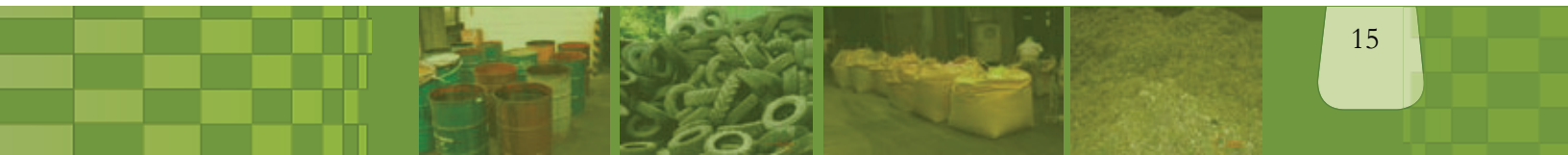
Table 2: Ideal Characteristics for Co-processing in Cement Kilns

8. CPCB Guidelines on Co-Processing, February 2010

with cement kilns thereby spending lesser for waste management; the society having a sustainable environment to live & grow and the cement kilns getting revenue for the environmental service extended for safe disposal of the waste & partly meeting their resource requirement.

Indian Cement industry, the second largest in the world with installed capacity of 260 Million MT Cement per annum (as of March 2010) is growing at rate of 8.1 percent every year.

This offers tremendous potential for waste absorption and raw material utilisation in cement kilns.



4.0 BRIEF OVERVIEW OF INDIAN CEMENT INDUSTRY

The Indian Cement Industry is second largest cement producer in the world, with an installed capacity of 260 Million MT Cement per annum (as of March 2010). This installed capacity includes 249.76 million tonnes from large cement plants and 11.10 million tonnes from white and mini cement plants. The corresponding cement production had been 187.46 million tonnes with 181.46 million tonnes from large cement plants and approximately 6 million tonnes from white and mini Cement plants⁹.

Indian Cement industry is composed of 148 large cement plants and more than 365 mini cement plants, mainly producing clinker, Ordinary Portland cement (OPC), Portland Pozzolana Cement (PPC) and Portland Slag Cement (PSC). The Chart shows the product mix of Cement Production in India.

Indian cement industry is going through a phase of substantial growth, rapid technological up gradation, very high market demand and a much greater & promising future in the next few years.

India's GDP is likely to grow by an impressive 9.2 percent in FY 11, Real GDP expanded by 8.9 percent in the first-half of FY 11. In the quarter ended March 2010, real GDP grew by a handsome 8.6 per cent and in the subsequent quarters, improved further to 8.9 percent in each quarter¹⁰. The economy is expected to perform even better in the second-half of 2010-11. Expect real GDP to grow by 9.7 percent during this period”.

Recent increases of coal prices in the Indian market again made the cement industry vulnerable to fuel cost. Energy consumption breakup in a typical dry process Portland Cement Plant is 75 percent fuel and 25 percent electricity. Ninety nine percent (99%) of the fuel (Thermal Energy) consumption is used for clinker burning or pyro-processing.

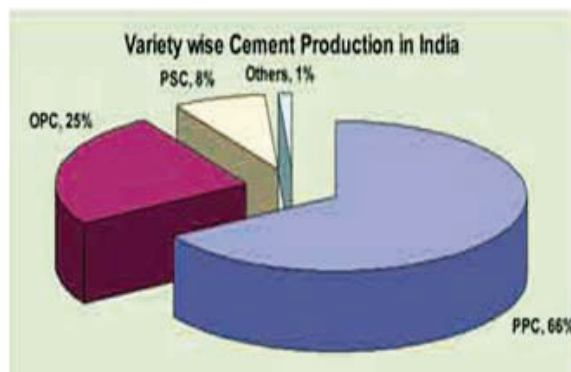
Fuel and power accounts for about 25 percent and 14 percent of total cement production cost, respectively. To reduce fuel cost in cement industry, globally, waste materials (for example, tires, industrial wastes, non recyclable waste oils, non-recyclable solvents, waste plastics, non-recyclable packaging materials, contaminated soils, trade rejects, segregated fractions from municipal solid waste etc.) and low-grade fuels are co processed extensively as alternative fuels or energy sources. Further, to deal with the constraints faced in extracting natural resources as raw materials for use in the cement manufacture, several wastes having raw material value (for example mill scale, steel slag, waste fractions from aluminum sources, Effluent Plant sludge, bottom ash, fly ash, drilling mud,

9. Cement Manufacturers Association (www.cmaindia.org)

10. Centre for Monitoring Indian Economy (CMIE)

lime sludge, etc) are co processed in the cement industry as alternate raw materials.

In Japan and some European countries alternative fuels & raw materials in cement kilns are in successful use since the early 90s.



Industrialized countries have over 20 years of successful experience (GTZ and Holcim 2006) in co processing of wastes as AFRs in cement kilns. The Netherlands and Switzerland, with respective national substitution rates of 83% and 48%, are world leaders in this practice¹¹.

4.1. CEMENT KILNS FOR WASTE DISPOSAL

Among large combustion plants that can engage in Co-processing, the cement kiln has gained wider acceptance and recognition in this kind of disposal method. For one, the cement manufacturing process has features that are suited for co-processing. These include:

1. Different feed points for AFR introduction in the cement process. Feed points can be via the main burner, secondary burners, precalciner burners, kiln inlet etc
2. Alkaline conditions and intensive mixing in the kiln favour the absorption of volatile components from the gas phase. This results in low emissions of sulphur dioxide (SO₂), hydrochloric acid (HCl) and most heavy metals.
3. The clinker reaction temperature at 1450 degrees Centigrade (°C) allows incorporation of ashes, in particular, the chemical binding of metals to the clinker
4. Cement kiln operates under negative pressure or draft, thus preventing the generation of fugitive emission
5. With the large mass of clinker processed inside the cement kiln, there is a presence of a huge thermal inertia thereby eliminating the possibility of rapid swings in temperature.

5.0. EMISSION & WASTE GENERATION IN CEMENT KILNS

Carbon dioxide (CO₂) emissions from cement manufacturing are generated by two mechanisms. Combustion of fuels to generate process energy releases quantities of CO₂. Substantial quantities of CO₂ are also generated through calcining of limestone or other calcareous material. This calcining process thermally decomposes CaCO₃ to CaO and CO₂. Emissions of metal compounds from cement kilns can be grouped into three general classes: volatile metals, including mercury (Hg) and thallium (Tl); semi-volatile metals, including antimony (Sb), cadmium (Cd), lead (Pb), selenium (Se), zinc (Zn), potassium (K), and sodium (Na); and refractory or non-volatile metals, including barium (Ba), chromium (Cr), arsenic (As), nickel (Ni), vanadium (V), manganese (Mn), copper (Cu), and silver (Ag). Although the partitioning of these metal groups is affected by kiln operating conditions, the refractory metals tend to concentrate in the clinker, while the volatile and semi-volatile metals tend to be discharged through the primary exhaust stack and the bypass stack, respectively.

6.0 USE OF ALTERNATE RAW MATERIALS, ALTERNATIVE FUELS & BIO MASS

A variety of industrial waste can be used as alternate raw materials / fuel in cement kilns. The broad types of waste used as Alternative Raw Material & its common sources are as under:

Raw Materials	Waste Material	Industrial Sources
Clay mineral / Al_2O_3	Coating residues Aluminium recycling sludge	Foundries Aluminium industry
Limestone / $CaCO_3$	Industrial lime Lime sludge	Neutralization process Sewage treatment
Silicates / SiO_2	Foundry sand Contaminate soil	Foundries Soil remediation
Iron-oxide / Fe_2O_3	Roasted pyrite Mechanical sludge Red sludge	Metal surface treatment Metal industry Industrial waste water treatment
Si-Al-Ca-Fe	Fl ashes Crushed sand	Incinerator Foundries
Sulphur	Gypsum from gas desulphurization Chemical gypsum	Incineration Neutralization process
Fluorine	CaF ₂ filter sludge	Aluminium industry

Table : Alternate Raw Materials for Cement Manufacture

Co processing of various wastes like waste carbon from pharmaceutical industries, paint sludge from Automobile industries, used tires and segregated fractions from municipal waste in cement industry as Alternative Fuels for producing clinker replacing coal is another high potential area of interest in the Indian Cement industry. Currently thermal energy consumption accounts for 31 % of the GHG emissions. Even if efforts are taken to replace the conventional fossil fuel with any of the wastes or alternate fuel by at least 10 %, this will result in reducing the emissions by about 22 kg CO₂ /MT cement.

Improper collection and segregation systems, lack of pre-processing facility for converting variable quality waste into uniform quality AFRs, absence of any incentives / credits / enabling policies for management of wastes in cement kiln and lack of technological and operating awareness on co pro-

cessing are some of the areas of concern the Indian cement industry is facing today in widespread adoption of alternate fuels & raw materials in cement manufacturing.

Biomass utilization as Alternative Fuel for thermal substitution could be a major area for the Indian cement industry.

Indian Cement industry is far behind its European / Japanese counterparts in usage of Alternative Fuels and raw materials. Some of the European countries have a thermal substitution rate as high as about 40%¹² in their cement manufacturing facilities. CII's estimates indicate that the Thermal substitution in Indian cement industry is less than 2%. India still has a long way to go in ensuring greater substitution of AFRs, resulting in sizable conservation of natural materials and fossil fuels.

12. Perspectives and limits for cement kilns as a destination for RDF, Elsevier

7.0 GHG REDUCTION POTENTIAL

CII's studies indicate that the GHG emission reduction potential through waste utilization in cement kilns is extremely high. A look at international experiences supports this presumption. For example, Japanese cement industry utilizes about 450 kg Waste / Ton of cement manufactured. In European cement plants, thermal substitution from alternate fuels is as high as 40%.

In Indian cement industry, if these initiatives could increase thermal substitution to those of European Cement industry (i.e. say 40%) , cement industry can reduce its GHG emission by over 13,771,000 MT CO₂ reductions annually.

As per the recent document released by MoEF, India's emissions in the year 2007 was estimated to be 1727.71 Million Tons¹³. Thermal substitution of about 40% in cement industry can reduce India's emissions by about 0.8¹⁴; This is a very large emission reduction opportunity; so large that it could make a difference in the overall country's emissions which is substantially in the national interest today.

There is, therefore, a pertinent need to facilitate creation of enabling policy framework for increased use of waste in cement kilns through directives / guidance from the central & state pollution control

13. India GHG Emissions 2007, MoEF, May 2010

14. Total cement production in 2007-08: 155.7 MTPA; specific emission intensity of 691 kg CO₂ /MT Cement and emissions due to thermal energy consumption at 32%, the total emission reduction by replacing conventional fossil fuel with alternate fuel by 40% would reduce emissions by 13.771 MT CO₂ /year, which is about 0.8% of India's emissions

8.0 CEMENT KILN CO-PROCESSING

Co-processing is defined as the reuse or recovery of mineral or energy content of waste materials while simultaneously manufacturing clinker in a single combined operation

In the process, portions of traditional fuels are replaced with the combustible components of the waste materials while non-combustible parts of the waste materials replace portion of the raw materials. Waste shall be co-processed only if there is no financially and ecologically better way of waste avoidance and recycling. The integration of co-processing into the waste hierarchy is shown in Figure. The waste management hierarchy is defined as follows:



- **Avoidance or prevention** of waste is the ideal solution. This can be achieved only through a strict product policy that ensures that certain materials do not appear as residues at all
- **Minimization or reduction** of waste, in particular by the application of the cleaner production concept or changes in consumer habits related to packaging
- **Recovery of waste material** by means of direct recycling and reuse of primary materials (e.g. metal to metal or paper to paper). It also includes other technologies like composting or anaerobic digestion
- **Co-processing** – recovery of energy and materials from waste as a substitute for fossil energy and virgin raw materials
- **Incineration** is primarily a disposal technology to reduce waste volumes, to reduce the potential negative impact of the waste material and to a certain extent recover energy

- **Chemical-physical pre-treatment** is a procedure to stabilize waste materials before final disposal
- **Controlled land-filling** is the common method for the final disposal of non-recyclable waste
- **Uncontrolled burning and dumping**, often accompanied by open burning, is still the most common method of waste disposal in developing countries, where these pose a major threat to natural resources and human health. This form of waste disposal should be avoided

The waste hierarchy has to be respected for any waste disposal option, including co-processing. Co-processing should be considered as a treatment alternative within an integrated waste management concept. Whenever possible, waste should be avoided or used for energy and material recovery, as from the ecological and economical point of view this is the most appropriate solution for any country.



9.0 PRINCIPLES OF CO-PROCESSING

The five guiding principles of co-processing has been summed up well in the GTZ-Holcim Guidelines on Co-processing Waste Materials in Cement Production:

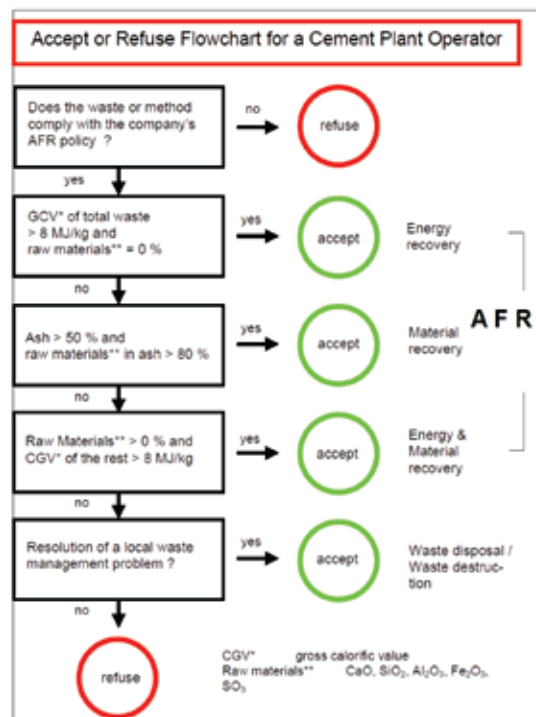
<p>Principle I</p>	<p>Co-processing respects the waste hierarchy:</p> <ul style="list-style-type: none"> • Co-processing does not hamper waste reduction efforts, and waste shall not be used in cement kilns if ecologically and economically better ways of recovery are available. • Co-processing shall be regarded as an integrated part of modern waste management, as it provides an environmentally sound resource recovery option for the management of wastes. • Co-processing is in line with relevant international environmental agreements, namely the Basel and Stockholm Conventions
<p>Principle II</p>	<p>Additional emissions and negative impacts on human health must be avoided</p> <ul style="list-style-type: none"> • To prevent or keep to an absolute minimum the negative effects of pollution on the environment as well as risks to human health. • On a statistical basis, emissions into the air shall not be higher than those from cement production with traditional fuel
<p>Principle III</p>	<p>The quality of the cement product remains unchanged:</p> <ul style="list-style-type: none"> • The product (clinker, cement, concrete) shall not be abused as a sink for heavy metals • The product should not have any negative impact on the environment as e.g. demonstrated with leaching tests • The quality of cement shall allow end-of-life recovery
<p>Principle IV</p>	<p>Companies engaged in co-processing must be qualified:</p> <ul style="list-style-type: none"> • Have good environmental and safety compliance track records and to provide relevant information to the public and the appropriate authorities • Have in place personnel, processes, and systems demonstrating commitment to the protection of the environment, health, and safety • Assure that all requirements comply with applicable laws, rules and regulations • Be capable of controlling inputs and process parameters required for the effective co-processing of waste materials • Ensure good relations with the public and other actors in local, national and international waste management schemes
<p>Principle V</p>	<p>Implementation of co-processing has to consider national circumstances:</p> <ul style="list-style-type: none"> • Country specific requirements and needs must be reflected in regulations and procedures • A stepwise implementation allows for the build-up of required capacity and the set-up of institutional arrangements • Introduction of co-processing goes along with other change processes in the waste management sector of a country

10.0 WASTE ACCEPTANCE CRITERIA

Before a waste material can be co-processed in cement kilns, it has to pass certain minimum waste acceptance criteria based on the applicable local environmental regulations, impacts on kiln operation, clinker & cement quality, and emissions & heavy metal content.

Consistent with the mentioned parameters, the following criteria shall be used for accepting wastes for Co-processing:

- It qualifies as alternative fuel or alternative raw material or disposal material. Alternate Fuels refer to non-traditional fuel, such as waste materials, providing thermal energy in the production of clinker while alternative raw materials refer to non-traditional raw materials, such as waste materials, providing minerals essential in the production of clinker. Co processing could be considered for Disposal if it resolves a local waste management problem in an environmentally sound manner.



- Its use in the cement kiln complies with applicable Central / State environmental laws
- Chlorine and sulphur may build up in the kiln system leading to accumulation, clogging and unstable operation. Excess chlorine may produce cement kiln dust or bypass dust that will require removal, treatment or safe disposal. These parameters vary in different kiln systems. (Refer GTZ - Holcim report 2006)

10.10 PRECONDITIONS FOR USAGE OF ALTERNATIVE FUELS & RAW MATERIALS

Waste materials can be used as alternative fuels & raw materials provided that they do not contain substances that are specifically precluded, or limited, in line with State or local regulations.



11.0. WASTE MATERIALS NOT ACCEPTABLE FOR CO-PROCESSING

Guidelines on Cement Kiln Co-processing issued by cement manufacturers worldwide identify the wastes that are not acceptable for co-processing. The reasons for exclusion are enrichment of pollutants in the clinker, excessive emission values, occupational health and safety (OH&S) issues, potential for recycling or land filling as better option, and negative impact on kiln operation. Table below shows the list of waste materials that are unacceptable for co-processing and the reason/reasons for their un-acceptability.

	Enrichment of pollutants in clinker	Excessive emission values	OH&S Provision	Potential for Recycling	Land filling as better option	Negative impact on kiln operation
Electronic assemblies and scraps	X	X		X		
All types of batteries	X	X		X		X
Health care wastes			X			
Mineral acids		X	X			X
Explosives	X		X			
Asbestos containing wastes			X		X	
Radioactive wastes	X		X			
Unsegregated municipal solid wastes	X	X		X		X
Cyanide wastes		X	X			
Fluorescent lamps	X	X				

Table : Waste not acceptable for Co-processing

12.0. ENERGY AND EMISSIONS CONSIDERATIONS

Using alternative fuels in cement manufacturing is recognized for far-reaching environmental benefits¹⁵. The embodied energy in alternative fuels that is harnessed by cement plants is the most direct benefit, as it replaces demand for fossil fuels like coal. The amount of coal or other fossil fuel demand that is displaced depends on the calorific value and water content of the alternative fuel in comparison to coal.

Additionally, the fuel substitutes often have lower carbon contents (on mass basis) than fossil fuels. Therefore, another direct benefit of alternative fuel substitution is a reduction in CO₂ emissions from cement manufacturing.

12.1. CHLORINE

The presence of chlorine in alternative fuels (e.g., sewage sludge, municipal solid waste or incineration ash, chlorinated biomass,) has both direct and indirect implications on cement kiln emissions and performance. Methods have been developed to properly manage chlorine and its potential implications – but it is important that these implications be recognized and managed. Trace levels of chlorine in feed materials can lead to the formation of acidic gases such as hydrogen chloride (HCl) and hydrogen fluoride (HF)¹⁶. Chlorine compounds can also build-up on kiln surfaces and lead to corrosion¹⁷. Introduction of chlorine into the kiln may also increase the volatility of heavy metals¹⁸, and foster the formation of dioxins (see Dioxins and Furans discussion below.)

12.2. HEAVY METALS

It has been demonstrated that most heavy metals that are in the fuels or raw materials used in cement kilns are effectively incorporated into the clinker, or contained by standard emissions control devices¹⁹ (A study using the EPA’s toxicity characteristic leaching procedure to test the mobility of heavy metals in clinker when exposed to acidic conditions found that only cadmium (Cd) could be detected in the environment, and at levels below regulatory standards (5 ppm)²⁰. As long as cement

15. CEMBUREAU 1999

16. WBCSD 2002

17. McIlveen-Wright 2007

18. Reijnders 2007

19. WBCSD 2002; European Commission (EC) 2004; Vallet January 26, 2007

20. Shih 2005

kilns are designed to meet high technical standards, there has been shown to be little difference between the heavy metal emissions from plants burning strictly coal and those co-firing with alternative fuels. Utilization of best available technologies is thus essential for controlling emissions.

Mercury (Hg) and cadmium (Cd) are exceptions to the normal ability to control heavy metal emissions. They are volatile, especially in the presence of chlorine, and partition more readily to the flue gas. In traditional incineration processes, Hg (and other heavy metals) emissions are effectively controlled with the combination of a wet scrubber followed by carbon injection and a fabric filter. Similar control options are under development for cement kilns including using adsorptive materials for Hg capture²¹ (. At present, the use of dust removal devices like electrostatic precipitators and fabric filters is common practice but they respectively capture only about 25% and 50% of potential Hg emissions²². The only way to effectively control the release of these volatile metals from cement kilns is to limit their concentrations in the raw materials and fuel²³. Giant Cement, one of the pioneer hazardous waste recovery companies in the US, limits the Hg and Cd contents in alternative fuels for their kilns to less than 10 ppm and 440 ppm, respectively. These limits are significantly lower than those for other metals such as lead (Pb), 11 chromium (Cr) and zinc (Zn) which can be as high as 2,900, 7,500, and 90,000 ppm, respectively²⁴.

12.3. DIOXINS AND FURANS

The formation of persistent organic pollutants such as polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs), known collectively as dioxins, is a recognized concern for cement manufacturing. Dioxins have the potential to form if chlorine is present in the input fuel or raw materials. Formation can be repressed, however, by the high temperatures and long residence times that are standard in cement kilns²⁵. Minimizing dioxin formation is further achieved by limiting the concentration of organics in the raw material mix, and by quickly cooling the exhaust gases in wet and long dry kilns²⁶. Evidence from several operating kilns suggests that preheater/precalciner kilns have slightly lower PCDD/PCDF emissions than wet kilns .

21. Peltier 2003; Reijnders 2007

22. UNEP Chemicals 2005

23. Mokrzycki, Uliasz-Bochenczyk et al. 2003; UNEP Chemicals 2005; Harrell March 4, 2008

24. Bech 2006

25. Karstensen 2008

26. WBCSD 2002; Karstensen 2008

The actual contribution of the cement sector to dioxin emissions remains controversial as the science of measuring these emissions is rather nascent. For example, the EU Dioxin Inventory and the Australian Emissions Inventory measured dioxin emission factors that ranged by orders of magnitude. In general, the US attributes a greater share of total dioxin emissions to the cement sector than do other countries such as Australia and those in the EU. The difference is largely due to divergent approaches to monitoring cement kiln emissions²⁷.

With respect to alternative fuels, numerous studies comparing PCDD/PCDF formation in kilns using conventional and waste-derived fuels have found no significant difference in the emissions from the two²⁸. They have also found that kilns using alternative fuels easily meet emissions standards. For example, non-hazardous alternative fuels (used oil, tires, waste-derived fuels) fed into dry preheater kilns equipped with electrostatic precipitators in Germany found no significant difference in PCDD/PCDF emissions compared to traditional fuels. Until recently, emissions factors for PCDD/PCDFs differentiated between plants that did and did not burn hazardous wastes. That distinction has been replaced with distinctions among kiln types and burning temperatures to determine appropriate dioxin emission factors.

27. WBCSD 2002

28. WBCSD 2002; WBCSD 2006; Karstensen 2008

13.0. ALTERNATIVE FUEL CHARACTERISTICS

Over view of key combustion characteristics and typical substitution rates of a variety of alternative fuels used for cement manufacturing

Fuel	Substitution Rate (%)	Lower heat value (GJ/DT)	Moisture or water content (%)	Ash Content (%)	C content by dry wt)	Carbon Emissions Factor (Ton C/ ton of fuel)	Co2 emissions offset /t of coal replacement	Associated emissions	Data Source
Agriculture Biomass									
Rice Husk	35	13.2-16.2	10	20.6	38.80	0.35	0.0	CI	(Mansaray1997; Jenkins,Baxter et al.1998 Demirbas 2003)
Wheat Straw	20	15.8-18.2	7.3-14.2 (7.3, 12, 14.2)	4.5-8.9	44.9-48.8	0.42	0.2		(Mansaray1997; Jenkins,Baxter et al.1998;Demirbas2003; Asian Development Bank 2006;Mclveen-Wright 2007)
Corn Stover	20	15.4	9.41-35	3.2-7.4	42.5	0.28	-0.6		(Demirbas 2003; ani, Tabil et al. 2004; sian Development Bank 2006)
Sugarcane leaves	20	15.8	<15	7.7	39.8	0.34	-0.1		
Sugarcane (Bagasse)	20	14.4-19.4	10-15	4.2	44.1	0.39	0.4		(Li 2001; Demirbas 2003; Asian Development Bank 2006)
Rapeseed stems	20	16.4	12.6	5.9	45.2	0.39	0.1		
Hazelnut Shells	20	17.5	9.2	3.5	52.9	0.48	0.4		
Palm nut shells	20	11.9	10			0.36	0.7		

Non-Agricultural biomass

Fuel	Substitution Rate (%)	Lower heat value (GJ/DT)	Moisture or water content (%)	Ash Content (%)	C content (% by dry wt)	Carbon Emissions Factor (Ton C/ ton of fuel)	CO ₂ emissions offset /t of coal replacement	Associated emissions	Data Source
Agriculture Biomass									
Dewatered sewage sludge	20	10.5-29	75	21.8	30-53.92	0.21-0.39	0.04	Heavy metals	(Fytli 2006; IPCC 2006; McIlveen-Wright 2007)
Heat dried sewage sludge			10				-0.37	Heavy metals	(Fytli 2006; IPCC 2006; McIlveen-Wright 2007)
Paper Sludge	20	8.5	70	26		0.2	1.36	Cl	(Maxham 1992; European Commission (EC) 2004)
Paper	20	12.5-22		8.33	47.99	0.42	-0.15	Cl	(Jenkins, Baxter et al.1998; European Commission (EC) 2004)
Saw dust	20	16.5	20	2.6	46.9	0.38	0.14	Cl (If treated wood)	(Resource Management Branch 1996; Demirbas 2003)
Waste wood	20	15.5-17.4	33.3	0.9	50	0.33-0.49	1.32	Cl, toxics if treated or painted	(Bhattacharya, Abdul Salam et al. 2000; Li 2001; IPCC 2006; McIlveen-Wright 2007)
Animal waste (bone meal, animal fat)		16-19	15		34	0.29	-0.71		(Bhattacharya, Abdul Salam et al. 2000; Zementwerke 2002; European Commission (EC) 2004)

Chemical and Hazardous waste

Fuel	Substitution Rate (%)	Lower heat value (GJ/DT)	Moisture or water content (%)	Ash Content (%)	C content (% by dry wt)	Carbon Emissions Factor (Ton C/ ton of fuel)	Co2 emissions offset /t of coal replacement	Associated emissions	Data Source
Agriculture Biomass									
Spent solvent		0-40 Avg 21-25	10.3-16.5		47.7	0.4	-0.89	dioxins	(Zementwerke 2002; Seyler2005; Seyler, Hofstetter et al. 2005)
Paint Residues		16.3	9	34	41-51	0.42	0.21		(Vaajasaari, Kulovaara et al. 2004; Saft 2007)
Hazardous waste (mis)					50	0.14		Dioxins, heavy metals	(IPCC 2006)
Obsolete pesticides	57	33.3						Nox	(Karstensen 2006)

Petroleum – Based waste										
Tires	<20%	27.8-37.1	0.3				0.56	-0.83	Nox, So ₂ , CO	(ICF Consulting 2006)
Polyethylene		46	2.1	27.4	71		0.7	-1.03	Cl	(Subramanian 2000; European Commission (EC) 2004)
Polypropylene		46	2.1	27.4	71		0.7	-1.03	Cl	(Subramanian 2000; European Commission (EC) 2004)
Polystyrene		41	2.1	27.4	71		0.7	-0.85	Cl	(Subramanian 2000; European Commission (EC) 2004)
Waste oils		21.6	5		46		0.44	-0.53	Zn, Cd, Cu, Pb	(Mokrzycki, Uliasz- Bohenczyk et al. 2003; Boughton 2004; IPCC 2006)
Petroleum coke (Petcoke)		18.9-33.7	0.4		78.24 %		0.5-0.9	0.21	So ₂ , Nox, Co	(Kaplan 2001; Mokrzycki, Uliasz- Bohenczyk et al. 2003; Prisciandaro, Mazziotti et al. 2003; Kaantee, Zevenhoven et al. 2004; IPCC 2006)



Miscellaneous waste

Fuel	Substitution Rate (%)	Lower heat value (GJ/DT)	Moisture or water content (%)	Ash Content (%)	C content (% by dry wt)	Carbon Emissions Factor (Ton C/ton of fuel)	CO ₂ emissions offset /t of coal replacement	Associated emissions	Data Source
Polypropylene carpet residues		28.1	0.2	21.2	56.9	0.57	-0.54	Cl, Sb, Cr, Zr	(Realff 2005; Boughton 2007)
Nylon Carpet residues		17.2	0.9	25.4	42.2	0.42	-0.15	Cl, Sb, Cr, Zn, Nox	(Realff 2005; Boughton 2007)
Textiles	30	16.3	5.8	1.2	44.6	0.42	0.11	Sb, Cr, Zn	(Ye, Azevedo et al. 2004)
Automotive shredder residues	2	16.5	2.2	36.2	46.2	0.44	0.10	Cl, Heavy metals	(Mirabile, Pistelli et al. 2002)
Demolition and commercial waste		25	18.8	20.6					(European Commission 51 (EC) 2004)
Land fill Gas		19.7	-			0.3	-1.02		(Asian Development Bank 2006)
MSW (hh)		12-16	10-35		40	0.26-0.36	-0.01	Cl, Heavy metals, Nox	(European Commission (EC) 2004; IPCC 2006)



**BEST PRACTICES FOR UTILISATION OF WASTES AS AFR
(ALTERNATIVE FUELS & RAW MATERIALS) IN
INDIAN CEMENT INDUSTRY**

CASE STUDY 1 : ALTERNATIVE FUEL AND RAW MATERIAL CO-PROCESSING EXPERIENCES - ACC LTD., KYMORE CEMENT WORKS

Project Implemented by : ACC Ltd, Kymore Cement Works

Project Implemented in : 2008

Company Details

ACC Limited is India's foremost manufacturer of cement and concrete. ACC's operations are spread throughout the country with 16 modern cement factories, more than 40 Ready mix concrete plants.

Since inception in 1936, the company has been a trendsetter and important benchmark for the cement industry in many areas of cement and concrete technology. ACC has a unique track record of innovative research, product development and specialized consultancy services. The company's various manufacturing units are backed by a central technology support services centre - the only one of its kind in the Indian cement industry.

Kymore Cement Works is one of the most modern cement plants in ACC Group. This is located at Kymore, Katni District, Madhya Pradesh. Capacity of ACC, Kymore are 2.20 MTPA.

Project Details

Co-Processing of Industrial waste from various Industries

ACC Limited, Kymore Cement Works, as part of its AFR Policy has taken steps for utilizing the hazardous waste/solid wastes generated from other industries of Madhya Pradesh. Thermal substitution of waste depends on type of waste material, quantity of waste & its supply mode and the continuity of its feeding for disposal.

A. Co processing of Poly Residue from M/s SRF Pvt. Ltd.,

SRF Pvt Ltd is a manufacturer of Nylon inter alia. Plant is situated at Malanpur, Bhind in the State of Madhya Pradesh. In the process of production of Nylon Fibers, Plant generates following waste

1. ETP Sludge
2. Residue of poly section (as the "solid waste material")



M/s SRF approached ACC Limited, Kymore Cement Works for evaluating the feasibility of safe disposal of their solid waste material (generated at its Nylon Plant), in an environment-friendly manner. After evaluating the same at its testing facilities in Thane, ACC Limited has offered to co-process the solid waste material generated by SRF's Nylon Plant at Kymore Cement Works.

Three trials were conducted and the 3rd trial was also successfully completed in the month of April 2010. The baseline, trial burn monitoring data and after burn monitoring data were taken by an independent third party (M/s SGS India Ltd, engaged by ACC Limited). The trial of waste disposal was witnessed by the representatives of MPPCB. The result of emission measurement reveals that none of the gaseous emissions, heavy metals or dioxin/Furans and TOC was exceeding from the base line measurement data.

ACC Limited is looking for co-processing of waste on regular Basis. After mutual agreement, M/s SRF will now be supplying waste on regular basis. Till date 530 MT of waste has been co-processed successfully at ACC Limited, Kymore Cement Works. Details of waste disposal are as under

- 1st Trail Burn – 61.4 MT
- 2nd Trail Burn – 400.0 MT
- 3rd Trial Burn – 69.02 MT
- Total – 530.02 MT

B. Co-processing of industrial wastes from M/s Hindustan Unilever

The rejected and outdated products from M/s Hindustan Unilever Limited (HUL) were co-processed in the cement kiln. The various types of rejected materials such as non-hazardous shampoo sachets, shampoo bottles, toothpaste, creams, Lotions etc were disposed off successfully at ACC Limited, Kymore Cement Works. The average quantity co-processed was about 300 MT/month.

As part of this waste disposal exercise, a trial-burn program of HUL waste material was carried out for the baseline monitoring data, trial-burn monitoring data and after-burn monitoring data by an independent third party (M/s SGS India Ltd, engaged by ACC Limited). The result of emission measurement reveals that none of the gaseous emissions, heavy metals or dioxin/furans and TOC was exceeding from the base line measurement data



C. Co-processing of industrial wastes from M/s Cadbury Industries

The rejected and outdated products of M/s Cadbury Limited were co-processed in the cement kilns of Kymore Cement Works. The various types of rejected non-hazardous materials were Bournvita, Bytes, and different types of chocolates. The quantity disposed off was approximately 1 Ton

D. Co-processing of industrial wastes from M/s EICHER

Paint sludge is being successfully co-processed in the Kilns of Kymore Cement Works. The quantity of paint sludge waste disposed till date is approximately 40 tones.

E. Co-processing of industrial wastes from M/s Narmada Geletene,

Lime sludge waste generated from Narmada Geletene is also being successfully co-processed at ACC Limited, Kymore Cement Works

F. Co-processing of industrial wastes from M/s Hindustan Coco Cola

Waste generated from Hindustan Coco Cola such as Paints, Activated Carbon, ETP sludge and Spent Granulated Carbon are being successfully co-processed at ACC Limited, Kymore Cement Works. Quantity of waste processed is approximately 1 Tonne.

G. Co-processing of industrial wastes from M/s A2Z Industries, Kanpur

ACC Limited, Kymore Cement Works is also successfully co-processing about 30 Tons of waste Re-fused Derived Fuel (RDF) from M/s A2Z Industries, Kanpur

H Use of Biomass, Mustard husk, Perthenium grass etc. in Power plant

ACC Limited, Kymore Cement Works has also been successfully co-processing various types of biomass based fuels available in the vicinity:

Sn	Biomass Fuel	Source
1	Mustard Husk	Local Market
2	Gram Husk	Local market, Jabalpur, Katni
3	Soya huskShahdol,	Local market, Jabalpur , Katni, Satna, Rewa
4	Cow dung	Katni, Jabalpur
5	Saw dust	Katni, Jabalpur
6	Cuttings of Jatropa	

I Plastic waste /garbage co-processing in Kilns

ACC Limited, Kymore Cement Works established the system and infrastructure for co-processing of the polythene garbage in its Kiln and the system is in operation since June 2008.

In order to identify a sustainable solution for management of plastic waste, ACC Limited undertook trial for processing in cement kiln. The co-processing trial run was carried out to demonstrate that the Cement kiln is able to co-process plastic waste in an environmentally friendly manner, without any adverse impacts on the product quality and emissions.

The emission monitoring results of the trial run provides a basis to demonstrate the environmentally sound performance of co-processing, to the authorities and other stakeholders in the waste disposal activity.

Data for AFR materials co-processed at Kymore Cement

AFR materials co-processed (year 2008) at Kiln & power plant

Name of Waste Stream	Hazardous / Non Hazardous	Total Jan - Dec, 2008 (Tonnes)
Biomass	Non Hazardous	1510
Trade Reject (HUL, Nivea, Cadbury's,)	Non Hazardous	2536
Spent carbon	Non Hazardous	0
Plastic waste	Non Hazardous	192
WTP Sludge	Non Hazardous	0
Lime sludge	Non Hazardous	141
Slag-as Mineralizer	Non Hazardous	23205
SRF Waste	Non Hazardous	401
Paint Sludge	Hazardous	0
		27986

AFR materials co-processed during year 2009 at Kiln & power plant

Name of Waste Stream	Hazardous / Non Hazardous	Total Jan - Dec, 2009 (Tonnes)
Biomass (Soya husk, rice husk, saw dust, gram husk, pruned materials etc.)	Non Hazardous	3632
Trade Reject (HUL, Nivea, Cadbury's,)	Non Hazardous	5044
Spent carbon	Non Hazardous	0
Plastic waste	Non Hazardous	396
WTP Sludge	Non Hazardous	0
Lime sludge	Non Hazardous	127
Slag-as Mineralizer	Non Hazardous	23950
SRF Waste	Non Hazardous	0
Paint Sludge	Hazardous	0
		33150

AFR materials co-processed in yr. 2010 at Kiln/power plant (Till Oct 2010)

Name of Waste Stream	Hazardous / Non Hazardous	Total Jan - Dec, 2010 (Tonnes)
Biomass (Soya husk, rice husk, saw dust, gram husk, pruned materials etc.)	Non Hazardous	2426.18
Trade Reject (HUL, Nivea, Cadbury's,)	Non Hazardous	2053.3
Spent carbon	Non Hazardous	41.35
Plastic waste	Non Hazardous	279.58
Water Treatment Plant sludge (from Hindustan Coco Cola)	Non Hazardous	8.9
Lime sludge	Non Hazardous	596.51
Slag-as Mineralizer	Non Hazardous	11836.45
SRF Waste	Non Hazardous	208.8
Paint Sludge	Hazardous	38.5
RDF (Refused Derived Fuel) from A 2 Z Industry, Kanpur	Non hazardous	26.9

Financing of the Project

ACC Limited, Kymore Cement Works has invested about Rs. 400 Lakhs for implementation of the project. This investment is for establishing system for alternative fuel storage and feeding. The investment has been taken up fully with internal funds.

Results of the Project

- Co-processing of waste at cement kiln is the best disposal option than conventional options of land filling and incineration.
- Substitutes precious fossil fuel reserves

Replication Potential

Similar project can be implemented in all cement plants in India to solve the disposal problems of the industrial solid wastes, plastic wastes and biomass etc. These wastes are otherwise very difficult to manage in the society

Recommendation to other units

It is recommended to co-process the waste in cement rotary Kiln.

Contact Information of the plant

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CASE STUDY 2 : CO-PROCESSING OF PLASTIC WASTE IN CEMENT KILN - ACC LTD, GAGAL CEMENT WORKS

Project Implemented by : ACC Ltd, Gagal Cement Works

Project Implemented in : 2010

Company Details

ACC Limited is India's foremost manufacturer of cement and concrete. ACC's operations are spread throughout the country with 16 modern cement factories, more than 40 Ready mix concrete plants.

Since inception in 1936, the company has been a trendsetter and important benchmark for the cement industry in many areas of cement and concrete technology. ACC has a unique track record of innovative research, product development and specialized consultancy services. The company's various manufacturing units are backed by a central technology support services centre - the only one of its kind in the Indian cement industry.

Gagal Cement Works is one of cement plants in ACC Group. This is located at Barmana, Himachal Pradesh. Capacity of ACC, Gagal is MTPA.

Background

Green Soldiers from Gagal Cement works launched first project titled 'Making Gagal Plastic Free'. Segregation is the essence of effective waste management and hence, a workshop was organized for the stakeholders. All colony and local village residents were invited for a discussion on the strategy. Green Soldiers team was trained on the ways to segregate the plastic waste.

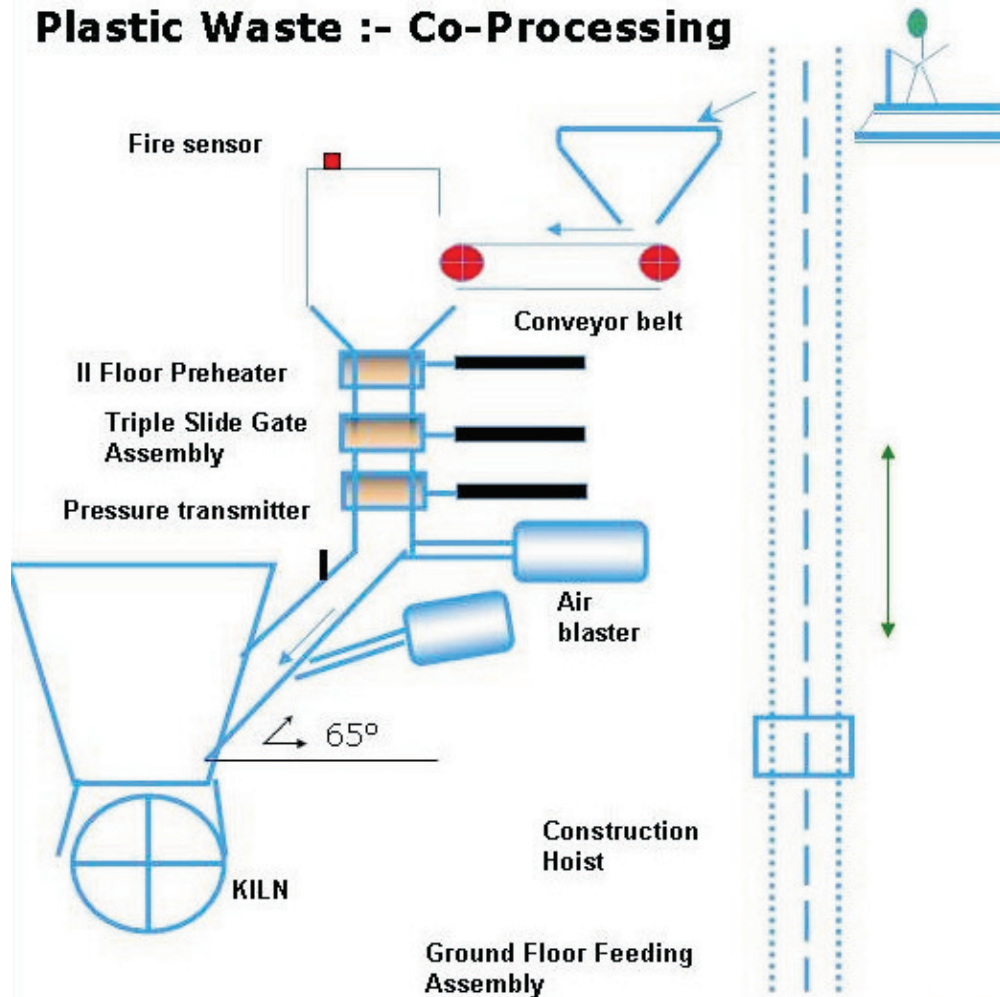
The Green Soldiers team collected about 53 Tons of plastic waste, which was successfully co-processed in Gagal cement kiln.

Project Details

The plastic waste collected from the villages, colony and plant premises were weighed at the weigh-bridge each week after the collection drive.



The drive started with collection of 50 kgs/week, which is presently recording approximately 2 Tons of collection per week. This gave a clear indication that the stakeholders were increasingly becoming more aware about segregation and concerned about their environment.



Flow Sheet for Co-Processing of Plastic

Process Description

Financing of the Project

Investment required for this project is very minimal as system was already developed.



Results of the Project

- Co-processing of waste at cement kiln is the best disposal option than conventional options of land filling and incineration.
- Substitutes fossil fuel

Replication Potential

The initiative can be replicated across other industries and companies countrywide, as well as at a global level. The beauty of the initiative is that, keeping the ideas intact, the projects can easily be moulded to suit the climate, topography and biodiversity of any area across the world. Our natural resources are getting scarce by the minute and alternate fuels such as bio-charcoal / plastic are an excellent way to alleviate this paucity of non-renewable energy sources

Recommendation to other units

It is recommended to co-process the waste in cement rotary Kiln.

Contact Information of the plant

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CASE STUDY 3 : COMMON EFFLUENT TREATMENT PLANT SLUDGE AS ALTERNATE FUEL IN CEMENT KILN - BINANI CEMENT LTD

Project Implemented by : Binani Cement Ltd
Project Implemented in : 2010

Company Details

Binani Cement Limited is the flagship subsidiary of Binani Industries Limited (BIL), representing the Braj Binani Group. The cement business started operations in 1997, in Sirohi District, Rajasthan with a 1.65 MTPA integrated cement facility and a 25 MW captive power plant with technological support from FLSmidth, Denmark and Larsen & Toubro Ltd.

The capacity was raised to 2.25 MTPA in 2005 through advanced in-house R&D and de-bottle necking and the Company was also certified to ISO 9001, ISO 14001 and OHSAS 18001 within a short span from commencement of operation. This is an achievement that clearly illustrates the management's commitment to quality, efficiency, environment, health and safety. In 2008, a split-grinding unit at Neem Ka Thana was commissioned, boosting the capacity in India to 6.25 MTPA.

Today, Binani Cement has established itself as one of the top companies in the industry in terms of efficiency and performance

Project Details

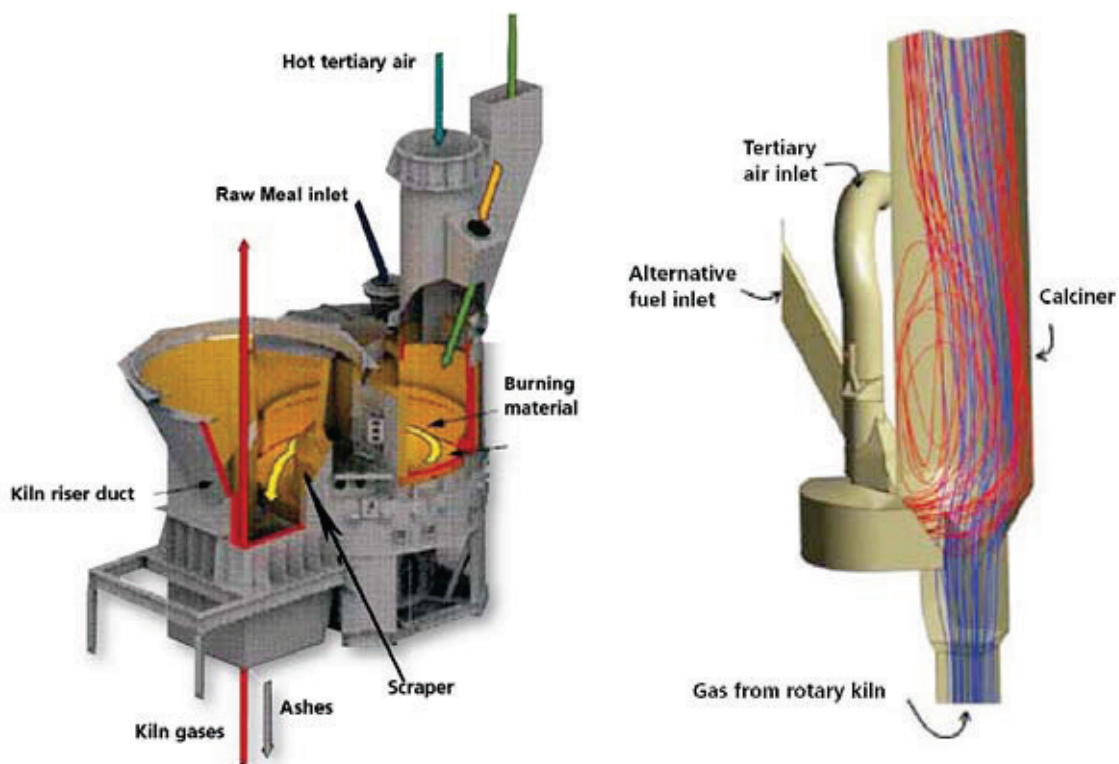
The Sludge from the Common Effluent Treatment Plant (CETP), Pali is being used as part of company's Social Responsibility towards environment protection.

The sludge, a potent hazardous waste, contains toxic chemicals such as PCBs, dioxins, Persistent Organic Pollutants (POPs) and heavy metals like cadmium, arsenic, zinc, mercury etc. which by virtue of being carcinogenic, are extremely harmful for human health & environment if disposed inappropriately into landfills or water bodies. Until the establishment of 'Pali Water Pollution Control Treatment & Research Foundation, the effluent generated by the textile industries used to be indiscriminately disposed into the local rivers & water bodies causing the city's industrial cluster to be declared by CPCB as one of the 14 most critically polluted areas in the country.



'Pali Water Pollution Control Treatment & Research Foundation', a non-profit organization running under the chairmanship of the District Magistrate, delivers the sludge @ 10 MT per day which is disposed in our kilns in a scientific and environment friendly manner under authorization from the RSPCB.

The material is fed through Hot Disc System



Results of the Project

Environmental Benefits

1. The project saves the local rivers & water bodies around Pali from getting polluted.
2. GHG emission reduction due to partial replacement of fossil fuel.

Investment

Since a full-fledged mechanized feeding system was already in place at Plant Premises, no additional investment was required to be made for this purpose.

Replication Potential

Similar project can be replicated not only in cement kilns but also in other industries such as steel, aluminium, refractory or others where incineration takes place at $>1200^{\circ}$ C. Since the material is a mixture of various organic compounds, it has some heat value (approx. 1000 Kcal/Kg) and as such it helps to replace an equivalent amount of fossil fuel. In addition, the material is delivered at no cost.

Issues faced during implementation

1. Jamming problems were faced due to high moisture content during rainy seasons. Hence, it is advisable to keep the moisture content well below 10% before it is fed into the system.
2. Clay content – the inherent clay contained in the feed tends to decrease the C3S content of the resultant clinker and was thus compensated by making appropriate adjustments in the raw mix.

Recommendation to other units

It is recommended to implement this project, not only in cement kilns but also in other industries such as steel, aluminium, refractory or others where incineration takes place at $>1200^{\circ}$ C.

Contact Information of the plant

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Binani Cement Limited,
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CASE STUDY 4 :RICE HUSK AS ALTERNATIVE FUEL IN CEMENT KILN - LAFARGE INDIA PVT LTD, ARASMETA CEMENT PLANT

Project Implemented by : Lafarge India Pvt Ltd, Arasmeta Cement Plant

Project Implemented in : 2008

Company Details

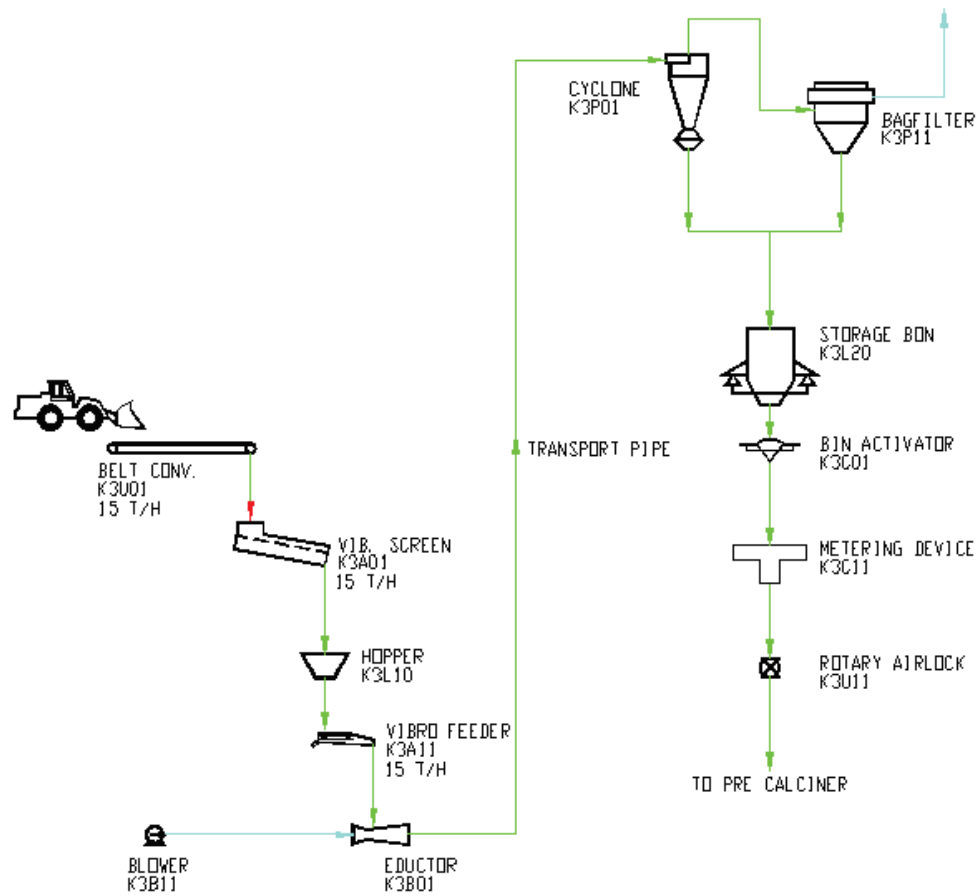
Lafarge Group, a Fortune 500 French giant, is a leader in construction. The group's Indian operations, Lafarge India Pvt. Ltd., started in November 1999, subsequent to the take-over of Tata Steel's Cement division. The company acquired a total capacity of 4 million tonnes of cement and after de-bottlenecking, currently, has a manufacturing capacity of 5 million tonnes of cement and 3 million tonnes of clinker. Two of its plants are located in Chhattisgarh and one Grinding Unit is located in Jharkhand. Lafarge India's operations include production and retailing of Portland Slag Cement, Ordinary Portland Cement and Portland Pozzolana Cement besides clinker and colour roofing products.

The company has a good social focus and some of its activities include providing training to unemployed youth, computer education for girls and computer-aided education for others, supporting the setting up of an eye care institute in Raipur. As part of its social initiatives Lafarge Group has launched a programme in India aiming to help provide affordable housing for the people belonging to the low-income group. In addition, Lafarge is also engaged in the rehabilitation of quarries that aid the near-by villages through water harvesting.

Project Details

Lafarge India Pvt Ltd has put up a system of firing Rice Husk as an alternative fuel for the Kiln to reduce Coal Consumption. The system comprises of a feeding system, a conveying system and a feeding system. This is a very effective way of disposing Risk Husk – an agricultural waste and is available in abundance in our region.





Results of the Project

Use of Rice husk substituted 5-8 % of coal used in kiln and PC firing. Reduction in CO₂ emission details as Mentioned below:

Actual	629	629	629	607	607	607	576	579	586
Planned	600	600	600	600	600	600	600	600	600
	Without rice husk in 2007						With rice husk in 2009		

Reduction in emissions of sulfur and other pollutants associated with the use of fossil fuels.

Replication Potential

Similar installations are possible in several cement plants, subjected to availability of rice in the same region.

Issues faced by the unit during the implementation of the project

Storage of high volume of rice husk is a problem as the bulk density of Rice Husk is very less and thus it occupies a big space for storage and in this process it gets contaminated with foreign materials and is exposed to moisture and thus creating a problem of flowability during feeding and firing. Thus Plant team has made many measures for safe storage of rice husk so that it does not get contaminated.

Recommendation to other units

Other cement plants are recommended to implement this project, subjected to availability of fly-ash.

Contact Information of the plant

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Arasmeta Cement Plant
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CASE STUDY 5 : USE OF PET COKE AND BIO-MASS AS ALTERNATE FUEL - MADRAS CEMENTS LIMITED, ALATHIYUR

Project Implemented by : Madras Cements Limited

Project Implemented in : 2008

Company Details

Madras Cements Ltd is the flag ship company of Ramco Group, a well known business group of South India. It is based at Chennai. The main product of the company is Portland Cement manufactured through the five advanced production facilities spread over South India. The cement capacity is 10.49 million tons per annum. The company is the fifth largest cement producer in the country. Ramco Super grade is the most popular cement brand in South India. The company also produces Ready Mix Concrete and Dry Mortar products. In addition, the company also operates one of the largest wind farms in the country.

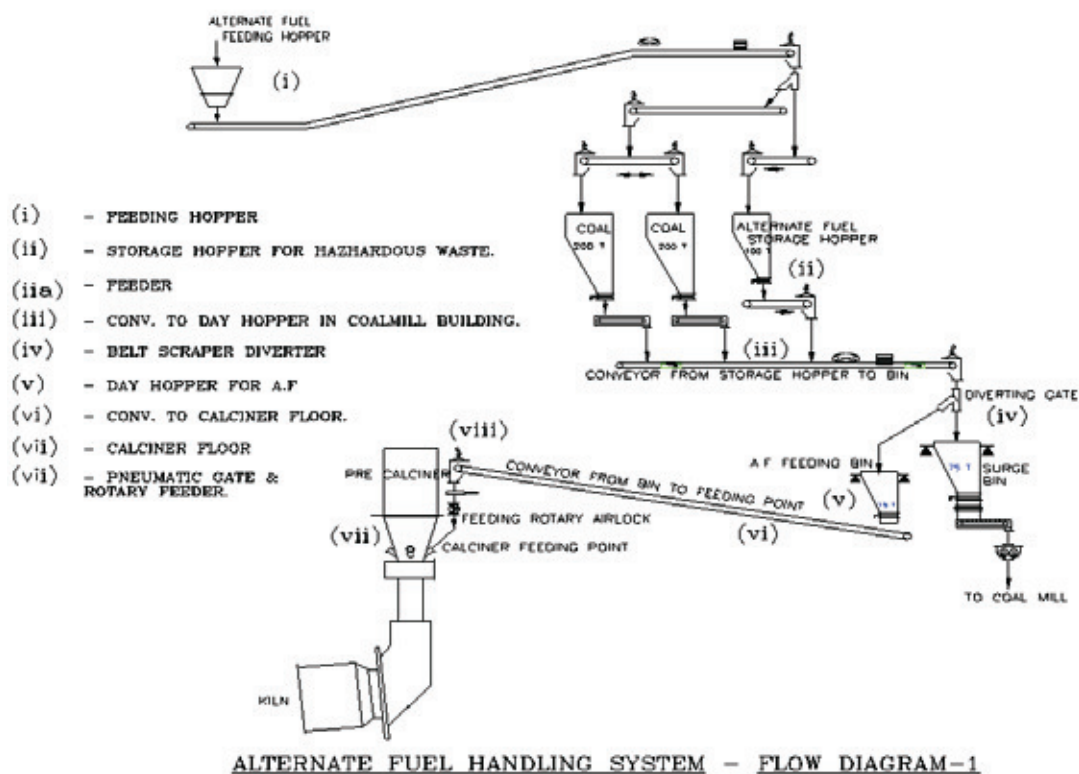
Project Details

Madras Cement Limited has set up a mechanized system for Alternative Fuel feeding in its cement works. The company burns various alternate fuels such as pet coke, coffee husk, cashew nut shell, ground nut shells, charcoal, and coal dust in their cement kilns

Process Description

Feeding Hopper is provided for alternate fuel feeding. Alternative fuel is extracted from hopper and is transported to storage hopper. From storage hopper, alternative fuel is extracted and fed to the calciner by belt conveyor through rotary air lock. Detailed process flow chart is given below:





Results of the Project

Implementation of this project resulted in following benefits Intangible Benefits:

- Conservation of Fossil Fuels
- Conservation of High Grade Limestone
- Reduction in GHG emission

Replacing the 1% of fossil fuels by alternate fuel reduces the GHG by 2.15 Kg CO₂/ MT of cement produced. Alternate fuel used in fuel mix is 5% reduced 28,734 MT CO₂/ Year

Tangible Benefits:

Average Pet Coke consumed is 81,154 MT / Year and Average alternate fuel consumed is 8,970 MT / Year.

1 Kg of Pet Coke equals 1.33 Kg of Coal.

1 Kg of Alternate Fuel equals 0.5 Kg of Coal.

Implementation of this project resulted in Rs 78.28 Million /year

Replication Potential

Similar installations are possible in several cement plants, subjected to availability in the same region. The substitution of Coal with Rice husk contributes to conserve the fossil fuel reserves

Issues faced by the unit during the implementation of the project

- Pet Coke has higher sulphur content; this causes the ring formation in the kiln. This problem was solved by adding the alkali to the kiln feed
- Carbon Monoxide (CO) formation was higher in the kiln inlet. This problem was rectified by grinding pet coke finer. The fixed carbon is higher in pet coke, so the residue in 90 micron is brought < 1%

Recommendation to other units

Other cement plants are recommended to implement this project.

Contact Information of the plant

Mr S.Shanmugam
Vice president (manufacturing)
Madras cements limited,
Alathiyur works,
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Sendurai taluk, Ariyalur distirct.
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CASE STUDY 6 : FIRING LOW SULPHUR HEAVY STOCK SLUDGE IN CEMENT KILN - THE INDIA CEMENTS LIMITED, DALAVOI

Project Implemented by : The India Cements Limited, Dalavoi

Project Implemented in : 2010

Company Details

The India Cements Ltd was established in 1946 and the first plant was setup at Sankarnagar in Tamilnadu in 1949. Since then it has grown in stature to seven plants spread across the states of Tamilnadu and Andhra Pradesh. The cement manufacturing capacity of ICL (as on March 2010) is about 14.05 MTPA. The Company is the largest producer of cement in South India

Project Details

ICL, Plant has 2 DG sets of capacity 12 MW. LSHS is used as fuel. Before supplying the fuel to engine, sludge is being separated by purifier and the sludge stored in sludge storage tank. This sludge is classified as hazardous waste and has a high heat value of more than 9000 kCal/kg. Hence, high calorific value sludge is used in kiln for firing.

For sludge, mobile tankers of 2 KL capacity are dedicated with electrical heater and tractor attachment provision in which sludge is transported from sludge storage tank to kiln firing. Before firing in the cement kilns, sludge is heated up to 80° C to transform the semisolid sludge to flow-able liquid. For attaining uniform flow of sludge, the sludge is initially re-circulated using the pump of 2500 LPM capacity. After ensuring that good flow of sludge is attained, this sludge is fired in pre-calciner inlet using the same pump.

Environmental benefits (tangible & intangible) achieved

1. Hazardous waste handling problems are minimized
2. Land Contamination and Water pollution may be avoided.
3. To avoid improper recycling method.
4. Hazardous waste utilized as fuel, hence conventional fuel is saved

Financing of the Project

The plant has invested about Rs. 75,000 for implementation of the project.

Results of the Project

Consumption of LSHS sludge is 29 T/ yearly, results savings of Rs 279,270/-

Replication Potential

Cement industries having diesel generator can adopt this system to utilize the sludge generated and the used oil for kiln firing.

Recommendation to other units

It is recommend to use the sludge generated and the used oil for kiln firing.

Contact Information of the plant

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CASE STUDY 7 : MANAGING DIVERSE ALTERNATE FUELS - ULTRATECH CEMENT LIMITED, GUJARAT CEMENT WORKS

Project Implemented by : UltraTech Cement Limited, Gujarat Cement works,

Project Implemented in : 2008

Company Details

UltraTech Cement Limited, a subsidiary of Grasim Industries Limited, a group company of Aditya Birla Group is a leading manufacturer of cement in India with installed capacity of about 17 Million Tonnes Per Annum (MTPA).

UltraTech's cement plants are located in Maharashtra (Awarpur), Chhattisgarh (Hirmi), Gujarat (Kovaya) and Andhra Pradesh (Tadpatri), NCCL (Jafarabad) with grinding units at Orissa (Jharsuguda), Tamil Nadu (Arakkonam), West Bengal (Durgapur), Gujarat (Magdalla) and Maharashtra (Ratnagiri). Grasim – UltraTech Cement combined is one of the largest cement producer in India having 21% of installed Indian cement manufacturing capacity & is the 8th largest cement producer in the world.

Project Details

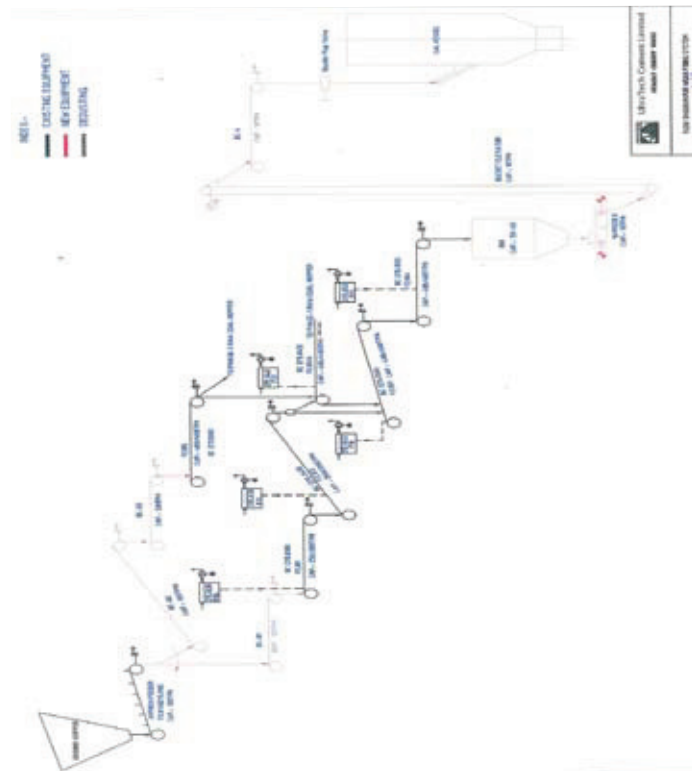
UltraTech Cement Limited, Gujarat Cement works (GCW) installed comprehensive system to feed alternative fuels in Calciner vessel.

Wastes such as tire chips, rubber dust, rice husk, processed municipal solid waste is fed to storage bin via ground hopper. These waste fuels will have calorific value in the range of 3000 to 3800 kCal/kg waste fuel. Alternative fuel or waste fuel will be dried, before firing to calciner vessel.

This system consists of

1. Separate belt conveyor system to carry alternative fuel in storage bin with capacity of 150 m³ and to feed Alternative fuel in calciner vessel.
2. Storage bin and weigh feeder below bin for controlled feeding of alternative fuel
3. Bucket elevator carries the waste fuel from weigh feeder discharge to feeding pan conveyor
4. Double air sluices gates at feed points avoid false air system





Issues faced during implementation

Following issues are faced during implementation of this project

1. Layout design & Erection of system, in running plant is big challenge
2. Jamming material at storage bin
3. Surges in the flow of lighter material

Financing of the Project

The plant has invested about Rs 200 Lakhs for implementation of the project.

Results of the Project

Reduction in CO₂ emission of 29,988 MT per annum is achieved.

Replication Potential

Replication potential is very high. This project can be implemented in other cement plants, where coal is fired. 7 cement plants from UltraTech group have implemented this project.

Recommendation to other units

It is recommend to try this project in other cement plants, wherever it is applicable.

Contact Information of the plant

Mr. K.Y. P Kulkarni

Senior Executive president & Unit Head

UltraTech Cement limited

Gujarat Cement works

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Gujarat

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CASE STUDY 8 : LIQUID INDUSTRIAL ORGANIC SOLVENT AS ALTERNATE FUEL - ULTRATECH CEMENT LIMITED, TADIPATRI

Project Implemented by : UltraTech Cement Limited, Tadipatri

Project Implemented in : 2007

Company Details

UltraTech Cement Limited, a subsidiary of Grasim Industries Limited, a group company of Aditya Birla Group is a leading manufacturer of cement in India with installed capacity of about 17 Million Tonnes Per Annum (MTPA).

UltraTech's cement plants are located in Maharashtra (Awarpur), Chhattisgarh (Hirmi), Gujarat (Kovaya) and Andhra Pradesh (Tadipatri), NCCL (Jafarabad) with grinding units at Orissa (Jharsuguda), TamilNadu (Arakkonam), West Bengal (Durgapur), Gujarat (Magdalla) and Maharashtra (Ratnagiri). Grasim – UltraTech Cement combined is one of the largest cement producer in India having 21% of installed Indian cement manufacturing capacity & is the 8th largest cement producer in the world.

Project Details

APCW has established a comprehensive system for usage of waste as Alternate Fuel in its process. It uses pharmaceutical waste (both solid and liquid) as alternate fuel. It also uses various other wastes such as paint sludge, spent carbon, Dicomol powder, cotton waste, ETP sludge, organic solvent.

APCW has installed 45 KL capacity tank at Line-1 and temporary truck tanker of capacity 20 KL in Line-2 for storage of Liquid Organic Solvent, which is a Pharma waste used as alternate fuel. Presently, the unit is using the Liquid Organic Solvent as a fossil fuel up to 3%. The target is to use this pharma waste up to 5%, which effectively replaces the conventional fossil fuel.

Issues faced during implementation

Handling of hazardous material is always an issue. With the help of supplier, the technical know-how was developed, necessary safety precautions have been taken for safer operation.



Financing of the Project

The plant has invested about Rs 1.0 Crores for implementation of the project. This investment is for conveying and handling equipment.

Results of the Project

APCW is replacing fossil fuel with alternative fuels in the range of 5-10 %. 1% replacement of fossil fuel (on thermal basis) with bio mass or alternate fuel can save 1.85 kg CO₂ /MT of clinker.

- Usage of alternate fuel substitutes coal consumption
- Found to be environmental friendly since it supports sustainable development
- Reduced CO₂ emissions of carbon foot print
- The variable cost of manufacturing is reduced

Replication Potential

Replication potential is very high. Cement plants can install alternative fuel handling system, depending on availability of alternative fuel.

Recommendation to other units

All cement plants are recommended to install alternative fuel handling system.

Contact Information of the plant

Mr P S Radha Krishna

UltraTech Cement Limited

APCW, Bhogasamudram, Tadipatri

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Email : radhakrishna.ps@adityabirla.com

CASE STUDY 9 : EXPERIENCES OF CO-PROCESSING HAZARDOUS WASTE FUELS - ULTRATECH CEMENT LIMITED, REDDIPALAYAM CEMENT WORKS

Project Implemented by : UltraTech Cement Limited, Reddipalayam Cement works

Project Implemented in : 2007

Company Details

UltraTech Cement Limited, a subsidiary of Grasim Industries Limited, a group company of Aditya Birla Group is a leading manufacturer of cement in India with installed capacity of about 17 Million Tonnes Per Annum (MTPA).

UltraTech's cement plants are located in Maharashtra (Awarpur), Chhattisgarh (Hirmi), Gujarat (Kovaya) and Andhra Pradesh (Tadpatri), NCCL (Jafarabad) with grinding units at Orissa (Jharsuguda), TamilNadu (Arakkonam), West Bengal (Durgapur), Gujarat (Magdalla) and Maharashtra (Ratnagiri). Grasim – UltraTech Cement combined is one of the largest cement producer in India having 21% of installed Indian cement manufacturing capacity & is the 8th largest cement producer in the world.

Project Details

UltraTech Cement Limited, Reddipalayam Cement works set up a system for usage of waste as Alternate Fuel in its process. The concept of utilization of waste fuels is conceived because of huge availability of alternate fuels throughout the country which otherwise is being dumped as land-filling, burning in unauthorized & unorganized way thereby creating high level of pollution in atmosphere & water. Hazardous wastes when dumped for land filling also contaminate soil.

Detailed discussions took place between representatives of KHD (OEM) & technical experts of Reddipalayam Cement Works at Corporate and Unit level. Various process & consideration of using waste fuel, its impact on operation, quality of product and emission level was deliberated at length and finally the scheme was finalized. The layout and storage of alternate fuel was finalized based on long-term planning and also considering aesthetic look of the plant. The scheme was derived based on the availability of agro-wastes & Industrial Waste like tyre chips, municipal waste, paint sludge etc in surrounding area.



Plastic shredding machine & Wood chipping machine has been installed also. With the help of this machine Reddipalayam Cement Works were able to dispose hazardous plastics and waste wood in to kiln by combustion process.

Issues faced during implementation

Since various alternate fuels have different chemical composition and characteristics like ash %, alkalis content and harmful metals / chemicals etc., it was required to adjust the chemistry of other inputs to maintain consistent quality in the output. It was a challenge to Quality Control team, which they could deliver with their in-house research. Since there was no impact on the quality, the customers were not affected.

The main hindrances in the project were the mind-set of operating personnel and the regulatory authorities. Change in Mind-set is a slow process and it has taken a long run for us to reach this level. The extensive efforts were put in for creating awareness among Regulatory authorities and other Government bodies. To take up the matter with State & Central Pollution Control Boards for obtaining their clearance for usage of the same, which was a major challenge.

Exploring the availability of different types of alternate fuels, their trial runs and subsequently plant scale trials and do process and raw material changes. Raw mix chemistry requires suitable modification to take care of absorption of ash generated & cycling of volatiles such as sulphur, alkalies & chlorides. Fuel size requires reduction to acceptable levels to ensure complete combustion in the calciner itself. Modification of material handling systems to ensure continuous & free flow of fuel to calciner.

Preparation of special storage yard with concrete flooring, concrete walls on all 3 sides & roof to prevent pollution of air, water & land.

Financing of the Project

The plant has invested about 2.5 Crores for implementation of the project. This investment is for conveying, handling equipment and storage facilities



Results of the Project

- Conservation of natural resources
- Prevents resource depletion of nonrenewable fossil fuels and hence increases life of mines
- Lowers the emissions of green house gases by replacing the use of fossil fuels thereby eligibility for carbon trading
- Maximizes energy recovery - All the available energy is used directly in the kiln for clinker production
- Eliminates the need for disposal of inorganic ashes from incinerator as it acts as a substitute to raw material in the cement kiln and completely absorbed in the cement without any adverse effect

Replication Potential

Replication potential is very high. Cement plants can install alternative fuel handling system, depending on availability of alternative fuel

Recommendation to other units

All cement plants are recommended to install alternative fuel handling system.

Contact Information of the plant

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CASE STUDY 10 : UTILIZING HAZARDOUS WASTE OIL AS ALTERNATE FUEL - VASAVADATTA CEMENT, SEDAM

Project Implemented by : Vasavadatta Cement, Sedam

Project Implemented in : 2008

Company Details

Vasavadatta Cement (VC) is a premier cement manufacturing unit founded in the year 1983. VC is product of BK Birla Group of Companies, Vasavadatta is an ISO 9001 Company. Vasavadatta Cement is producing Vasavadatta-43, Vasavadatta -53 and Birla Shakti (PPC) brand of Cement.

Project Details

Good amount of lubricating oil and grease is used in T.Gs, gear boxes etc at various machineries in cement plant. Thus producing used oil and grease as a waste/used material from the vehicular as well as from the machineries with in the industry



In VC, High performance MOx additive oils are used in critical gear boxes for longer life of oil. Waste oil and Grease is collected in barrels and stored at Hazardous waste storage platform (impervious) with compound wall and tin shed and collected grease is sold to authorized reprocessors and waste oil is burnt in the Kiln. VC had obtained permission/authorization for burning of waste oil in kiln.

Sr.No.	Calendar year	HW Category	Opening Balance (Tonne)	HW Generation, collection and Storage (Tonne)	Disposal or sold (Tonne)	Burnt in kiln (Tonne)	Closing Balance (Tonne)
1	2009	5.1 & 5.2	0	89.87	73.15	6.27	10.45
2	2010 as on Sept'10	5.1 & 3.3	10.45	62.89	27.55	34.58	11.21



Arrangement of Burning of waste oil system in Kiln

The waste oil so collected in barrels is transferred to waste oil day tank of capacity approximate 1000 lit situated at Kiln-1 area and for lifting of oil pump is provided. Waste oil firing nozzle of 6 mm size is put in burner pipe in addition to the coal firing oil is pumped through burner pipeline.

By utilizing this waste we can conserve natural fossil fuel (coal) to the extent, of heat available in used oil.

Capacity of waste oil burning is approximately 400 liters per hour (avg.) resulted in saving of coal approximately 2.5-3.0 tons per hour.



Issues faced during implementation

Waste oil produced is mixed oil with different viscosity in nature. Due to change in viscosity the following problems were faced:

1. The malfunctioning of pump
2. Due to high viscosity incomplete combustion of waste oil in the kiln.

To solve this problem waste oil with higher viscosity in nature is heated before pumping, so that, frees flow and no choking of pump and burner pipe.

Financing of the Project

The plant has invested about Rs 4.0 Lakhs for implementation of the project. This investment is for conveying, handling equipments and storage facilities. Implementation of project will result in Rs 2.8 Lakhs with payback period of 18 months

Results of the Project

- Reduction in cost & risk of disposal of waste oil (hazardous waste in nature)
- Decreasing in recycling of waste oil

Replication Potential

Replication potential is very high. Similar project is possible in several cement industries or in other areas where high temperature (1200 degrees) heating is required.

Burning of 1 lit of waste oil results in saving of 7.5 kgs of coal.

Recommendation to other units

All cement plants are recommended to install alternative fuel handling system.

Contact Information of the plant

Mr C K Jain,
Joint President (Engg & PP),
M/s VASAVADATTA CEMENT, Sedam – 585 222
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Email : c.k.jain@vasavadattacement.com

CASE STUDY 11: UTILIZING MUNICIPAL SOLID WASTE AS ALTERNATE FUEL - GRASIM INDUSTRIES LTD., VIKRAM CEMENT

Project Implemented by : Grasim Industries Ltd, Vikram Cement

Project Implemented in : 2007

Company Details

UltraTech Cement Limited, a subsidiary of Grasim Industries Limited, a group company of Aditya Birla Group is a leading manufacturer of cement in India with installed capacity of about 17 Million Tonnes Per Annum (MTPA).

UltraTech's cement plants are located in Maharashtra (Awarpur), Chhattisgarh (Hirmi), Gujarat (Kovaya) and Andhra Pradesh (Tadpatri), NCCL (Jafarabad) with grinding units at Orissa (Jharsuguda), TamilNadu (Arakkonam), West Bengal (Durgapur), Gujarat (Magdalla) and Maharashtra (Ratnagiri). Grasim – UltraTech Cement combined is one of the largest cement producer in India having 21% of installed Indian cement manufacturing capacity & is the 8th largest cement producer in the world.

Group Vision

To be a premium global conglomerate with a clear focus on each business

Project Details

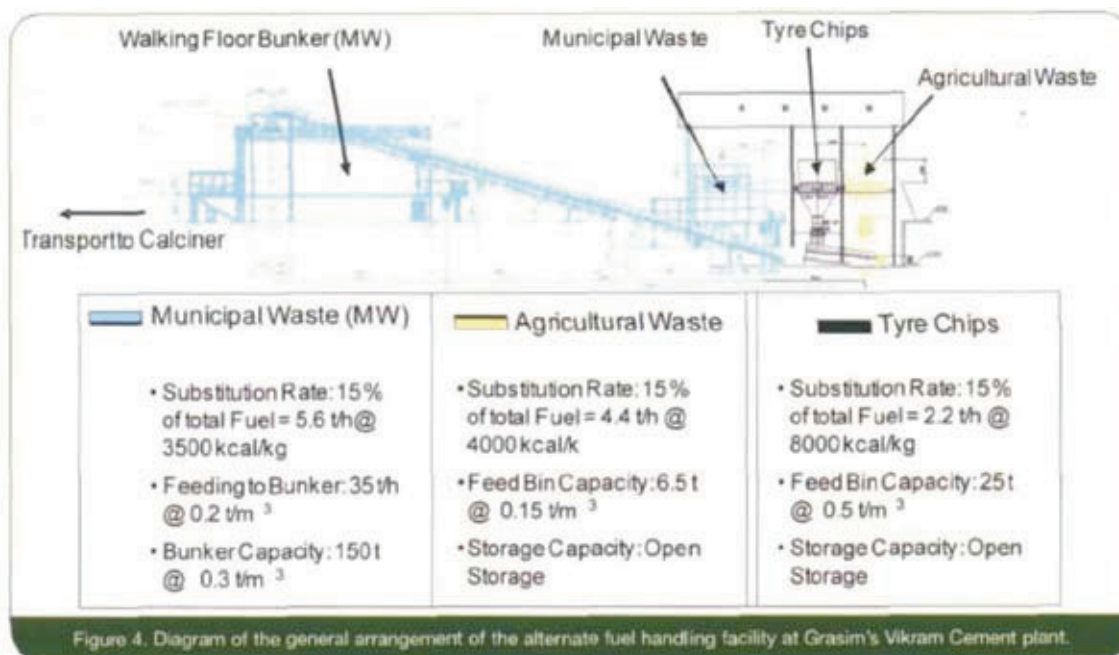
Vikram Cement has installed a comprehensive waste management system at its facility comprising of unloading, storage, dosing and feeding system for municipal waste, agricultural waste and tyre chips. To avoid environmental problems during storage and handling of municipal waste, a special storage silo with walking floor extraction and a closed belt conveyor system is installed. The feeding and substitution capacity of the facility is designed to replace 15 per cent of the total heat consumption of the system by municipal waste, tyre chips or agricultural waste. The waste derived fuel (WDF) compounds are stored and dosed according to their physical properties.

The walking floor extraction system consists of storage-cum-feed silo with an active bottom discharge designed for a continuous operation of 24 hrs/day with minimum maintenance requirements. The material transport takes place at a pre-determined volumetric or gravimetric rate and the move-



ment is actuated by hydraulic cylinders. The sensor located in the surge hopper senses the proper filling of the surge hopper. The feeding occurs through a set of two chain conveyors that distribute the material across the silo. Discharge is through a rotary feeder. Table indicates a summary of the waste fuels being handled by the system.

Table : Summary of waste fuels handled by this system				
Sr. No.	Specifications	Waste derived fuel		
1	Material	Shredded tyre chips	Municipal waste	Agro waste (soya husk, rice husk, ground nut shell)
2	Size (mm)	30-50	0-50	30-75
3	Bulk density (t/m ³)	0.25-0.50	0.15-0.25	0.10-0.15
4	Moisture (1%)	3	10-12	5-10
5	Calorific value (kCal/kg)	8000	3000-3500	4000



Results of the Project

Reduction in cost & risk of disposal of hazardous waste in nature



Replication Potential

Replication potential is very high. Similar project is possible in several cement industries or in other areas where high temperature (1200 degrees) heating is required.

Recommendation to other units

All cement plants are recommended to install alternative fuel handling system.

Contact Information of the plant

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Vikram Cement Work,
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Phone : 07420 - 235568
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CASE STUDY 12: EXPERIENCES OF UTILIZING DIVERSE WASTE AS ALTERNATE FUEL - ACC LTD., LAKHERI CEMENT WORKS

Project Implemented by : ACC Ltd, Lakheri Cement Works

Project Implemented in : 2009

Company Details

ACC Limited is India's foremost manufacturer of cement and concrete. ACC's operations are spread throughout the country with 16 modern cement factories, more than 40 Ready mix concrete plants.

Since inception in 1936, the company has been a trendsetter and important benchmark for the cement industry in many areas of cement and concrete technology. ACC has a unique track record of innovative research, product development and specialized consultancy services. The company's various manufacturing units are backed by a central technology support services centre - the only one of its kind in the Indian cement industry. Lakheri Cement Works is one of cement plants in ACC Group. This is located at Lakheri, Bundi, Rajasthan.

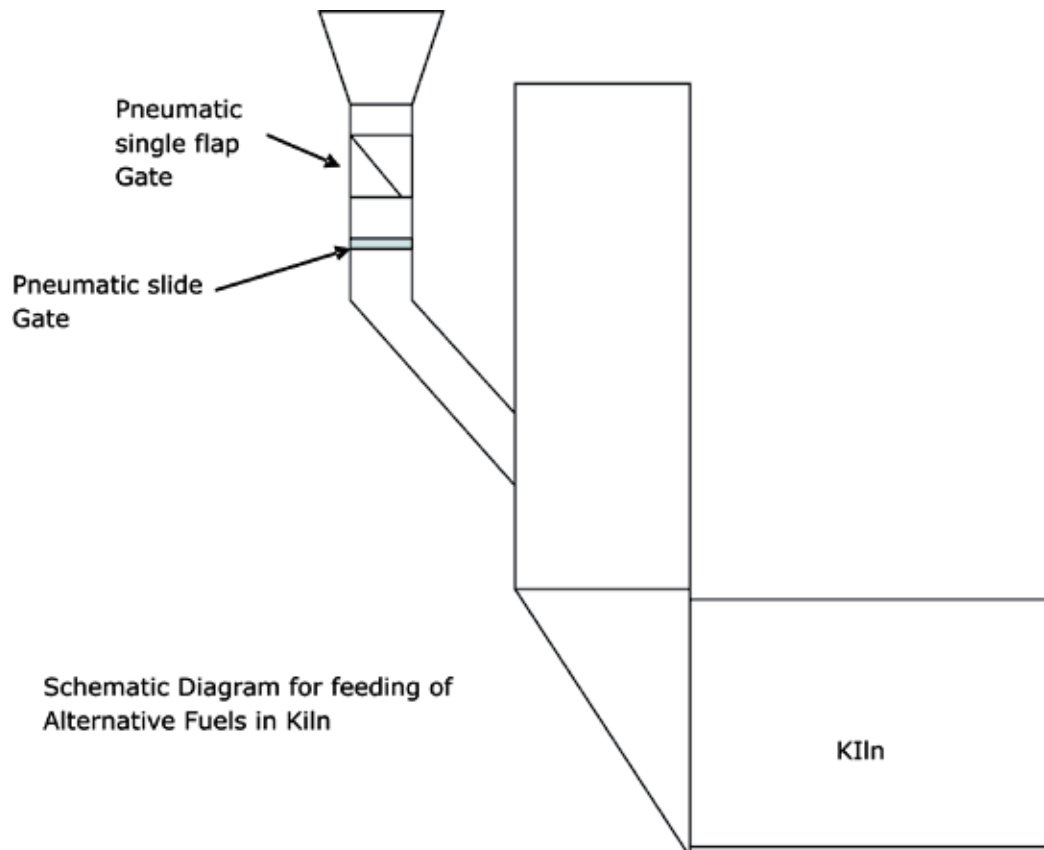
Project Details

ACC Ltd, Lakheri Cement works, burning waste as alternative fuel in their rotary kiln. List of wastes are being burnt is summarized in table below.

No	Type of Waste Fuel used	Quantity of waste fuel used (Tons or any other Eq Unit)	Equivalent of Conventional energy used (kWh of electricity or Ton / kL of fuel)	Waste fuel as % of total energy
1	Soya bean Waste	3	2	0.017
2	Saw dust	174	88	0.74
3	Mustard Husk	721	412	3.45
4	Scrap tyre cutting	207.27	368	3.08
5	Animal Waste	21	9	0.075
6	Nevia Waste products	71.26	46	0.385
7	ETP bio solid sludge	41.15	13	0.11
8	White Coal	27.9	19	0.16
9	MSW	0.3	0.08	-
	Total AFR	1266.88	957	8.01



Following arrangement has been made to feed the various Alternative fuels in kiln to ensure maximum co-processing of waste fuel/ material directly into kiln.



Issues faced during implementation

While selecting the waste, Lakheri Cement Works has ensured various aspects of related with occupational health & safety.

1. Refuse the listed “banned wastes”
2. Guarantee the quality of our products

Feasibility study by AFR team was done; to study following aspects :

1. Know the potentials and limits of the kiln for co-processing Technical AFR assessment
2. Co-processing needs full control & legal compliance Baseline emission and Trial Burn
3. Waste fuel is not allowed to enter the plant without Quality checking
4. Waste sample analysis, co-processing plan & Finger print analysis
5. Use AFR Standard Equipment for storage, handling, and dosing

Financing of the Project

The plant has invested about Rs 85.00 Lakhs for implementation of the project. This investment is for conveying, handling equipments and storage facilities. Implementation of project will result in annual savings of Rs 19.00 Lakhs with payback period of 4 years

Results of the Project

Following environmental benefits associated with implementation of this project

- Reduction in CO₂/GHG emissions
- Safe and optimal waste disposal
- Reduction in consumption of natural materials
- Reduction in overall emissions
- Effective contribution to waste management at local / regional levels
- Regional job creation in waste collection and pretreatment etc.
- Saving of public funds in building alternative infrastructure
- Substitution of Fossil fuels or natural raw materials
- Income from co-processing service



Replication Potential

Replication potential is very high. Similar project is possible in several cement industries. At present, uses of alternative fuel in cement kiln is the key issue/ target for cement sectors and many cement companies are co-processing the waste in cement kiln.

Recommendation to other units

All cement plants are recommended to install alternative fuel handling system.

Contact Information of the plant

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CASE STUDY 13: DISPOSING INDUSTRIAL ORGANIC RESIDUE AS ALTERNATE FUEL IN CEMENT KILN - DR. REDDY'S LABORATORIES, HYDERABAD

Project Implemented by : Dr. Reddy's Laboratories, Hyderabad

Project Implemented in : M/s Ultra Tech Cement, Tadipatri,

Project Implemented in : 2007

Company Details

Dr. Reddy's Laboratories established in 1984, The Company is an emerging global pharmaceutical company. As a fully integrated sustainable organization that simultaneously pursues economic, social and environmental benefits & their purpose is to provide affordable and innovative medicines through their three core businesses:

Pharmaceutical Services and Active Ingredients, comprising our Active Pharmaceuticals and Custom Pharmaceuticals businesses, Global Generics, which includes branded and unbranded generics; and proprietary products, which includes New Chemical Entities (NCEs), Differentiated Formulations, and Generic Bio-pharmaceuticals.

Background of the Project

The API (Active Pharmaceutical Ingredients) manufacturing process generates high calorific value organic residue, mostly from the solvent distillation process. These wastes were earlier disposed either through site incineration or sent to TSD for incineration. The opportunity of consumption of high calorific value wastes such as sludge from petrochemical plant; spent solvent residue from pesticide plant in cement industry as alternate fuel was thereby explored.

The waste generated at the Dr Reddy's API plants had a calorific value equivalent to the other waste already used in cement kiln; hence an effort was initiated to look at the possibilities of utilization as alternate fuel, by Co processing waste residue material as a source of energy, to minimize use of fossil fuels at cement plants.



Although there were some restrictions and uncertainties in types and quantities of wastes that could be used as fuels in cement plants, this form of disposal was found to be cost effective, with less environmental impact as compared to conventional disposal methods such as land fill and incineration.

Project Details

All high calorific value residue and its physical states were quantified and four streams of waste in liquid state identified which could be used as alternate fuel. The first batch of residue was sent to the cement plant for a trial that proved very successful. In the mean time visits were made to the cement plant to understand the process thoroughly.

As a consequence the possibility of pumping the liquid residue to the kiln from the top was identified and successfully tested out by installation of two pumps as in the schematic system of firing below.

Residue Collection

A total of 2395 MT (10.3% of total waste) of waste was sent to the cement plant in the FY 09-10.

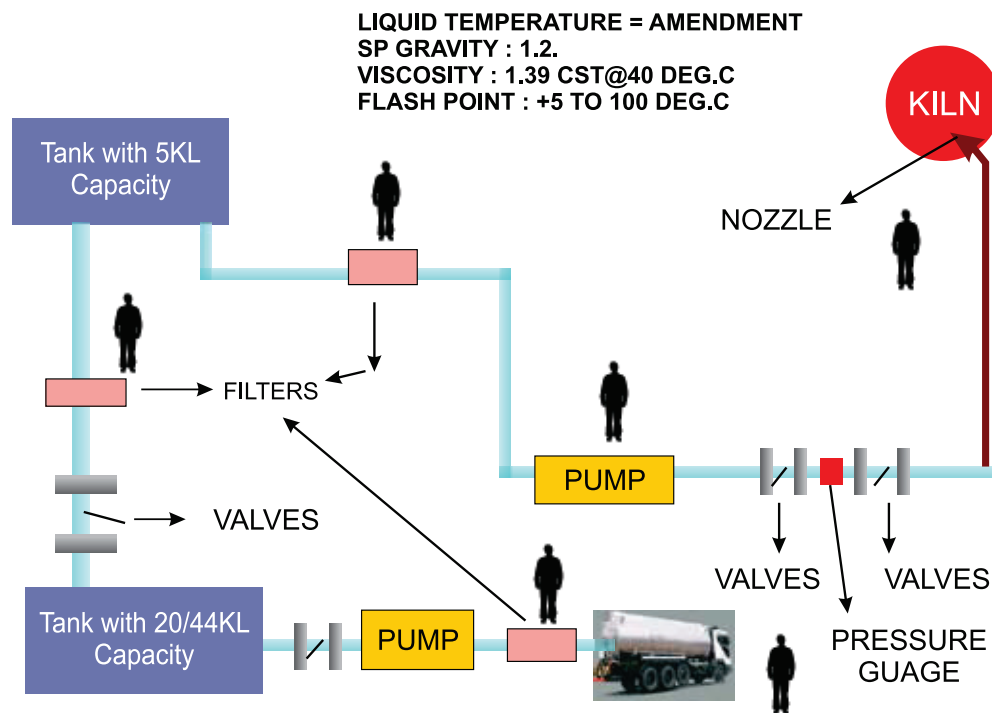


Figure : A facility to simultaneously mix 4 different streams of waste to make a homogeneous solution was created as in the visuals below:

Issues faced during implementation

- Organic residue generated from process & distillation had high specific gravity and was both difficult to transfer and segregate. Based on practical experience in the mixing sumps a specific gravity in the range 1.0 to 1.2 was maintained to ensure the ease of material pumping. Awareness was created amongst all employees handling this distillation process to ensure the material parameters to ensure proper flow.



- A comprehensive Risk Analysis by competent personnel was conducted to minimize the potential hazards during transportation and handling as also safety re-enforcement at the cement industry while handling waste organic residue to ensure safety at each stage.
- Continual awareness was ensured through continuous feedback on residue handling, storage and transfer from the co-process provider and the cement industries. The same learning's were also communicated to all production personnel at site to strengthen the procedures and systems. DRL believes that complete ownership is required at all stages and from every individual to handle; store and transfer residue smoothly with any safety compromise.

Savings

- Reduction of GHG emission = 1185 MT/Annum of CO₂
- 527 MT/Annum of coal savings at cement plant
- Reduced Organic waste disposal cost by 50%

Results of the Project

- Diversion of 2395 MT waste to cement industry for use as alternate fuel
- Reduction of GHG emission to the tune of 1185 MT/Annum of CO₂ e and about 527 MT/Annum of coal savings at cement plant.*.
- Reduced Organic waste disposal cost by 50%.

*Average Calorific value considered for coal and hazardous waste is 5076 kCal/Kg and 6200 kCal/Kg, based on CV 1 kg of Hazardous waste gives energy equivalent to 1.22kg of coal.

Replication Potential

Replication potential is very high. Cement plants can install alternative fuel handling system, depending on availability of alternative fuel.

Recommendation to other units

All cement plants are recommended to install alternative fuel handling system.

Contact Information of the plant

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CASE STUDY 14: EFFECTIVE UTILIZATION OF RED MUD AS ALTERNATE RAW MATERIAL - DALMIA CEMENT (BHARAT) LIMITED

Project Implemented by : Dalmia Cement (Bharat) Limited

Project Implemented in : 2009

Company Details

Dalmia Cement (Bharat) Limited founded in 1935 by Jaidayal Dalmia. The cement division of DCBL was established in 1939 and enjoys a heritage of 70 years of expertise and experience. The Company is headquartered in New Delhi with cement, sugar, travel agency, magnesite, refractory and electronic operations spread across the country.

The Dalmia Group had established four cement plants in pre-independence years, two of which were affected by the partition and Independence. The two remaining plants operate as Dalmia Cement and we have also made strategic investment in Orissa Cements Limited (OCL). It is Managed by a professional team, have sustained the path to innovation and growth for seven decades.

Project Details

Limestone, bauxite and Iron ore are used to manufacture clinker. Cost of Additive (Bauxite) is high resulting high cost of clinker production. Plant team explored feasibility for using industrial waste to compensate costly additives preferably to suit high sulphur fuel.

Dalmia team identified Red Mud as alternative Raw material which contains rich alkali which will subside the impacts of excess sulphur. Red Mud is an industrial waste from Malco, an Aluminium manufacturing unit contains 7 % of alkalis which has the great potential to balance the excess SO_3 that enters the system through LS and High sulphur fuel.

New raw mix with red mud and high sulphur fuel was so designed that Bauxite use was totally eliminated. Following benefits are associated with the help of red mud at Dalmia cement.

- Raw mix cost is reduced by Rs 10/MT, since the Red mud cost is half that of bauxite
- The silica of the Red mud was lower than that of LS, and eliminating the high silica bauxite was desirable for Limestone used at the plant



- Red Mud could increase the alkali content by 0.28% in raw mix
- The Titania contained in the Bauxite was supposed to produce clinker with less hydraulic properties and thus resulting in long setting cement. By eliminating the usage of bauxite, the Titania intake to the clinker is reduced and the opportunity to produce high hydraulic clinker opened up

The clinker produced before the trial, during red-mud trial and during the red mud /pet coke combo trials were collected and tested in the laboratory for the product characteristics.

The hydraulic property of the clinker has improved drastically. The 1Day strength has increased by 4MPa, the 3 day strength by 11 MPa, and the 7day strength by 6MPa i.e., the elevation of strength was in the range of 18%, 25% and 11% for 1day, 3days and 7days respectively.

This improvement in hydraulic properties is achieved because of the alkali sulphates formed by the combination of SO_3 in Pet coke/LS with Na_2O contained in red mud. These alkali sulphates have a unique property to accelerate the hydration of di-silicates and tri-silicates of cement to gear up the overall strength of resultant cement.

These minor constituents when present in clinker, can activate the pozzolanic properties of fly ash or hydraulic properties of slag, giving the freedom to increase their percentage in cement. The increased amount of Portlandite generated in the hydration of C_3S will be available for pozzolanic activity at an earlier age itself to give high early strength, a very desirable property of PPC.

Parameter	Blank before trial	Trial with Red mud	Trial with red mud/Pet-coke combo
SiO ₂ , %	21.91	21.90	21.89
Al ₂ O ₃ , %	5.12	5.08	5.04
Fe ₂ O ₃ , %	4.82	4.62	4.79
CaO, %	65.31	64.99	65.03
MgO, %	1.08	1.07	1.07
SO ₃ , %	0.43	0.62	0.72
Na ₂ O, %	0.41	0.58	0.62
K ₂ O, %	0.2	0.42	0.38
F.CaO, %	1.52	1.53	1.50
LSF	0.92	0.92	0.92
SM	2.20	2.26	2.23
AM	1.06	1.10	1.05
C3S	50.60	49.35	49.45
C2S	24.65	25.57	25.46
C3A	5.41	5.65	5.25
C4AF	14.67	14.06	14.58
Liquid, %	28.04	28.05	28.41

Red Mud/Pet coke Trials

Parameter	Blank before trial	Trial with Red mud	Trial with red mud/Pet-coke combo
1 Day, MPa	22.10	24.00	26.00
3 Days, MPa	43.90	50.70	55.00
7 Days, MPa	55.00	60.00	61.70
28 Days, MPa	70.50	68.00	64.00

The excellence is also exhibited in the production of green products at Kadapa unit of Dalmia Cement, because huge quantity of red mud an industrial waste, alkaline in nature which does not support growth of vegetation and that which might make the area of storage and around barren, is productively eliminated.

The micro-fine particles, which might fly in the air around the storage area and can cause serious bronchus & skin problems to human beings and animals is very productively accommodated in our raw meal with comparatively lower raw grinding energy and cost. The usage of this waste in our process instead of bauxite saves the latter from getting depleted and conserves it for future generation.

The pollutant waste is fine in nature and hence the raw grinding energy has to come down at least by 4%. The alkali contained in the Red mud is established as the best flux, modify the viscosity of the melt favorably and saves heat energy at least by 5 kCal/kg of clinker.

Since the alkali sulphates can activate the pozzolana and since the hydraulic property of the clinker is superior, we can elevate the cement clinker ratio and reduce the carbon factor/MT of cement.



Red Mud in Stockyard

Issues faced during the implementation of the project

- High Moisture presence in the material causes jamming of Hoppers and weigh feeder chutes which were addressed by using Air Blasters
- Initially unloading problem occurred at truck tippler due to high moisture
- Requested the supplier to load sun dry material and problem was solved

Financing of the Project

Using of Red Mud will result in annual savings of Rs 3.00 Crores annum

Results of the Project

- Large quantity of waste of Malco was used in our cement process as an alternative raw material
- Avoided usage of 100 % Bauxite
- Red mud is in fine in nature which reduces our raw mill power consumption and increases the liquid content in kiln results in saving of heat energy 5 kCal/ kg of clinker

Replication Potential

Similar project can be implemented in all cement plants in India

Recommendation to other units

It is recommended to use Red mud as alternative raw material instead of Bauxite.

Contact Information of the plant

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CASE STUDY 15: JOURNEY TOWARDS ZERO FUEL COST - ACC LTD., MADUKKARAI CEMENT WORKS

Project Implemented by : ACC Ltd, Madukkarai Cement works

Project Implemented in : 2007

Company Details

ACC Limited is India's foremost manufacturer of cement and concrete. ACC's operations are spread throughout the country with 16 modern cement factories, more than 40 Ready mix concrete plants.

Since inception in 1936, the company has been a trendsetter and important benchmark for the cement industry in many areas of cement and concrete technology. ACC has a unique track record of innovative research, product development and specialized consultancy services. The company's various manufacturing units are backed by a central technology support services centre - the only one of its kind in the Indian cement industry.

Madukkarai Cement Works is one of cement plants in ACC Group. This is located at Palghat main road, Madukkarai.

Project Details

The Project Zero Fuel Cost was launched at ACC Madukkarai Cement works in the month of December'09, when the Thermal Substitution rate (TSR) was 0.91%. TSR is increased from 0.91 to 3.41% after taking many initiatives in use of alternative fuels.

Mission: To achieve zero fuel cost at Madukkarai Cement works by sustained usage of Alternative Fuels and raw materials (Industrial waste and MSW) without compromising cement quality, environment and OH&S.

Process Description

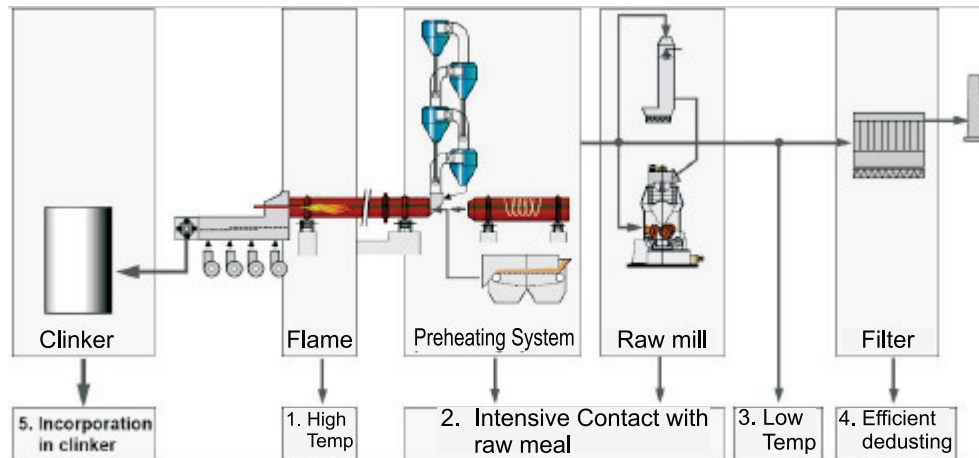
Madukkarai Cement works uses waste from textile, rejected shampoos, rejected face powder, plastic.

Received Waste materials are stored in storage shed. Dump hopper is provided near storage shed. Waste material is fed to dump hopper by means of dozer. Waste fuel is extracted from dump hopper and is transported Precalciner with help of belt conveyor. Waste fuel is fired in kiln riser duct also.

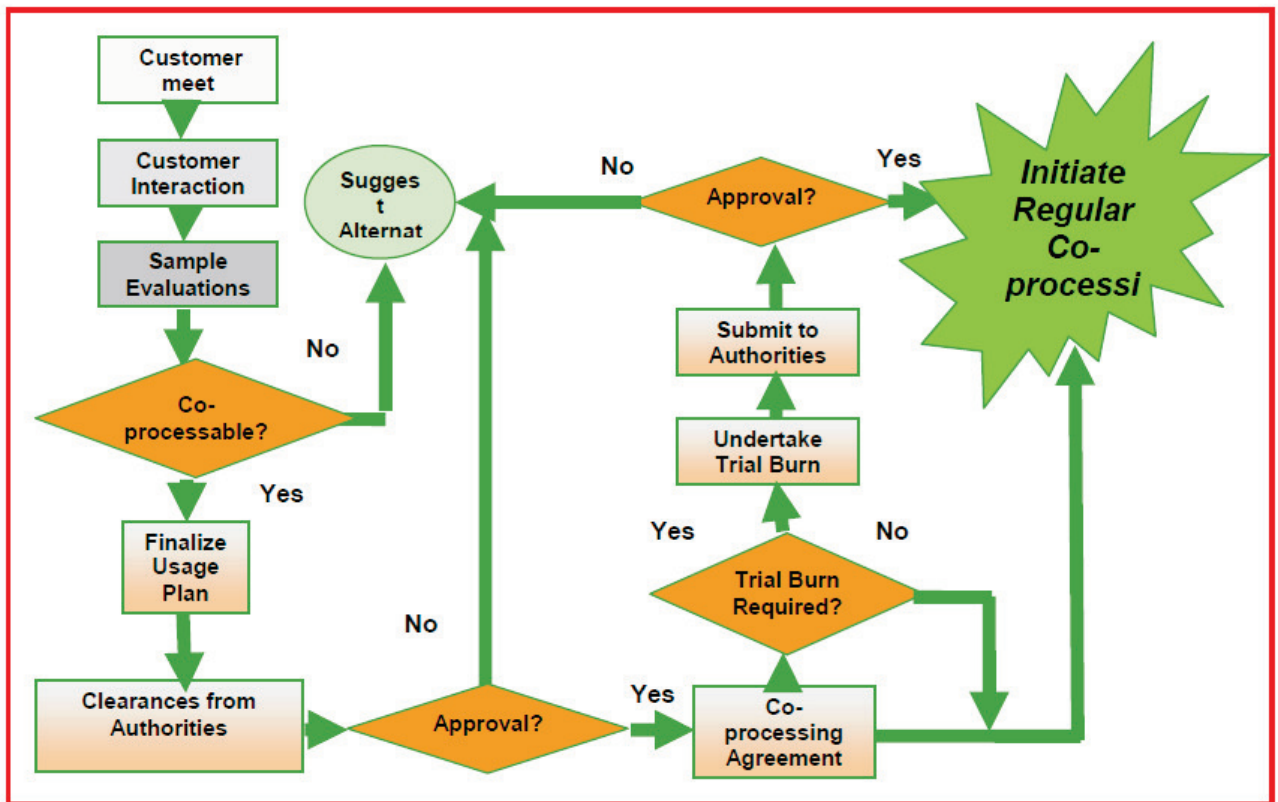


Some of proactive practices and procedures followed at Madukkarai Works for co-processing of Industrial Wastes are summarized below

- Minimal emissions from AFR are ensured by strictly observing the some principles., which are distilled from Holcim’s two decades of experience.
- No Industrial Wastes will be fed via the “cold end” (raw mill or kiln feed) of the kiln system where the temperatures are not adequate for destruction. The concentration of volatile Heavy Metals (Hg, Tl, Cd) and input of other heavy metals are limited in the AFR by determining the adequate feed rates by Fuel Mix Optimizer model
- The negative impacts of co-processing the Industrial Wastes in kiln on clinker, cement and concrete quality are checked by:
 1. Carefully watching and counteracting if the sulphurization degree in clinker becomes too low by an increased sulfur volatilization
 2. Strictly limiting the input of water of each AFR to avoid production loss
 3. Strictly observing the limits for kiln feed fineness to avoid a degradation of clinker burnability and clinker variability
 4. Avoiding reducing conditions in the kiln, by feeding the Industrial Wastes in calciner where the velocity of hot gases is high. This ensures that the waste is destroyed due to greater turbulence and higher residence time in the calciner
 5. Strictly limiting the input of some critical minor elements such as P₂O₅ which affects the setting time of cement



The following procedures are followed prior to acceptance of the Industrial Wastes from WASTE GENERATORS:



Waste Profile Details:

Contamination (with water, dirt, other materials) in the material is risk from the Industrial Wastes. Precautions for handling and storage including required personnel protective equipment and requirement for transportation were understood and the MSDS are being provided to ACC by the waste generators.

AFR Technical Assessment:

Thermal characteristics of the kiln system is assessed and the point of feeding of the Industrial Wastes in the kiln system was established. Process sulfur/alkali/ chloride balance is within the allowed range for stable cement kiln operation. The AFR technical assessment helps in averting production loss, quality problems and additional emissions from the kiln stack. AFR technical assessments done in the past in other ACC cement works has shown that 20-25% (or higher) of the total thermal requirement in the plant may be met by feeding the Industrial Wastes and other wastes in the form of solids and foils in the calciner, where the feeding system for feeding the waste is installed.

Baseline Emission Monitoring:

The annual baseline emission monitoring of the kiln stack at kiln was conducted when no waste or AFR materials are used. It will form the basis for assessing the incremental emissions from co-processing wastes in the subsequent years. Emission parameters that were measured in this exercise are dust, SO₂, HCl, NH₃, H₂O, CO, O₂, Benzene, Mercury, Heavy Metals (Sb, As, Cd, Cr, Co, Cu, Pb, Mn, Ni, Tl, V); Dioxins / Furans (PCDD / PCDF) and Total Organic Compounds.

Issues faced during implementation of this Project

- Delay in obtaining Co-processing permits from Pollution Control Board for regular Co-processing of Industrial waste
- Delay in allotment of land from Municipal Corporation to establish the one and only kind pre-processing platform
- Investment for set up of system for handling and storage
- Process issues while the usage of Waste

Results of the Project

- Co-processing of waste at cement kiln is the best disposal option than conventional options of land filling and incineration.
- Substitutes fossil fuel



Replication Potential

Replication of Similar project is possible in several Cement/steel/Power plants, where there is high use of energy.

Recommendation to other units

It is recommended to co-process the waste in cement rotary Kiln.

Contact Information of the plant

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