

RDF production and utilisation in India

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 CO₂ emissions.

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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. According to a planning commission task force report in 2014,¹ of the 62Mt of MSW generated in urban India, 12Mt is combustible fraction which can be potentially converted into refuse-derived fuel (RDF), thereby replacing 8Mt of coal. Currently, more than 30 per cent of India's population live in cities and this figure is projected to rise to 50 per cent by 2050.

To dump 62Mt of MSW without treatment, 1240ha per year of precious land is required. With a projected MSW generation of 165Mt by 2031, the land requirement for creating landfill space for 20 years (considering a 10m-high waste pile) could be 66,000ha. Until the reporting year 2013-14 of the Central Pollution Control Board (CPCB) study,² there are 22 RDF plants in operation. A CPCB study in 2016³ revealed that presently 90 per cent of MSW is collected and 25 per cent is processed or treated. Urban local bodies spend about 60-70 per cent of total expenditure on street sweeping, 20-30 per cent on transportation, and less than five per cent on final disposal of waste.

Input waste quality for RDF and compost production at Ramky Enviro Engineers' Hyderabad facility, India



The objective of Prime Minister Narendra Modi's 'Swachh Bharat Abhiyan' or 'Clean India Mission' is to achieve 100 per cent scientific management of MSW in selected towns across the country. To deliver on the promises of this mission, RDF production and RDF utilisation in the cement industry offers a sustainable waste management option.

RDF production

The principle of RDF production is recovering quality fuel fractions from the waste, particularly through the removal of recyclable particles such as metal and glass, and converting the raw waste into a more usable form of fuel with uniform particle size and higher calorific value than raw MSW. The required RDF quality

Table 1: quality of MSW in India¹

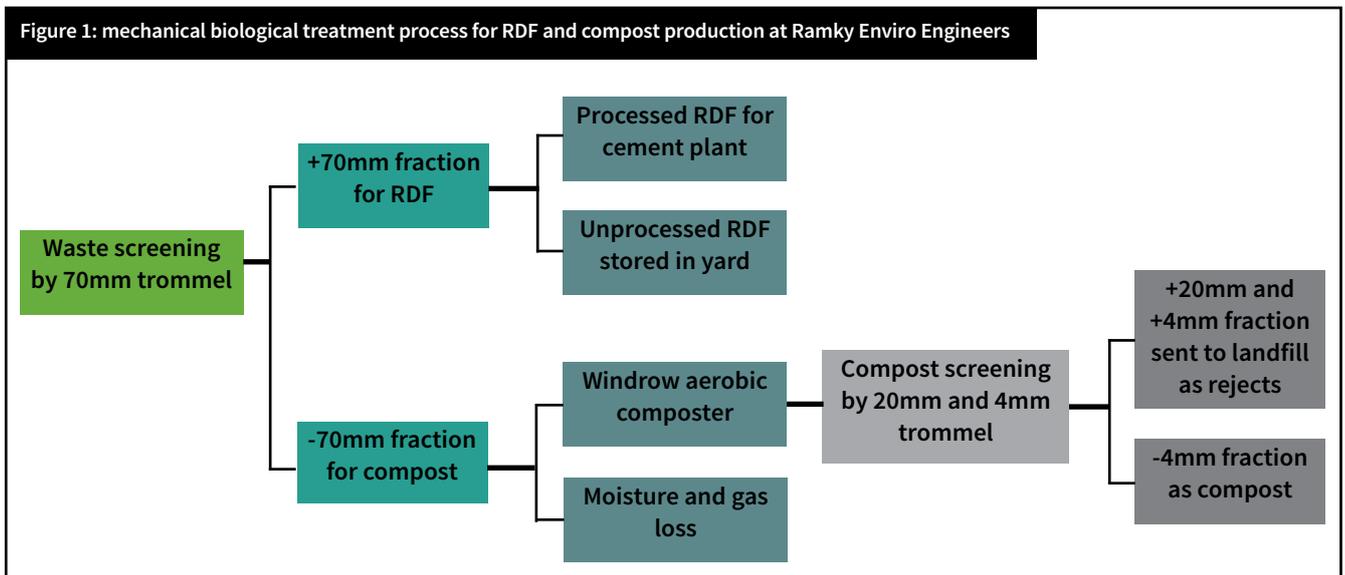
Year	MSW type and volume (Mta)							
	Biodegradable waste	Paper	Plastic/Rubber	Metal	Glass	Rags	Others	Inert
1996	42.21	3.63	0.6	0.49	0.6			45.13
2005	47.43	8.13	9.22	0.50	1.01	4.49	4.02	25.16
2011	42.51	9.63	10.11	0.63	0.96			17.00

Source: Planning Commission, 2014

Table 2: equipment for separation, size classification and size reduction of MSW to produce RDF

Concept	Technique	Materials
Trommels or drum screen	Size classification	Paper, plastic, organics, glass, fines
Disc screen and vibrating screen	Size classification	Paper, plastic, organics, glass, fines
Manual separation	Visual examination	PVC, contaminants, oversize materials
Magnetic separation	Magnetic properties	Ferrous metals
Eddy current separation	Electrical conductivity	Non-ferrous metals
Wet separation technology	Differential densities	Plastics, organics will float; stones, glass will sink
Air classification	Weight	Plastics, paper, stones, glass
Ballistic separation	Density and elasticity	Plastics, paper, stones, glass
Optical separation	Diffraction	Specific plastic polymers
Shredder	Shearing action of knives or hooks at slow speed with high torque	(+) 70 or 80 mm combustible fraction
Bag splitter	Gentle shredder to split plastic bags	Plastic bags

Figure 1: mechanical biological treatment process for RDF and compost production at Ramky Enviro Engineers



is determined by the end use of the fuel. For example, the Ministry of Urban Development (MoUD), now called the Ministry of Housing and Urban Affairs, specifies the broad specification of RDF

suitable for the Indian cement plants as follows:⁴

- moisture – preferably < 20 per cent
- size – 2D: <120mm, 3D: <70mm depending on the process limitations of

the specific cement plant

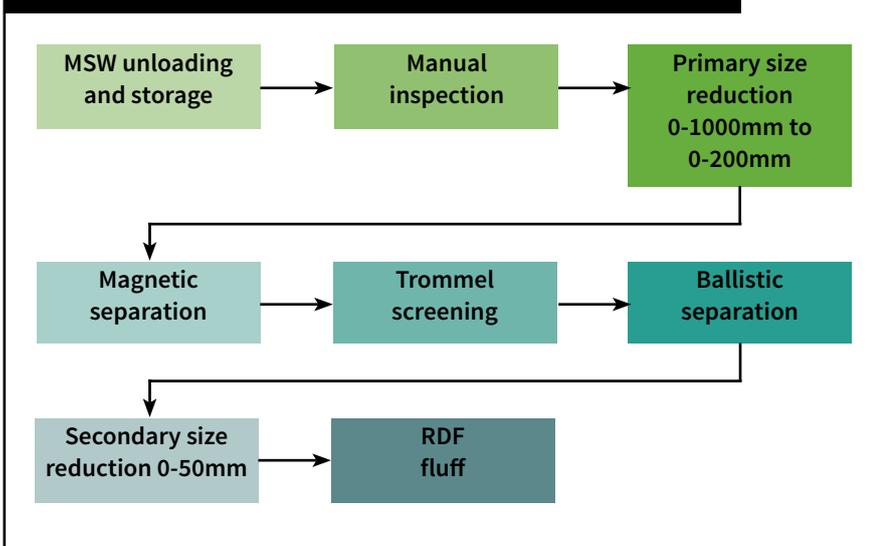
- chlorine – preferably <0.7 per cent, depending on the particular raw mix and fuel mix
- calorific value – preferably >3000kcal/kg (the calorific value of RDF produced in Europe is in the range of 4000-6000kcal/kg)
- sulphur – <2 per cent, however this depends on the particular raw mix and fuel mix
- free of restricted items such as PVC, explosives, batteries, aerosol containers and bio-medical waste.

The quantity of RDF that can be produced per tonne of MSW varies depending on the type of collection, pre-processing and composition of the waste source. The usual yield of RDF from mixed MSW is in the range of 20-30 per cent although if the waste is properly



Trommel screen at Ramky's Hyderabad facility

Figure 2: process of RDF production at UltraTech's RDF facility in Jaipur, India



segregated, a yield of 80-90 per cent can be achieved. Depending on the need of the end user, RDF fluff is further processed in the densification unit to produce RDF pellets. A material recovery facility, depending on the level of complexity, will consist of a combination of unit processes as shown in Table 2, in varying degrees of mechanisation.

Ramky Enviro Engineers Ltd is one of the leading providers of waste management services in India. Its Hyderabad facility receives and processes 4500tpd of MSW from Greater Hyderabad Municipal Corporation to produce RDF and compost. Approximately 45 per cent of the incoming waste is +70mm fraction which is processed to RDF and sent to cement plants in Andhra Pradesh and Karnataka. A quarter of the waste is lost as moisture or gas, 7-8 per cent is converted to compost and 16 per cent is sent to landfill as compost rejects. This waste is processed to the following quality parameters:

- moisture – <20 per cent
- calorific value – >3500kcal/kg
- ash – <12 per cent
- chlorine – <0.5 per cent.

The UltraTech Jaipur RDF facility can produce 150tpd of RDF from 500tpd of MSW delivered by Jaipur Municipal Corporation. The final RDF produced has the following specification:

- size – <50mm
- calorific value – 3000-3500kcal/kg
- moisture content – 10-20 per cent
- bulk density – 0.2t/m³.⁴

One of the RDF analyses from the Goa MSW treatment facility shows the following quality:

- moisture – 37.4per cent

- calorific value – 7266kcal/kg
- ash – 13.9 per cent
- Cl – 0.54 per cent.⁵

In the facility, which is fully compliant with the Solid Waste Management (SWM) rules of 2016, RDF is obtained from the following processes:

1. Old dumped MSW is remediated using multi-deck vibratory screens on the site.
2. Mixed MSW is segregated using OREX (organic extrusion press) whereby the segregated organic fraction goes into the fermenter (composting drums) and the dry fraction goes on to the RDF line consisting of magnetic separator, flip flow screen and wind sifter.
3. The +30mm fraction is used for RDF production, while the -30mm fraction is

sent for compost production.

The calculations suggest that the cost of setting up a 500tpd MSW mechanical biological treatment producing 150tpd RDF and 50tpd compost would cost INR250m (US\$4m) with a payback period of 9-10 years. The cost of setting up a 100tpd RDF feeding system in a cement plant would be INR150m (US\$2.5m) with a payback period of 7-8 years.

In line with the new SWM Rules of 2016, local bodies have to set up facilities for segregation, collection, treatment and disposal of wastes in an environmentally-sound manner. The non-recyclable waste with calorific value of 1500kcal/kg or more will not be land-filled, and only used for generating energy either through RDF or by giving away as feedstock for preparing RDF. The high-calorific value wastes will be used for co-processing in the cement industry or thermal power plants. All industrial units using fuel and located within 100km of an RDF plant will arrange within six months from the date of notification of the rules to replace at least five per cent of their fuel requirement by the RDF produced in this way.

Utilisation of RDF in cement kilns

Recovery of wastes and substitution of coal has only recently been practiced in India's cement industry. The thermal substitution rate (TSR) is estimated to average ~2.5 per cent.

Ramky Hyderabad sends 300tpd of RDF to cement plants in Andhra Pradesh and Karnataka. UltraTech's Vikram cement plant in Madhya Pradesh uses 6-7tpd of

Ballistic separator at UltraTech's RDF plant in Jaipur



“The use of RDF is essential if the Indian cement industry is to achieve a higher TSR. To achieve a five per cent TSR by 2020, ~1.25Mt of RDF would be needed by the cement industry, equivalent to 2000t of RDF for every million tonne of cement produced. Similarly, to achieve a TSR of 20 per cent in 2030, 7Mt of RDF would be needed, equivalent to 7500t of RDF for every million tonne of cement produced.”

RDF from the RDF facility in Jaipur. The Goa MSW treatment facility sends 30tpd of RDF to ACC Wadi for co-processing. RDF is always fed to the calciner.

ACC's Madukkarai cement plant in Tamil Nadu has associated with Madukkarai special grade panchayat (local body) and NGOs in Madukkarai village for door-to-door waste collection of 4-5tpd of MSW, waste segregation into eight different categories, composting of organic waste, recycling of plastic and paper, and co-processing of high calorific value non-recyclable fraction in the cement kiln.⁷ The small-scale public-private partnership employs women and benefits close to 45,000 citizens.

MSW processing companies cover their costs from tipping fees paid by the municipality and from the sale of RDF and compost. For a cement plant, the substitution benefit of replacing fossil fuels with RDF must outweigh the material cost, kiln and equipment upgrades, pre-processing (if required), costs towards sampling and testing of RDF as well as other operational and administrative costs. The increasing cost of coal/petcoke and the potential price of CO₂ emissions (via emission trading schemes) will further enhance the use of RDF in the cement industry.

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Environmental considerations

Both nitrogen and sulphur content are lower in RDF compared to coal and petcoke. In UltraTech's Vikram cement plant the average NO_x emission was six per cent lower when using RDF than the plant's baseline emission.⁹ A further study shows that mercury emissions increase when substituting 50 per cent of the petcoke with RDF but remain still well below the limits set out in the Waste Incineration Directive.⁶

A high chlorine content in RDF may be detrimental for the process and emissions, but volatile alkali chlorides can be controlled by installing a bypass. However, the increased alkali chloride content limits the recycling level of the bypass dust, which is normally re-introduced into the kiln.

India's Ministry of Environment, Forest and Climate Change has notified emission limit values for cement plants co-processing wastes for the following parameters: dust/particulate matter, SO₂, NO_x, HCl, HF, TOC, heavy metals and PCDD/PCDFs.⁷ The installation of continuous emission monitoring systems (CEMS) is mandatory in the cement kiln stack for particulate matter, SO₂ and NO_x in the first phase with data uplinked to State and Central Pollution Control Boards.

Conclusion

There is a need for effective implementation of SWM rules and integrated MSW management including cement kiln co-processing. In addition, to improve the yield of RDF produced, source segregation of MSW is essential. A regular supply of MSW to RDF plants and quality RDF to cement plants at an agreed price is essential for optimising the return on investment.

In terms of investing in the set-up of RDF plants, real partnerships between private sector and local government will bring greater efficiency and enhanced performance. The funding issue can be addressed by grants or viability gap

funding under India's Smart Cities initiative and the Clean India Mission.

SINTEF is currently working on a Norwegian government-funded project in India named “Co-processing of Alternative Fuels and Resources in the Cement Industry: Phase II”, 2017-20. One of the objectives of the project is to demonstrate the potential to increase the TSR by using RDF out of MSW and dried sewage sludge. CII-GBC will assist SINTEF in describing the actual production and use of RDF, the potential in optimised utilisation and current barriers, and in conducting demonstration trials. ■

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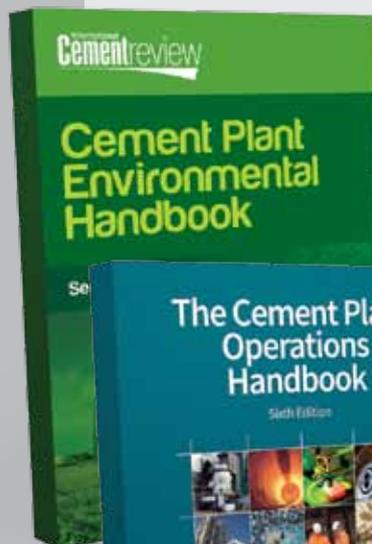
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