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The Role Of Rdf In Place Of Coal

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Abstract

The MSW collected for disposal is tested for its moisture content and when the moisture content in more than 35-40% it requires drying to produce fuel pellets with reasonable heating values. The reduction in moisture can be done artificially or by natural sun drying. Sun drying is preferred when adequate land is readily available. However, during periods of heavy rainfall, alternate arrangements for drying will have to be made. The moisture level of waste is brought down to around 35-40% by uniformly spreading it on an open, paved area and allowing it to sun dry. The duration of sun drying varies form 1 to 2 days depending upon the garbage quality. In the process of spreading the garbage, manual inspection is carried out to remove large debris, tree cuttings, tyres etc. which are harmful to the downstream process equipment. The sun dried garbage is then uniformly fed into a rotary drying system i.e. Hot Air Generation burning oversize garbage or other fuel to further bring down the moisture level to about 10-12%. It is reported as well as proved that 10-12% moisture content is desirable to be maintained in the garbage for densifying into fuel pellets. After drying is over, the garbage is passed through a screening equipment to separate sand/grit (below 8mm), heavier combustibles & ferrous materials which are abrasive in nature and may cause harm to process equipment. This fine fraction having organic matter in it is already proved to be useful as garden manure. The dried and screened garbage is then passed through an Air-Classifier (Density Separator) in which the light combustibles and dense fractions (e.g. stones, glass etc.) are separated over an air barrier. At the same time, the garbage is passed over a magnetic separation unit to remove magnetic materials. The light combustibles are ground to 10/15 mm particle size. The binder and additives are mixed with ground garbage in mixer/conditioner before pelletising. The pellets coming out of pelletiser are cooled and stored in the pellet storage yard for dispatch. The pellets so produced cab be used in industrial boiler and thermal power plants as fuel. India on a plant to process 150 tonnes per day (t.p.d.) Municipal Solid Waste (MSW) to 80 t.p.d pellets. The Production of refuse-derived fuels (RDFs) from municipal Solid Waste (MSW) offers one solution to address the growing waste issue in countries with increasing populations such as India. At the same time, these RDFs enable the cement industry to substitute fossil fuels and reduce its CO_2 emissions. At present municipal solid waste (MSW) in India is generally unsegregated with high moisture content, low calorific value, odour and a wide range of particle size. The 32 mt of MSW generated in urban India, 12 Mt is combustible fraction which can be potentially converted into refuse derived fuel (RDF) thereby replacing 8mt of coal.

Keyword

Refuse derived fuel, Garbage, Pellet, Moisture, Reduction, combustible

Definition in the Rule

The municipal solid waste (management and handling rule 2000) "Pelletisation" means a process whereby pellets are prepared which are small cubes or cylindrical pieces made out of solid wastes and includes fuel pellets which are also referred as refuse derived fuel;

The solid waste management rule, 2016 " Refused derived fuel" (RDF) means fuel derived from combustible waste fraction of solid waste like plastic, wood, pulp or organic waste, other than chlorinated materials, in the form of pellets or fluff produced by drying, shredding, dehydrating and compacting of solid waste;

The solid waste management rule, 2016 " Materials recovery facility" (MRF) Means a facility where non-compostable solid waste cab be temporarily stored by the local body or any other entity mentioned in rule 2 or any person or agency authorized by any of them to facilitate segregation, sorting and recovery of recyclables from various components of waste by authorised informal sector of waste picker, informal recyclers or any other work force engaged by the local body or entity mentioned in rule 2 for the purpose before the waste is delivered or taken up for its processing or disposal;

The solid waste management rule, 2016 " Duties of the industrial units located within one hundred km from the refused derived fuel and waste to energy plants based on solid waste" All industrial units using fuel and located within one hundred km from a solid waste refused derived fuel plant shall make arrangements within six months from the date of notification of these rules to replace at least five percent of their fuel requirement by refused derived fuel so produced.

"Criteria for waste to energy process" (1) Non-recyclable waste having calorific value of 1500 K/cal/kg or more shall not be disposed of on landfills and shall only be utilized for generating energy either or through refuse derived fuel or by giving away as feed stock for preparing refuse derived fuel.

(2) High calorific wastes shall be used for co-processing in cement or thermal power plants.

(3) The local body or an operator of facility or an agency designated by them proposing to set up waste to energy plant of more than five tones per day processing capacity shall submit an application in Form-I to the State Pollution control board or Pollution Control Committee, as the case may be for authorization.

(4) The state Pollution Control Board or Pollution Control Committee, on receiving such application for setting up waste to energy facility, shall examine the same and grant permission within sixty days.

Table No. 1 The Category of The RDF

S.No.	Parametes	RDF-Grade III	RDF- Grade II	RDF- Grade I
1.	Intended Use	For co-processing directly or after processing with other waste materials in cement kiln	For direct co-processing in cement kiln	For direct co-processing in cement kiln
		Grade III	**Grade II**	**Grade I**
2	Size	<50 mm or< 20 mm depending upon use in II. C or SLC, respectively		
3	Ash- maximum permissible	<15%	<10%	<10%
4	Moisture-Maximum Permissible	<20%	<15%	<10%
5	Chlorine-maximum permissible	<1.0%	<0.7	<0.5
6	Sulphur-maximum permissible	<1.5%		
7	Net Calorific Value (NCV) in Kcal/kg (Average figure of every individual consignment)	>3000 Kcal/kg net	>3750 Kcal/kg net	>4500 Kcal/kg net
8	Any other parameter	RDF-any offensive odour to be controlled.	RDF-any offensive odour to be controlled.	RDF-any offensive odour to be controlled.

Use of Refuse as Supplementary Fuel

In USA, upto a few years back, the effort was towards installation of incinerators burning refuse alone and having heat recovery facilities. These faced a number of problems due to variable composition of refuse having different calorific value which resulted in variable output. The European countries, on the other hand, were using separated and shredded waste as a supplementary fuel in existing thermal power plants using coal or gas as the principal fuel. Such plants did not suffer due to variable calorific value of refuse. Further, by burning solid waste in a utility power plant, the process took advantage of an existing system. The trend now in USA has been towards adoption of this system as exemplified by the installation of a plant in St. Louis [(55)] which use 650 tpd of refuse in a 125 MW tangentially suspension fired boilers that burn pulverized coal. Some more similar plants are now being constructed. Air- classified light fraction as fuel. Because mixed municipal wastes are approximately 50% paper products and 3% plastics and because these materials cab readily be removed in standard air classifiers either with or possibly without prior shredding, several pro-cesses rely on the fuel value of the air-classified light fraction. It is being sold "as is" under such trade names as "Eco-fluff" and "Eco-fuel". It is being pelletized or bricketted and sold as a solid fuel. It is b eing burnt directly in vortex burners in coal-burning utility boilers up to a proportion of 15 % of the total heat input (1975). This last development has followed the pioneering full-scale experiments of Union Electric at its Meramec, St. Louis station.

RDF Use in Cement Plant & boiler

For initiating the RDF usage in cement industry, the committee members agreed that different RDF types have different calorific values, and so the cost of each combustible fraction have tyo be expressed in INR per 1000 Kcal/kg to be comparable. The commercial acceptability of properly processed RDF was agreed at rs. 0.4 per 1000 Kcal/kg by the members with reference to the specifications as defined in the guidelines. It is also suggested that RDF prices be dynamic and linked with the cost of coal.

In overall, once RDF of the quality/specification is made available, on a dependable basis, within the transport influence zone of 400 km of a cement plant, market forces would prevail upon where the ULB, the RDF processors and cement plants would negotiate an agreeable cost of RDF considering various factors. To begin with, the suggestive maximum and minimum prices of the respective grade of RDF as worked out for guidance is presented below

Table No. 2 Challenges of using RDF as a fuel in Thermal Power Plants

S.No.	Parameter	Performance
(I)	Calorific value	The highly variable nature of size, density, calorific value across regions and seasons of the RDF produced can never ensure that the RDF will be of the same calorific value. Heat release rate of RDF is not consistent compared to the coal and hence study on the combustion behavior of RDF while co firing with different blend rations needs to be done
(II)	Size	RDF being in fluffy or loose form cannot be mixed with coal directly as the existing milling system is not designed to pulverize RDF. Separate milling system, conveying system and modification in combustion system shall be required
(III)	Quality of output	(i) Presence of silica with alkalis creates agglomeration and fouling on heating surfaces (ii) Silica in fly ash cause erosion of heating surfaces (iii) Chloride compounds of RDF cause corrosion of heating surfaces (iv) RDF combustion products contains SO2/SO3 that cause acid dew point corrosion The presence of such corrosive non-metals in the RDF will over a period of time reduce the productivity of the boiler and hence the productivity of the turbine as well.
(iv)	Creation of Slag	Combustion temperature above ash fusion temperature leads to ash fusion and clinker formation on grate over a period of time this reduce the productivity of the boiler through deposits and increases the cost of maintenance.
(v)	Policy and finance	(i) Absence of a policy on financials, incentive, technology choice, capacity building and other regulatory issues (ii) Absence of long term power purchase agreements with favourable tariff structure
(vi)	Boiler Metallurgy	The present boiler metallurgy of the PC fired plant in not suitable for highly corrosive atmosphere generated by burning of high plastics, PVC and alkaline element in RDF. This would result in frequent shutdown of the boiler on account of tube leakages and corrosion related failures.

Iron and Steel Industry

The Indian steel industry currently has very little experience in using RDF as a fuel source. This is generally due to the concerns related to the possible negative impacts on the production process or the product quality. The expert members form SAIL have friefed that MSW derived RDF cannot be used in Iron and steel industry as the process is autogenous. The usage of RDF as fuel in processes like sinter making or in reheating furnaces was also explored and it is opined that since the present mode of energy supply to sinter and reheating furnaces was also explore and it is opined that since the present mode of energy supply to sinter and reheating furnaces is gaseous, the solid RDF would not be the appropriate material for those applications. The challenges of using RDF as a fuel in Iron and steel industry is further elaborated in

Brick Kilns

Biomass and MSW derived fuel has not been considered in the case of brick kilns as the temperature of the furnace is typically less than 700º-1100ºC and the combustion of RDF at such temperatures will lead to the generation of toxic emissions like dioxins and furans.

Cement Industry

Processing of the combustible fraction of MSW yields refuse derived fuel (RDF) and Cement Industry can play a vital role in utilizing RDF as Alternative Fuel in cement kilns. The current thermal substitution rate (TSR) of fossils fuels by alternative fuels such as Industrial waste, biomass and municipal waste, stands at only 3.0 percent, far below the double-digit rates achieved in developed countries. The MSW based SCF/RDF use in cement kiln contributes only 0.6% of thermal substitution. Cement manufacturing Association (CMA) and Cement Sustainability Initiative (CS)) are supporting the Alternative fuels & Raw Material (AFR) usage and over last decade, AFR substitution rate has been increased from less than 1% in 2010 to more than 3% in 2016. The industry aims to achieve 25% of TSR by 2025. In same model across its cement kilns in India and has been co-processing sorted MSW at its plants in Gujarat, MP. Karnataka and Andhra Pradesh. However the bottlenecks, regarding assured quality and quantity of sorted combustible fraction of MSW remain as the major bottlenecks in investing for related infrastructure.

The burning of RDF with high chlorine content could be detrimental for the cement clinker. However, the formation of these volatile alkali chlorides can be controlled by the means of a kiln by-pass. The major factors which create slag and cause fouling is the ash composition, slag viscosity, the SiO_2/Al_2O_3 ration and acid/base ratio. Therefore, the particle size of the RDF used becomes an important consideration, as large particles of glass may generate nucleri that encourage slag forming reactions. Since the part of non-combustible particles in RDF will be different from that of coal, it will have a different impact on fouling and slagging.

The corrosion of metal surfaces is also a concern when RDF is combusted in the boiler. This is due to the high temperature liquied corrosion due to alkali sulphate, a reducing atmosphere within the boiler may reate corrosive agents like CO and HzS due to partial combustion.

The emission norms for co-processing of waste/RDF in cement plant are notified by the ministry of environment forest and climate change in may 2015. A copy of the same is provided as Annexure II.

Co- processing in cement kiln achieves effective utilization of the material and energy value presnt in the waste thereby conserving the natural resources by reducing the use of virgin material. Table 4 b elw illustrates the benefits of using RDF as an alternate fuel in cement industries.

Table No. 3 Benefits of using RDF in Cement Industries.

Indicators	Benefit
RDF Specifications	Cement plants usually require RDF to be shred to the size less than 50 mm which is not a technological challenge. Particle sizes less than 50 mm usually disintegrate completely with 4-5 seconds in an oxygen rich atmosphere as is present in a cement kiln.
Feeding of RDF	The installation of alternate fuel feeding mechanism enables RDF to be fed into the cement kiln without any difficulty. Usually, cement factories build a separate entry point for AFR which cab include pharma waste FMCG waste packaging waste lubricants etc. The same feeding mechanism cab be used for RDF.
Impact on Product	Very high temperatures of approximately 1400ºC and a residence time of 4-5 seconds in an oxygen rich atmosphere ensure complete combustion of RDF without affecting the productivity. The fuel has a calorific value of ar3000 kcal which cab generate enough tyhermal energy required in the processes in these plants, reducing the use of non-renewable fossil fuels like coal..
Environmental Impact	RDF usage replace fossil fuels with materials which would have been landfilled leading to emission. Furthermore, improper land filling would have allowed leachate to run into ground water and become a major source of pollution. Furthermore, the use of equipment of check stack missions can lead to a reduction of dioxins and furans from being emitted int the atmosphere.
Residual Disposal	Acidic gases generated in the combustion process are neutralized by the alkaline raw material in the cement kiln and are incorporated into the cement clinker. The interaction of the raw material and the flue gases in the clinker ensures that the non-combustible part of the residue is held back in the process and is incorporated in the clinker in an almost irreversible manner. No additional waste is generated in the process .

Table No. 4 RDF consumption in Cement Plant in M.P.

S.No.	Name of Industry	Coal Consumption per/day	RDF consumption may 2022	RDF Consumption April 2022	RDF consumption April to December 2021
1	Ultratech Cement Plant Bela Distt Rewa	400	560	52.69	474
2	Ultratech Cement Plant Baghwar Distt Rewa	600	840	235	651
3	J.P. Rewa Cement Plant nowasta Rewa	500	700	93	503
4	Prism Cement Ltd Vill Mahiar Distt Satna	500	560	46	650
5	Birla Corporation Ltd unit satna cement works satna	500	700	0	200
6	Ultratech Unit maihar Cement works Maihar Distt. Satna	250	770	44	960
7	KJS Cement Ltd Maihar Distt. Satna	400	350	195	100
8	Reliance Cement Ltd Maihar Distt. Satna	1200	1680	10	150
9	Bihalai JP Cement Ltd. Vill. Babupur Distt. Satna	400	560	50	500

Waste-to-Energy (Incineration)

Waste-to-energy (W to E) or energy-from-waste is the process of generating energy in the form of electricity and/ or heat from the primary treatment of waste. Energy recovery in the form of electricity, heat and fuel from waste using different technologies is possible through a variety of process, including incineration, gasification, pyrolysis and anaerobic digestion. These processes are often grouped under “W to E technologies”

Two groups of technologies could be used for processing different fractions of wastes:

(i) Bio-chemical waste to energy technologies cab be categorized into biomethanation and fermentation. As this technology provides a solution for the organic waste only, the same can,t be considered for using RDF.

(ii) Thermo-chemical waste to energy technologies: MSW thermal technologies are processes that create energy in the form of electricity, fuel or heat from thermo-chemical process such as, gasification, pyrolysis incineration or mass burning of municipal solid wastes. MSW after limited or full pre-processing is used in most of these

Need for standards for RDF in India

The committee deliberated and considered the following factors pertinent to evolve the standards for RDF

a) Waste heterogeneity: India MSW is highly heterogeneous (with non-existent segregation at source), and the RDF thus generated not only varies widely in quality but is often inferior quality. On the other hand, cement producers need RDF of consistent quality and quantity to ensure that cement quality, plant output, and compliance to regulations are not affected.

b) Different requirements and capacities of cement plants: RDF of one quality required by a cement plant may not be suitable for another plant; every cement plant has specific requirements and therefore standards will help to categorize the requirements.

c) Business prospects: The standards will be helpful to enter into long-time agreements between cement and RDF plants.

d) Compliance to SWM Rules 2016: Standards will enable the implementation of SWM Rules 2016, by defining the characteristics/qualities of RDF, so that cement producers cannot claim that the product of the nearby RDF plants is not standard RDF.

e) Market Development: For a waste stream to be certified as RDF (after appropriated processing) would help the RDF plant better market their product and would increase the confidence of cement manufacturers in using RDF.

Segregated combustible waste fraction can be sent in the form of fluff, bales or pellets. To optimize transportation cost, reverse haulage option may be explored by the parties. The weighment record of material transported and received by waste to energy plant or cement plant shall be maintained at both sites.

The RDF co-processing in cement plants involves three key steps involving collecting and supplying MSW to RDF plants for RDF production followed by use of RDF in cement kiln.

Conclusions

In this study, the environmental and economic aspects of refuse-derived fuel (RDF) production and utilization as an alternative fuel in the existing cement factories in. By using a biodrying process, the possibility of using RDF material derived from domestic waste with high organic waste content as a supplementary fuel in cement factories in cement factories in waste to energy plants. Regarding to increasing constructions and industrial plans in country, cement utilization is increasing. Cement factories need energy for production which is secured by fossil fuels. The RDF produced was of high calorific value, low moisture content, and acceptable chlorine content. It was compared with the typical composition of RDF from MSW originating in different countries. The quality of the produced RDF did not differ from the RDF quality set by some European countries.

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