Alternative Fuels in Developing Countries

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provides an insight into RDF utilisation in developing countries.

Introduction

Higher fossil fuel prices are increasingly forcing cement plants to consider the use of alternative fuels for clinker production. It is well known that refuse-derived fuels (RDF) save large amounts of money, based on various experiences in mostly European countries, where well developed waste collection and disposal systems combine with high disposal costs. For example, in Germany in 2007, more then 54% of the industry’s heat demand was met using RDF, and some plants now operate with “zero fuel costs” or even earn money through their ability to offer environmentally friendly utilitsation of appropriate wastes.

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Figure 1. Scavengers separating usable wastes.

Figure 2. Landfill at Rawalpindi, Pakistan.

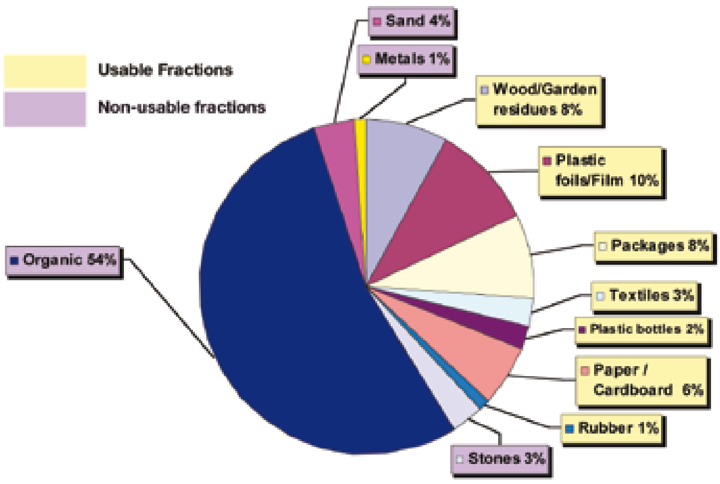

Figure 3. Usable and non-usable waste fraction (landfill in Rawalpindi, Pakistan).

However, the use of alternative fuels in the developing and third world countries is not well known – at least not yet. Increasing energy prices and the availability of financial support through the tools of the CDM (Clean Development Mechanism) Kyoto protocol are allowing the economic implementation of RDF in these countries.

In developing countries, it is a common practice to burn all kinds of waste in the open. Collection systems are not fully formed: only in main city centres is the residential waste collected regularly and transported directly to landfill sites. However, these landfills are often not designed properly, causing problems, such as the incomplete decomposition of municipal solid waste (MSW), methane production, and the contamination of groundwater by leachate. Scavengers collect the usable wastes, sometimes living solely off the residues of wealth.

A proper system of solid waste management is lacking in these countries, and the various bodies responsible for waste disposal are inefficient. For countries with a rapidly expanding population, the existing waste management capacities are inadequate, outmoded and need to be improved if the problem of ineffective solid waste management is to be solved.

MVW Lechtenberg is developing a number of projects in such countries, which are demonstrating that the use of RDF in cement plants has multiple positive effects, including safe and environmentally friendly disposal of wastes, and savings of both fossil fuels and direct costs. To implement RDF, the company developed a 3-stage plan, which allows the plants to be on the safe side when starting to use RDF. For RDF project implementation, the company works on the following three phases:

Phase I

- Fuels, raw materials and clinker are evaluated.
- The impact of RDF utilisation on the kiln line and coating tendency is verified.
- Studies of different technical and economical alternatives are undertaken, which inform the plant of the total investment costs, savings and returns.

On this basis, the plant is able to select the optimum solution.

Phase II

On the basis of the findings from Phase I, MVW supports the plant in choosing and requisitioning equipment.

- For the assessment of the required technologies, the company develops a project, which includes engineering and sketch drawings for imported and locally manufactured items.

- The company then develops a technical concept, according to state-of-the-art technology.
- At this stage, and after the plant's approval of the final layout, the company presents a summary list for the equipment supply, which is ordered by the plant.

Phase III

After the finalisation of Phase II and the requisitioning of materials, MVW supports the plant in the successful implementation of the secondary fuel project, including ongoing monitoring.

What follows is a detailed, model Phase I for the implementation of RDF at a cement plant in a developing country.

Technical and economic evaluation

In Phase I, the availability of wastes and their classification as a potential source for secondary fuels is evaluated. Based on interviews with local municipalities and governmental agencies, the current waste disposal situation is assessed.

Detailed manual sorting tests and analyses of the chemical and physical parameters of the available wastes are carried out; in particular, the quantity and quality of the available wastes are studied to obtain detailed information as a basis for further processing. The chemical analyses are used to calculate the effects of the RDF on clinker production. Fuels, raw materials and clinker are evaluated, and the impact of RDF utilisation on kiln line and coating tendency is verified.

The possible feeding points of the RDF to the kiln are assessed in order to provide the optimum solution. Most of the kilns in developing countries are modern precalciner types, so RDF of up to 80 mm, with three dimensions, can be used, which saves costs in processing.

These studies are carried out for different technical and economic alternatives, thus informing the plant of the total investment costs, savings and returns.

Environment

The environmental impact is also studied during Phase I. In most developing countries, the authorities have no experience with the use of RDF in cement plants; the comparison of local emission standards with standards in Europe or Germany is therefore taken into account. Various experiences indicate that the use of RDF in a cement plant has no negative impact on the environment, thus most authorities and local governments support the plants.

The effect on greenhouse gases (CO_2) is especially analysed and calculated to apply to the carbon credits. The "biogenic" content of RDF in developing countries is up to 60%, containing paper and cardboard, wood, textiles and other biomass.

CO_2 emissions will, however, be considerably reduced since, as a renewable resource, RDF

Table 1. Emissions reductions calculation for RDF usage in cement plants

Assumptions	
Crediting period	10 years
RDF output	5 tph 120 tpd
Operating hours	7200 pa
RDF-amount	36 000 tpa
Baseline emissions	
CH_4 avoidance	
Fresh waste total	500 tpd
Fresh waste total	175 000 tpa
CO_2 emission reductions from avoided methane emissions of fresh waste	33 502 tpa
Old waste used for RDF production	83 tpd
Old waste used for RDF production	29 050 tpa
CO_2 emission reduction from waste older than 15 yrs	-
Equivalent CO_2 emissions	**33 502 tpa**
Kiln operation	**Kiln operated with coal (anthracite)**
NCV anthracite	0.0267 TJ/t
CO_2 emission factor anthracite	98.3 t CO_2/TJ
NCV ratio	0.55
Required coal amount for equal energy output	19 820 t
Total energy	529 TJ
CO_2 emissions	52 020 tpa
Project emission	
Kiln operation	**Kiln operated with RDF**
NCV RDF	0.0147 TJ/t
CO_2 emission factor RDF	27.2 t CO_2/TJ
Incinerated RDF amount	36 000 t
Total energy	529 TJ
CO_2 emissions	14 416 tpa
CO_2 emissions reduction	71 106 tpa

Figure 4. Waste evaluation on landfill (Jaipur, India).

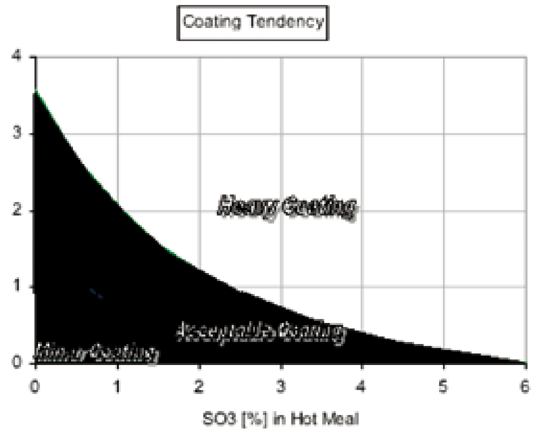

Figure 5. Coating tendency while using RDF in a cement plant.

reduces consumption of, and emissions from, fossil fuels. The reduced CO_2 emissions are recognised by the Kyoto protocol and are subject to trade on the CO_2 trading floor. As CO_2 produced from renewable resources is neutral to the climate, plants can sell their carbon trading certificates on the stock market. The current price for biogenic CO_2 emissions is approximately US$20/t.

Generally, most of the bigger municipalities with over 500 000 habitants produce enough waste to provide quantities that can be used for the economical introduction of RDF. The daily waste production per inhabitant varies from country-to-country between 0.6 – 1.2 kg of waste, which provides up to 500 tpd of waste. Based on the detailed sorting tests on the landfill, the amount of “high calorific value” wastes, such as paper and cardboard, packaging, wood, film and others, is approximately 25%, with a calorific value of more then 3500 kcal. In this example, this provides about 125 tpd, or 5 tph, of usable RDF.

Waste treatment in developing countries does not yet exist. The processing and separating of high calorific value waste has a positive side effect. The organic fraction is automatically separated and can be used for composting or as fertiliser. Stones and inert materials are used for construction purposes, so that the landfill holding time is extended. This means that most of the municipalities support plants in the development of such RDF projects and provide land as well as power supply for the separation equipment that needs to be installed.

Economics

The high calorific value fraction is separated and then transported to the processing plant on the cement plant site. At the plant, equipment is installed for shredding, metal separation, dosing and kiln feeding. A basic layout of the waste processing plant is made to evaluate the investment costs for such a project. The project costs for a processing plant with a capacity of 5 tph RDF, including dosing and feeding systems and depending on the local manufactured parts, is between €1.2 and €2 million. The processing costs of RDF, depending on the local labour costs, is between €15 and €25/t.

Table 2 shows that the plant is saving approximately US$1.3 million pa on fuel purchases, not counting possible gate fees for the waste from the municipalities. Most municipalities in developing countries do not have the financial background to pay such a gate fee. Even in this case, MVW is developing successful projects in Pakistan and India.

Table 2. Economic effects of using 4.5 tph RDF in a cement plant with 3000 tpd clinker production			
Kiln production			
Daily production (tpd)	3000		
Production rate (tph)	125		
Clinker production (tpa)	900 000		
Fuel consumption	**Total**	**Precalciner**	**Kiln**
Calorific consumption (kcal/kg Clk)	800		
%	100	60	40
tph	13	8	5
tpa	90 000	54 000	36 000
kcal/kg coal	8000		
kcal/kg RDF	4000		
Kiln operation			
Hours	7200		
Days	300		
Hours per day	24		
Revenue (US$/t)			
Cost of coal (US$/t)	130		
Cost of RDF (US$/t)	25		
Substitution of RDF (kiln in operation with nominal capacity)			
	Precalciner	**Main kiln**	**Total**
% substitution	30	0	30
tph	4.5	0	4.5
tpd	108	0	108
tpa	32 400	0	32 400
Annual cost of RDF (US$)	810 000	0	810 000
Coal equivalent (tpa)	16 200	0	16 200
Coal equivalent (US$)	2.106 million	0	2.106 million

The economical effects of carbon trading are twofold: firstly, gases (methane) produced in landfills belonging to municipalities are reduced; and secondly, CO_2 emissions are reduced because of the change from fossil fuels to green RDF.

The price for certified emission reduction (CERs) is approximately US$15/t for the new trading period. Assuming a total CO_2 reduction of 70 000 tpa, this will add a value of approximately US$1 million pa. Return on investment for such a project will therefore take 1.5 years, taking into consideration that the plant will only gradually introduce substitution.

Summary

Findings of Phase I have shown that the implementation of RDF from MSW in developing countries is environmentally friendly and gives plants a new opportunity for economical and sustainable development.