Mixing It Up

Dirk Lechtenberg, MVW Lechtenberg & Partner, Germany, investigates whether it is feasible to use mixed waste as a fuel resource.

Introducton

The production of refuse derived fuels (RDFs) from waste is common practice in developed countries, where municipal solid wastes are separated at the source and there are high waste disposal costs for collection and processing. Is it also possible to produce RDF from mixed waste? How can cement plants evaluate if it is feasible to process mixed waste in developing countries?

An idea is born

The first oil crises in 1973/1974 triggered discussions to evaluate waste as a resource. The idea was to separate waste to recover recyclables and a high calorific valuable (CV) fraction. The quality parameters were mainly defined with the CV, and the environmental and technical parameters at the power plants and cement plants were not taken into consideration.

The sorting and processing technologies available at that time made it impossible to produce a defined and homogenous alternative fuel capable of fulfilling the minimum requirements as defined by the German "Immisionsschutzgesetz". These were as follows:

- Homogenous and low in trace elements, such as heavy metals.
- Representative sampling in order to replicate sampling results.

Table 1. CV calculation for raw waste, pre-sorted waste and resulting processed RDF									
					Sorted only			Sorted and screened	
Material	**kcal/kgm**	**MSW contents per kg per 1 t before being sorted**	**Remaining % for each item upon sorting**	**RDF after being sorted (kg)**	**Sorted items per kg in every 1 t of MSW**	**Total kcal**	**RDF after being screened (kg)**	**Screened items in 1 t (kg)**	**Total kcal**
Hard plastics	7000	40	40%	16	68	475	68	89	622
Plastic film	7000	80	70%	56	237	1661	237	311	2178
Textile	3500	60	80%	48	203	712	203	267	933
Agricultural waste	1500	100	50%	50	212	318	212	278	417
Paper	3500	100	10%	10	42	148	42	56	194
Organics	800	400	10%	40	169	136	0	0	0
Metal	0	30	0%	0	0	0	0	0	0
Glass	0	30	0%	0	0	0	0	0	0
Other non-combustibles	0	160	10%	16	68	0	0	0	0
Total		**1000**		**236**	**1000**	**3449**	**763**	**1000**	**4344**

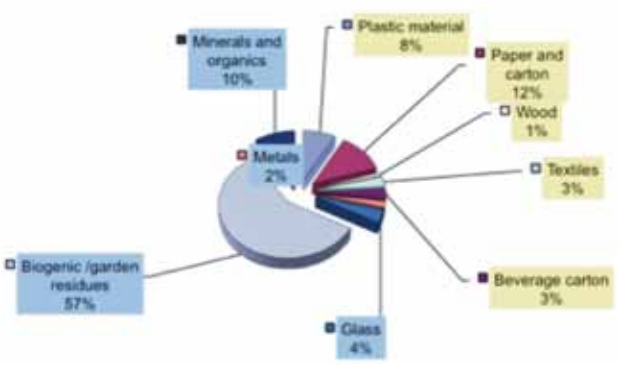

Figure 1. Average waste composition in developed European countries (58% of the waste can be processed into a RDF).

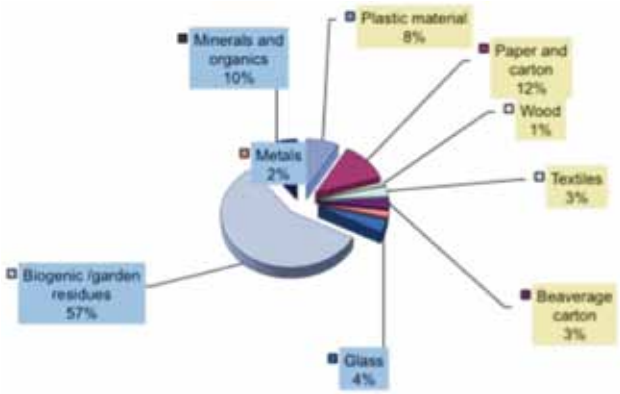

Figure 2. Only 27% of the municipal solid waste can be used for the production of RDF in India.

- CV and other physical parameters, such as ignition point, density, and burning behaviour, to allow a continuous substitution of fossil fuels.
- Simple transportation, storage and feeding at the plant.

For this reason, mixed municipal solid waste cannot be recognised as alternative fuels or even as product, even if it is processed into RDF. On the one hand, the CV can be increased, but, at the same time, trace elements or chlorine can also be concentrated.

Evaluating fuel characteristics

To substitute fossil fuels with RDF, the fuel characteristics (such as the mechanical, calorific, chemical and process specifics) have to be evaluated. Mechanical characteristics include the density, flow factors, grain size distribution, ash and unburnable content, as well as feeding to the kiln. The CV, heating value, moisture content, carbon content, minimum air requirements, thermal conductivity, and ignition behaviour also need to be defined. The authorities require a defined chemical composition in order to ensure pollution is minimised.

It is difficult to calculate the effects and behaviour of RDF due to their differing compositions and parameters. They are produced either from a defined, separately collected waste fraction (such as post-industrial wastes), or from pre-separated mixed waste, where defined fractions (such as textiles, paper, cardboard, plastic films, etc.) are processed. Following significant developments in the waste processing technologies, an average of 20 - 40% of mixed industrial or municipal solid wastes in Europe can be further processed into RDF (based on the waste composition in developed countries).

In many countries, especially developing countries, the waste composition is completely different due to other living circumstances and economics. An example from India can be seen in Figure 2. These figures are based on unsorted raw waste at the doorstep. Waste collection is carried out by an informal sector (waste pickers or scavengers), so the content of RDF usable fractions is even lower.

This has a direct effect on the required sorting technology, as well as on the achievable CV. To calculate the achievable CV in the remaining RDF, Lechtenberg & Partner calculates the possible quantities and values on a theoretical basis, before starting a costly sorting test with the waste.

Sorting, to separate all components of the waste, has to be carried out during a one year period in order to take seasonal differences into consideration, as well as special occasions such as Ramadan and Christmas.

The CV is also dependent on the moisture content, as only the original substance is analysed, including ash and moisture. MVW Lechtenberg can evaluate the expected RDF, based on its experience and large database of wastes (set to be published this year).

Separating the high CV fraction

There has been a significant development in sorting, separation and shredding technologies over the last 20 years. It is now possible to identify and separate different types of plastics within the material flow using technologies such as physical separation by density, volumes, magnetic, eddy current, or using opto-electronic separations systems.

With such systems in combination, a homogeneity of up to 95% can be guaranteed to secure a defined RDF. Even glass fragments from bottles can be sorted automatically by colour. Such equipment is expensive, so most waste processing plants use adaptive technologies, depending on the economical and technical needs.

In many waste management facilities, a manual separation is standard. In such stations, either valuable recyclables (such as aluminium cans) or foreign particles (such as stones) are separated, or a combination of both takes place.

The main equipment includes fully automated screens, air classifiers and shredding equipment to process a defined grain size and homogenous RDF. The equipment is usually imported from recognised, specialist manufacturers, combined with locally manufactured equipments such as screens and conveyor belts.

Three stage plan

MVW Lechtenberg has developed a three stage plan, which allows the cement plants to safely begin using RDF. For turnkey project implementation, the company works on the following three phases:

Phase I

- Verification and classification of existing waste types available at the source.
- Suitability of available wastes as RDF, and recommended feeding points.
- Quality requirements of secondary fuels.
- Impact of RDF utilisation on clinker chemistry and production processes.
- Impact on air quality (emissions).
- Thermal energy substitution and economical benefits.
- Project capital investment cost evaluation and return on investment.

Phase II

- MVW will support the cement plant in equipment choice, requisition and equipment verification.
- Development of the turnkey project, including engineering and sketch drawings for imported and locally manufactured items.

Phase III

- Support in the successful implementation of the secondary fuel project, including ongoing monitoring/quality management.

This year, the company started a processing plant for mixed wastes in Rajasthan, India, providing RDF for the local cement industry. Based on the feasibility study and basic design, the plant was manufactured in India. Reduced investment costs allow a production price of < US$30/t of RDF with a CV of 3500 kcal - less than half the price of coal, with a CV of 6000 kcal and a current sales price of US$100/t.

The result is an environmentally friendly waste management solution, reducing the environmental impact of land filling waste, creating new jobs and reducing CO_2 emissions while burning fossil fuels.

Within this system, only non-recyclable fractions are processed into RDF (such as coated papers, textiles or other composite materials). Valuable recyclables are sorted and returned to the material recycling. Hazardous wastes (such as batteries) are stored separately for further disposal.

Every cement plant can save natural resources and reduce fossil fuel emissions with a small investment in adaptive technologies.

Figure 3. Waste processing plant in Egypt.

Figure 4. The view inside a drum screen for fines separation.