CEMENT MANUFACTURERS ASSOCIATION

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CEMENT

ENERGY

ENVIRONMENT

EDITORIAL

I am happy to present to you the January–June 2022 edition of the CMA Journal *CEMENT, ENERGY AND ENVIRONMENT*. Keeping in mind the diverse information needs of the readers ranging from mining of raw materials to sustainable cement production, including sustainability and cement, this issue of the journal once again brings to you a bouquet of articles and case studies.

There is widespread convergence now on sustainability being recognised as a business imperative. Businesses must reduce their environmental impact. The Indian Cement Industry long realised this and maintained an excellent track record on this front. The Indian Cement Industry has the least carbon footprint in the sector worldwide.

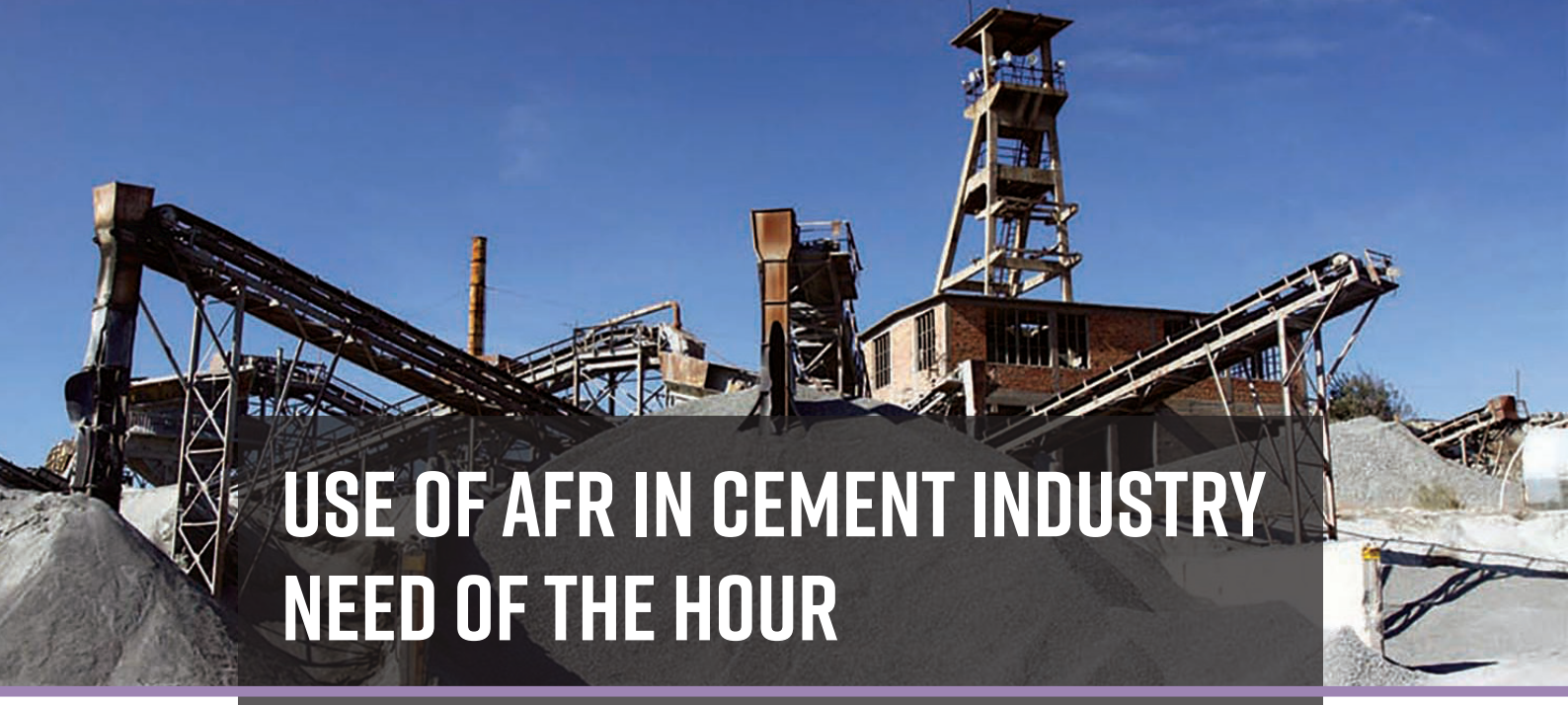
The ongoing issue of Climate Change also is demanding new global obligations. The Cement Industry can be seen gearing to the clarion call for Net Zero Carbon and working in tandem with the Government to achieve this in times to come. The support of the Government is essential for further enhancement of clinker substitution in cement, alternative fuel and RDF usage besides exploring untapped WHR potential that could substantially contribute to CO_2 reduction in the short term. It is now equally important to foster innovation and support R&D activities in renewable energy storage, hydrogen, new cements, CCUS, etc to achieve net zero in the long term.

We intend covering such topical themes and continue to share with you articles, case studies and findings on issues that would impact the future sustenance of the Cement Industry. As always, we value your feedback and suggestions. I wish you a good read!

APARNA DUTT SHARMA
Secretary General

Editor: K K Roy Chowdhury

CONTENT



USE OF AFR IN CEMENT INDUSTRY NEED OF THE HOUR

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ABSTRACT

The cement industry is a Resource Intensive Industry which uses large quantity of natural resources as Raw materials and Fuels. 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. Similarly, 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.

INTRODUCTION

Sustainability or green initiatives have set as a wider canvas for companies to define a set of standards to be more environmentally conscious. With climate change being a reality, and with the awareness of actions to arrest climate change increasing, all corporates feel the pressing need to initiate, activate, measure and audit the steps that are taken under sustainability.

The cement sector historically carries the burden of being the most polluting manufacturing. Starting from mining to packaging, there are various stages where the industry is burdened with the tag of being a polluting industry. Much has been changed in the recent decade with many of the companies, globally adopting measures to bring in improvement that are otherwise neglected. One of the measures that Cement Industry are adopting, is use of alternate fuels and raw materials which reduces carbon emissions that result from using fossil fuels and also impacts cement manufacturing. The Indian cement industry has been steadily progressing in AFR substitution over the years.

LITERATURE SURVEY

Worldwide use of Alternative Fuels In The Cement Industry

The first major use of alternative fuels in the cement manufacturing industry emerged during the mid-1980s. The primary goal in substituting fossil fuels was to enable the industry to remain economically competitive, as fuel consumption accounts for almost one third of the cost of producing clinker. Any positive impact on the environment was considered an added benefit.

Since then, there has been increasing sensitivity to the environmental impact of human and industrial activities. Beyond the cost-cutting benefits of alternative fuels, use of these fuels can contribute greatly to the environmentally sound disposal of waste and to the mitigation of greenhouse-gas emissions (GHG). Therefore, key cement players started to consider alternative fuels as a lever to improve their contribution to sustainable development and as a key component of corporate social responsibility. Alternative fuels are at the heart

of the Cement Sustainability Initiative (CSI), in which the largest worldwide cement companies are actively involved under the umbrella of the World Business Council for Sustainable Development.

REVIEW OF ALTERNATIVE FUELS, MARKETS

Although a variety of technical constraints limit the use of alternative fuels in cement plants, the range of wastes that potentially can be used in the cement sector is very broad. In addition to any processing limitations, the cement sector has developed international guidelines listing waste that is prohibited for use as alternative fuel, including radioactive waste, infectious waste, and explosives. The waste used by cement plants as alternative fuel can be classified into five broad categories, which generally are associated with specific regulations and/or implementation constraints related to the materials

- Municipal waste
- Biomass
- Non-hazardous industrial and commercial waste
- Other unclassified alternative fuels.

Both research and international experience suggest that no single alternative fuel can, by itself, meet the entire thermal demand of cement manufacturing. However, a mix of different alternative fuels can achieve that goal.

AVAILABLE HAZARDOUS WASTE WHICH CAN BE USED AS PARTIAL FUEL IN CEMENT KILN

- Organic residue from Pharmaceuticals and Pesticide industry
- Spent solvent
- Sludge from petrochemical / oil refinery
- Slaughter House Waste
- Waste Oil
- Paint sludge
- Effluent Treatment Plant Sludge
- Spent Pot Lining from Aluminum Industry
- Spent Carbon

AFR's can reduce input costs, but they can also adversely affect process stability and product performance due to their variable composition and undesirable levels of moisture, inert ballast and volatiles. Alternative fuels can also be difficult to ignite and usually need to be burned at higher oxygen levels to make sure calorific value variations do not cause intermittent reducing conditions in the kiln. These and other AFR material properties can work against stable kiln operation and when AFRs are used in large quantities some loss in capacity and product quality variation can usually be expected.

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

S No	Fuel	Calorific Value (kcal/kg)
1	RDF from Municipal Solid waste	2800-3800
2	Used Tires	6700-7700
3	Hazardous Waste	4000-9500
4	Industrial Plastic Waste	4070-6620
5	Biomass	2500-3800
6	Slaughter House Waste	700-1400
7	Poultry Litter	2700-3800
8	Dried Sewage Sludge	1700-1900

Source : Holtech & CPCB

Alternative Raw Materials which can be used as blending material

S No	Alternative Raw material	Available Quantity in million tonnes per annum
1	Fly Ash (cement blending material)	200.0
2	Blast Furnace Slag from Steel Industry	10.0
3	Lime Sludge (Paper, Carbide, Sugar Industry Sludge)	4.5
4	Red Mud from Aluminum Industry	3.75
5	Foundry Sludge / Sand	-
6	Chrome Sludge as mineralizer	-
7	Lead Zinc Slag	0.5
8	Phosphate Chalk	-

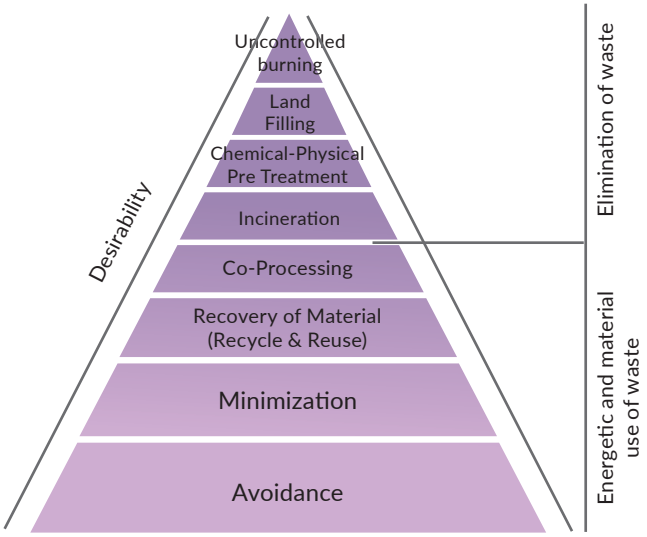
Source : Holtech

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°C and material temperature up to 1400°C)
- Long residence time
- Oxidizing atmosphere
- High thermal inertia
- Alkaline environment
- Ash retention in clinker

POLICIES FORMULATED FOR SUSTAINABLE WASTE MANAGEMENT THROUGH CO PROCESSING

Waste Management Hierarchy

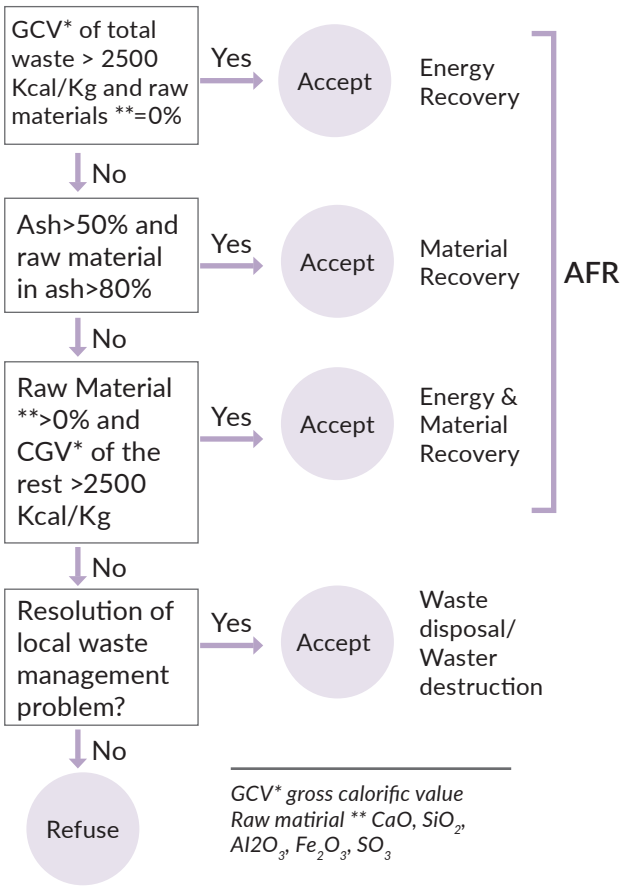


- The waste management hierarchy needs to be respected.
- Additional emissions and negative impacts on human health must be avoided.
- The quality of the cement must remain unchanged
- Companies that co process must be qualified with appropriate infrastructure.
  - Assure compliance with all laws and regulations.
  - Have good environmental and safety compliance records.
  - Have personnel, processes, and systems in place committed to protecting the environment, health, and safety.
  - Safe and sound receiving, storage, processing and feeding of hazardous wastes.
  - Systems for the provision and analysis of waste representative samples should be in place.
- For optimal performance, AFRs should be fed to the cement kiln through appropriate feed points, in adequate proportions and with proper waste quality and emission control systems.
- Due to the heterogeneity of waste, pre-processing is required to produce a relatively uniform waste stream for coprocessing in cement kilns. To be carried out in a purpose made facility, which may be located outside or inside the cement plant.

The co-processing of hazardous substances in cement industry is much beneficial option, whereby hazardous wastes are not only destroyed at a higher temperature of around 14000 C and longer residence time but its inorganic content gets combined with the clinker apart from using the energy content of the wastes. Apart from this, no residues are left, which in case of incineration still requires to be land filled as incinerator ash. Further the acidic gases, if any generated during co-processing gets neutralized, since the raw material is alkaline in nature. Such phenomenon also reduces resource requirement such as coal and lime stone. Thus, utilization of Hazardous wastes for co-processing makes a win win situation.

SUITABILITY OF SUBSTANCES FOR CO PROCESSING

Accept / Refuse Flowchart for a Cement Plant Operator



As a basic rule, waste accepted must give an added – value for the cement kiln

- Calorific value from the organic part
- Material value from the mineral part

Many substances, particularly those of low calorific value, contain a significant proportion of incombustible substance(s), while inorganic substances are used as a combination of high and low calorific value raw material.

In some cases, kilns can be used for the safe disposal of hazardous waste such as obsolete pesticides, PCB or outdated pharmaceutical products, which may not have appropriate material or energy value, but can be disposed in cement kiln without impacting the product quality. However, for this type of treatment, regulatory authorities and cement plant operators must come to individual agreements and standards on a case by case basis in consultation with CPCB.

FEEDING OF MATERIALS FOR CO PROCESSING

Different feed points can be used to insert the co processing materials into the cement production process. The most common ones are:

- The main burner at the rotary kiln outlet end.
- The rotary kiln inlet end.
- The pre calciner.
- The mid kiln (for long dry and wet kilns)

Appropriate feed points have to be selected according to the physical, chemical and toxicological characteristics of the substances, if relevant, used. Wastes of high calorific value have to be always fed into the high temperature combustion zones of the kiln system. Such wastes containing stable toxic components should be fed to the main burner to ensure complete combustion in the high temperature and long retention time. Alternative raw materials containing components that can be volatilized at low temperatures (for example, hydrocarbons) have to be fed into the high temperature zones of the kiln system. Feeding of alternative raw materials containing volatile (organic and inorganic) components to the kiln via the normal raw meal supply should be avoided unless it has been demonstrated by trial runs in the kiln that there is no undesired emission from the stack.

IISPL Ajmer, a company founded by Late "Smt. K.K. Sharma" who was renowned Chemical Engineer & Process Expert, has recently developed a product called Arrest Master AFR- Liquid AFR Charging Nozzle, for effective combustion of Liquid AFR & Hazardous Waste.

IISPL has developed the above product after extensive research at its highly efficient, design & manufacturing facility. In conventionally used systems a lot of compressed air consumption is there, but Arrest Master AFR Charging Nozzle is a special design Nozzle which uses less than 10 CFM of compressed air to atomize the AFR Liquid. It has been designed to give trouble free & maintenance free service as there is no moving part in it.

EXPERIMENT WORK

- We requested the management of ABC Cement Limited, Rajasthan for our Pilot Project to install very first of our Nozzle system & got approval in July- 2020. At ABC Limited Plant, they are having two categories of Liquid AFR material sourced from different facilities in Gujarat having difference in Calorific Values in range as below
  - High-CV Waste: 2800-6000 Kcal/Kg
  - Low-CV Waste: 0 Kcal/Kg
- The ABC Cement Limited, plant had consumption of Liquid AFR before installation of our nozzle system around 0.5 KL/Hr for a 3000-4000 TPD Plant having Five Stage, Double String Preheater. The problems faced due to Liquid AFR Usage were
  - Unstable & Disturbed Operation
  - CO Generation
  - Coating problem due to incomplete combustion & material dripping
  - Refractory Damage & Wear.
  - Frequent Jamming of Nozzle
  - Life of Nozzle is Less
- Negative Cost of Liquid AFR is 2200-3000 Rs/KL for Low CV Material.
- For High CV Material Transportation cost of Rs 500-600 Rs/KL is in Plant Scope.

OBESRVATIONS, DISCUSSIONS, FURTHER IMPROVEMENT IN DESIGN & RESULTS

After the very first installation of our Nozzle system in July- 2020 at ABC Limited Plant. The Nozzle Design version being V 1.0 installed and its performance characteristics were noted with the joint efforts of our engineers by conducting timely visits & regular monitoring by Plant Team. The following were the observations

Version 1.0 Specifications

- Length- 1000 mm, OD- 50 mm, ID- 10 mm, Wall thickness- 3mm, Nozzle end- Straight
- Compressed air passage orifice- 0.5 mm
- Compressed Air requirement- Constant 5.5 - 6.0 Bar
- Material of Construction SS-304
- Pocking Hole size required to insert the nozzle- 55mm

Version 1.0: After first installation, the Liquid AFR Consumption by the plant was increased significantly from 0.5 KL/Hr. to 1.2 KL/Hr with no loss of production. The used nozzle design was at Straight-Jet type.

a. The following observations/feedback received after 01 week from plant engineers,
   - There was coating problem at calciner wall & potential damage could also occur to the refractory in long term usage as the nozzle spray is touching the other side of calciner wall.
   - Also, the NRV used was getting jammed due to deposition of corrosive particles of liquid AFR.
   - The hose pipe may get damaged if come in contact with hot surface.

Version 1.2: Thus, the design was improved after the feedback & nozzle angle was also changed to 70 Degrees & Length of Nozzle increased to 1250 mm. Also, the NRV used at by-pass valve was eliminated by changing the location of bypass valve location. Thereafter, the consumption of Liquid AFR increased to 1.5 KL/Hr.

a. The observation after 04 weeks of usage was
   - There happens to be nozzle jamming due to usage of high viscosity material.
   - The nozzle angle to be changed to 90 Degrees.
   - Hose pipe to be insulated with ceramic fibre to avoid any damage after coming in contact with hot surface.
   - By pass valve location is changed

Version 1.5: After several visits conducted & feedback obtained from the plant team, the nozzle design was further optimized to increase the consumption of Liquid AFR to 2.0 KL/ Hr.

a. Following Changes were done
   - Mixing Chamber Design was improved.
   - ID increased to 16 mm
   - Material of construction changed to SS-316
   - Feeding Point location of Liquid AFR to at nozzle changed to avoid internal deposition of Liq. AFR Particles.
   - Air consumption further reduced by decreasing the compressed air passage orifice to 0.3 mm

Version 2.0: The nozzle design has been furtheroptimized to increase the consumption of Liquid AFR to 3.0 KL/ Hr.

a. Following Changes have been done
   - Mixing Chamber Design has been further improved.
   - Air consumption has been further reduced by decreasing the compressed air passage orifice to 0.2 mm.

CONCLUSIONS

Thus, after several improvements the Commercial Launch was done in end of Oct-2020. The Modified & refined end product (Version 2.0) was highly efficient for purpose of effective combustion of different types of Liquid AFR used in cement plants.

Version 2.0 Specifications

- Length- 1200 mm
- OD- 50 mm, ID- 16 mm
- Wall thickness 5 mm

- Nozzle End Curvature- 90 Degrees
- Compressed air passage orifice- 0.2 mm
- Compressed Air requirement- Constant 5.5 - 6.0 Bar
- Material of Construction SS-316
- Pocking Hole size required to insert the nozzle- 160 mm

It has following properties

- By Atomization through compressed air, the uniform stream of atomized particles of AFR liquid burn effectively and CO % is not generated.
- Discharge- Flow rate can be controlled by Control valve (0.2 to 3.0 KL/hr).
- Very less compressed air consumption.
- High Quality Material Construction by SS-316.
- Bypass System- Manual control valve is provided to clean nozzle through compressed air in running condition.
- Maintenance free, as there are no moving parts.
- Liquid AFR consumption per day can be increased by using multiple nozzles at once.
- Length of spray from nozzle can be changed by the control valve provided.

Safety Precautions

- Nozzle should be grounded to avoid generating Static Charge.
- Ensure there will be no leakage through nozzle.
- Proper clamping should be done to avoid movement of nozzle direction & to avoid any leakage.
- During Changeover, kindly flush the Nozzle with Compressed air by the By-pass valve provided.
- Compressed air should be dust free to avoid the choking of air passage of nozzle, which affects the life of nozzle, use of pre-filter (40 Microns) is recommended.

Following Plants are using the product at their manufacturing facilities

- Shree Cement Limited: All Kilns at RAS, Beawar & Kodla Units.
- The Mehta Group: All Kilns
- Dalmia Cement (Bharat) Limited: Kadapa & Rajgangpur.
- Nuvoco Vistas Corp. Limited, SCP, CCP, NCP.
- Ultratech Cement Limited
- JK Cement Limited
- The Ramco Cements Limited, Ariyalur
- Chettinad Cement Corporation Private Limited (Puliyur & Karikkali Works)
- JSW Cement Limited, Nandyal Works

Invotech Industrial Solutions Private Limited keeps itself abreast of latest development in Cement Industry so as to cater the need of the Industry using latest technology and quality systems. Also, with a view to retain the requisite competitive edge in the market, participated in various Seminars, details as under

- 15th & 16th NCB International Seminar on cement, concrete & building materials held from 5th to 8th Dec, 2017 and 3rd to 6th Dec, 2019 at Manekshaw Center, New Delhi. Will also be participating in upcoming 17th NCB International Seminar to be held during 08-11th March-2022.
- "National workshop cum technology exhibition to promote energy efficient & cleaner production for sustainable industrial growth" held from 8th to 9th March, 2018, at India Habitat center, New Delhi, where presented a Technical Paper on "Significant savings in energy through false air reduction" & received an award for "upcoming entrepreneur in the field of energy efficiency" presented by Mr. Pankaj Kumar, Secretary, Bureau of Energy Efficiency.
- 14th Green Cementech in 2018 held from 17th to 18th May, 2018 at Hyderabad International Convention Center, Hyderabad where we presented Technical Paper on "Enhancing Energy efficiency in Captive Power Plants by reduction of False Air". Also attended 16th Green Cementech in 2020 through Online mode.
- Articles Published In Prestigious Publications:

a. CMA's Technical Journal "Cement Energy & Environment"

- "Energy Savings Through False Air Reduction", Vol. 17 No. 1 (Jan – Jun 2018).

- "ENERGY SAVINGS BY REDUCTION OF THERMAL LOSSES FROM KILN SHELL", Vol. 18 No. 1 (Jan – Jun 2019).
- Our Latest Article Compressed Air Saving Device "A Portable, Economic Hot Spot Cooling Solution To Plug And Eliminate Routine Energy Waste In Cement Plants", Volume 20, No. 01 (Jan-June 2021)

b. Indian Cement Review Magazine

- Energy Efficiency Through False Air Reduction" Volume 35, April 2021, No 9.

c. Arab Union For Cement And Building Materials, U.A.E.

- "The Method Of Reducing Carbon Footprint In Cement Plants", No. 84, June 2021

- Recently our Product "Arrest Master ABS: Compressed Air Saving Device For Cooling Applications" Was Nominated For National Energy Efficiency Innovation Awards-2021 and we have been felicitated with above award by, Bureau of Energy Efficiency, presented by Hon'ble Union Minister Shri R.K. Singh, Ministry of Power & New and Renewable Energy on 14th Dec, 2021 at Vigyan Bhawan, New Delhi.

CONCLUSION

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.

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