Pakistan: Alternative Fuels and the Cement Industry

Cement manufacturers in Pakistan are currently examining the possibilities of reducing the cement industry's energy imports by using alternative fuels from waste. Atif Munir of "Cement Pakistan Company" highlights Pakistan's first refuse derived fuel (RDF) project and the prospects of RDF in the cement industry.

MSW being screened at a landfill site in Islamabad.

Introduction

The cement industry in Pakistan plays a vital role in the country's economy. With 29 cement plants and an annual production of cement over 44 million t, it contributes significantly to the national GDP.

Table 1. Calorific values of various alternative fuels

Alternative fuel	Calorific value (GJ/t)*
Traditional fuels used in the cement industry:	
· Coal (6000 kcal/kg)	25.3
· Petcoke	33.7
· Coal-petcoke mix	29
Scrap tyres	27 – 31
Fractions from industrial and commercial waste:	
Pulp, paper and cardboard	17
Plastics	21
Packaging	22
Textile wastes	21
Others	21
Rice husk	13.3
Meat bone meal and animal fat	19
Waste oil	33
Mixed fraction from municipal wastes	15
Scrap wood	13
Solvents	24
Fuller earth	11
Miscellaneous, such as: Oil mud Organic distillation Residues	13

**To convert into Kcal/Kg multiply by 239*

Cement production in Pakistan has experienced great changes throughout history, passing from vertical wet-process kilns to short dry-process rotary kilns with cyclone towers, high-efficiency coolers and tertiary air to precalciners. Nowadays, after the improvement in production brought by high-efficiency clinker coolers, which allow the recovery of a significant amount of thermal energy through the preheating of secondary and tertiary air, one of the most important changes that can be identified is the use of alternative fuels.

At the moment, all fuels consumed by the Pakistan cement industry are imported to some extent, and energy typically accounts for at least 40% of the production cost of cement. Therefore, it is in the interests of the community and industry to increase energy efficiency by reducing the quantity of imported fuels for the cement manufacturing process.

Coal constitutes a major share of energy required for cement manufacturing. Some 90% of Pakistan's coal requirement is being fulfilled by imported coal. Since most cement plants are situated in the northern zone, there is a considerable cost associated with transportation and handling of coal, from unloading at the sea-port in Karachi to the respective cement manufacturing facility. On average, a 6500 tpd cement plant operating solely on coal requires 40 000 tpm of coal with consumption of 1100 – 1400 tpd of coal. Currently, cement manufacturers are paying US$90/t on CIF Karachi basis for 6000 Kcal/kg coal. Furthermore, after transportation and handling, each t of coal costs approximately US$120 to cement plants situated in northern zone, depending upon their location.

Like many developing countries, the disposal of municipal waste in Pakistan is a big problem that requires serious consideration. So far, landfill and incineration have been the main methods of waste disposal. However, such methods are becoming very difficult because of decreasing landfill capacities, pollution of seawater caused by the landfill sites in coastal areas, and air pollution caused by the emission of dioxins during waste incineration. Consequently, urgent improvements are required.

Types of alternative fuels in the cement industry

Alternative fuels of different nature and types can be used in the cement manufacturing process. Wastes from virtually all industries, including chemical wastes, agriculture waste, healthcare waste, out-dated consumer products, industrial and municipal solid waste (MSW) and whole or shredded scrap tyres, rice husk and refused derived fuels (RDF), i.e. plastic, polythene, paper, wood, glass, clothes, mud and fruit trash, can be used as fuel. Cement kilns present an excellent opportunity to use such wastes for the burning process. These wastes partially replace fossil fuels and therefore help in reducing the power bills.

Alternative fuels are materials such as used tyres that are rich in energy and that can replace coal or fuel oil as a source of thermal energy in the cement manufacturing process. For example, the thermal energy released from burning 1 t of tyres is equal to the thermal energy released from burning 1 t of high quality coals and 0.7 t of mazut. Additionally, alternative fuels often contain lime, silica, alumina or iron oxides, which are primary components in the production of clinker.

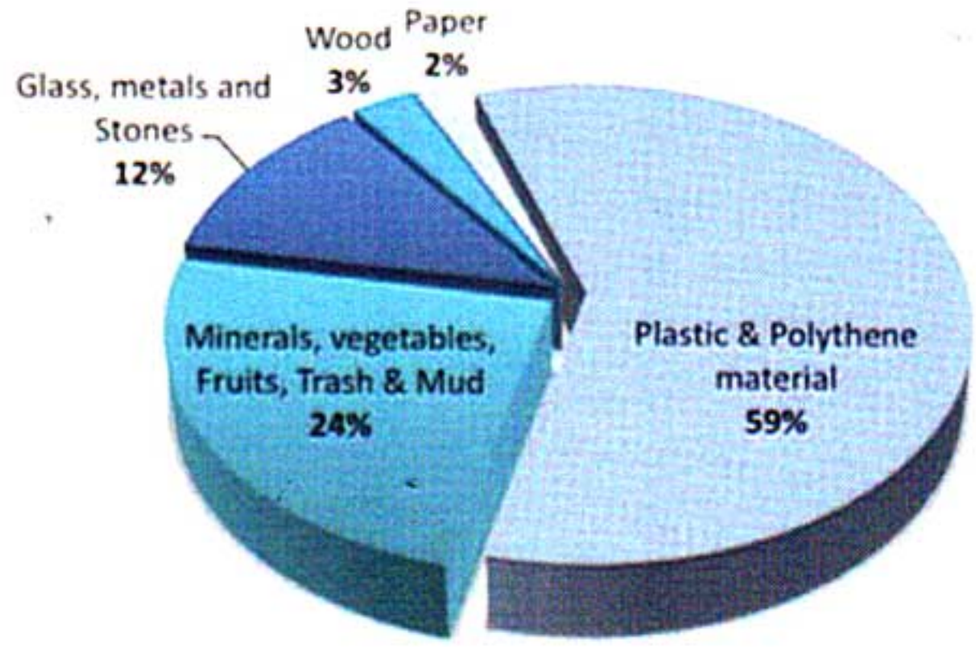
Using waste as alternative fuel is not only an excellent source of thermal energy, it is also an intrinsically safe method to dispose of community waste because of the relatively long residence times and the high temperatures in the kiln burning zone (1450 – 1600 °C), the cement manufacturing process creates very favourable conditions for the complete combustion of organic material such as community waste.

Pakistan's first RDF plant at Fauji Cement

For more than 10 years, the use of waste as an alternative fuel in cement production has been a well-established process across much of the European cement industry. However, cement manufacturers in Pakistan have been relying heavily only on rice husk as alternative fuel. In 2008, Fauji Cement Company became the first cement plant in Pakistan to install a Refuse Derived Fuel (RDF) processing plant, with a capacity of 12 tph.

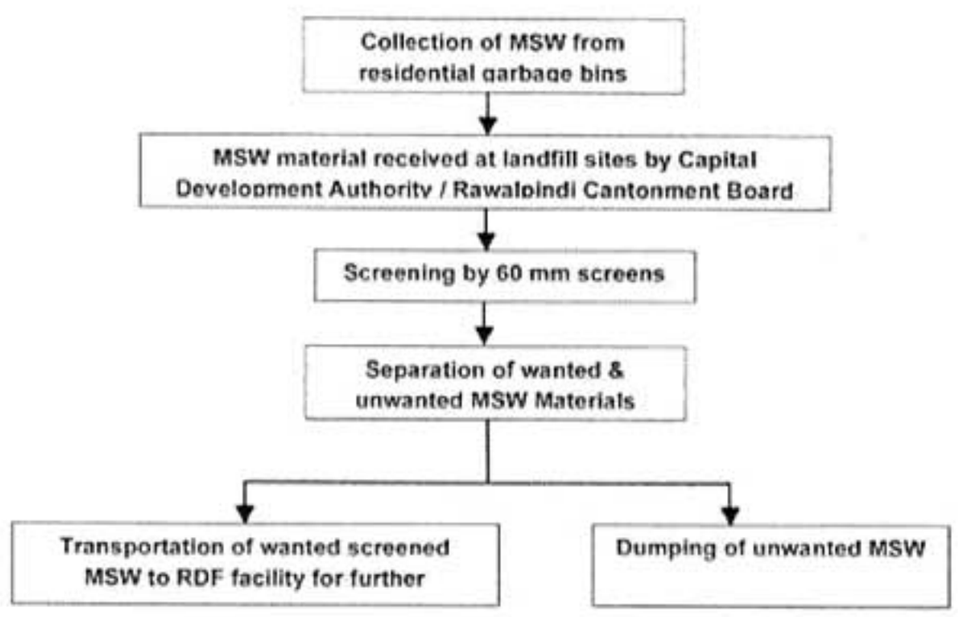
Fauji Cement Company operates a 3700 tpd cement plant at Jang Bahtar in Punjab province. Works are also in progress for the new 7200 tpd production line in parallel with the existing line.

As an environmentally conscious company, Fauji Cement Company recognised that the use of alternative fuels in cement production could bring multiple environmental benefits, such as reducing the need for natural resources and allowing for proper disposal of community waste.

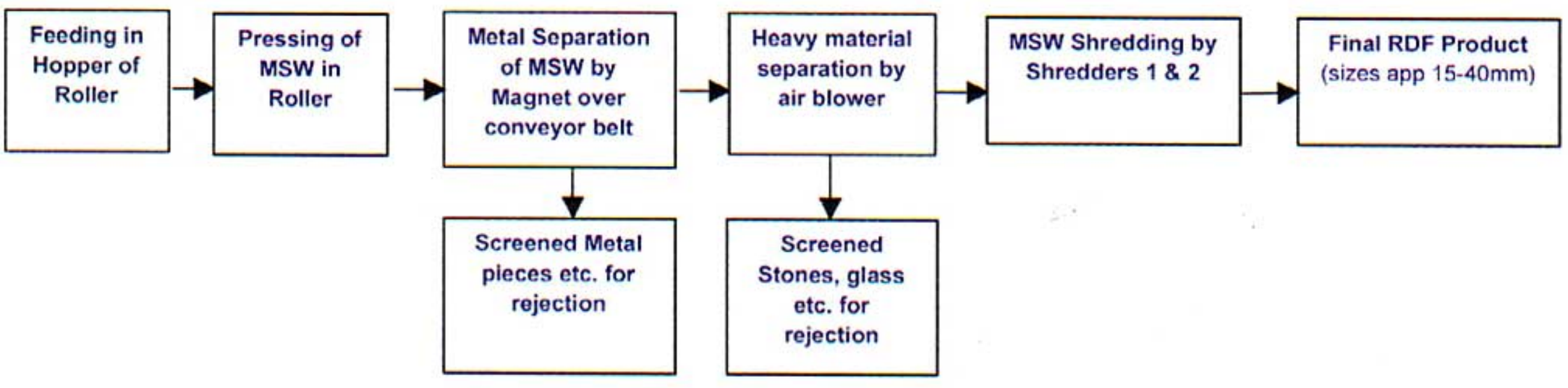


Typical composition of municipal waste.

Typical properties of final RDF product derived from Islamabad and Rawalpindi MSW			
Sr. No.	Parameters	Before treatment	After treatment
1	Calorific value (kcal/kg)	1500	3000 - 3500
2	Moisture content (%)	20 - 40 (max)	10 - 25
3	Bulk density (t/m^3)	0.5	0.2
4	Feed size (mm)	1000 (max)	15 - 40



Flow sheet diagram of MSW handling and processing.



Flow sheet diagram of MSW processing at RDF plant.

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Collection and handling of municipal solid waste (MSW)

Fauji Cement Company has the advantage of having its production facility near two big municipal cities, namely Islamabad and Rawalpindi. The RDF processing plant at Fauji Cement Company primarily processes municipal solid waste (MSW) from both cities. MSW is collected from the residential and commercial areas of Islamabad and Rawalpindi by various types of dumpers. This MSW is dumped at landfill sites in the cities, where Fauji Cement has installed three drum screen machines.

The quantity of fresh garbage available at Islamabad landfill site is approximately 300 tpd (120 trucks/day), whereas, the quantity of fresh garbage available from landfill site of Rawalpindi is approximately 150 tpd (60 trucks/day).

The MSW collected from the landfill sites is fed to the drum screens by the loaders. The useful MSW goes on for further processing, while the unwanted MSW (measuring less than 60 mm and comprising stones, glass, metallic pieces, mud and fruit trash) is buried at the relevant landfill sites. After screening, the useful MSW is lifted and transported by dumpers for further processing at the Fauji Cement plant.

RDF processing plant at Fauji Cement.

Processed RDF being conveyed to a rotor weighfeeder.

Processing of MSW at RDF plant

The screened MSW is again segregated and shredded in an RDF plant on site. A roller feeds the MSW to the loader where the MSW is pressed. The pressed product is then transported by a conveyor towards a metal detector, which segregates the metal pieces. The MSW is then pushed by a blower where the heavy material, glass and stones are again segregated. The MSW is then pressed hydraulically for feeding into shredders where it is shredded into small pieces of 15 – 40 mm as final RDF product and stored in the yard.

Feeding RDF into the kiln

Cement kilns are a very safe and effective alternative for disposal of waste compared to landfills or dedicated waste incinerators, where ash or energy may not be fully recovered. The prepared RDF is transferred with the help of dumpers to the dosing hopper over the conveyor belt, which takes the RDF and drops it into the pre-hopper for the weighfeeder. Afterwards, the RDF material enters in the rotor weighfeeder where the load cells calculate the tonnage of the RDF material. From there it is pushed/lifted through a high pressure blower and fed into the kiln via the calciner. The use of alternative fuels maximises the recovery of energy from waste that would otherwise have been incinerated and would have produced harmful emissions. The process also maximises the recovery of the non-combustible part of the waste and eliminates the need to dispose of slag and other residues, since the inorganic part of waste is used as a substitute for raw material in cement production.

Although Fauji cement's RDF plant has a capacity of 12 tph, it is not being fully utilised due to the nature of the final product and feeding problems. Therefore only 2 – 3 tph of processed RDF is currently being used, which also raises many questions on how effective this system can be in Pakistan.

Rice husk as alternative fuel

Unlike MSW, the use of rice husk as alternative fuel is widely accepted in Pakistan's cement industry and has been adopted by cement manufacturers for many years. Pakistan, being an agricultural country, provides excellent opportunities for cement manufacturers to utilise agricultural waste, especially rice husk, as alternative fuel. The husk, which accounts for 20% by weight of rice, comes from the rice milling process as a byproduct. Generally, a large amount of rice husk is dumped as waste, which results in waste disposal problems and methane emissions. Moreover, the low density of rice husk can cause it to be airborne, resulting in respiratory problems.

Rice husk has several advantages over MSW. Firstly, there is no cost involved in the preparation of feed. Secondly, rice husk is preferred for its easy transportation, handling and uniformity. Rice husk briquettes (briquetting is a technology that uses either a dry or a wet process to compress rice husks into definite shapes) are unloaded from trucks and fed directly into a large hopper. Metals are removed with the help of a metal detector installed on a conveyor belt from where the feed is taken to a screw conveyor and fed into the calciner with the help of rotary feeder.

Rice husk is effectively used as an alternative fuel at D.G Khan Cement plant.

Benefits Of RDF

Using RDF benefits the community as well as the cement industry. The combustion of RDF in cement manufacturing kilns allows for a reduction of about 1.61 kg of CO_2 per kg of utilised RDF compared to conventional combustible fuel (coal).

- The use of RDF:
  Reduces production costs of cement manufacturing by replacing a significant percentage of imported fossil fuels (coal, fuel oil, petcoke).
- Prevents resource depletion of valuable non-renewable fossil fuels.
- Increases the recovery of energy from wastes and also ensures their safe disposal.
- Maximises overall environmental benefits by reducing releases to air, water and land.
- Overcomes the need for the construction of dedicated incineration facilities and landfill sites.
- Contributes positively to the principles of sustainable development.

Challenges

In the absence of an effective waste collection mechanism in Pakistan, the separation of the 'high calorific-value' part from MSW is difficult. The secondary fuel obtained from municipal solid waste, in the context of waste characteristics, corresponds to only 3000 – 3500 kcal/kg compared to Germany, where mainly only suitable secondary fuels with calorific values greater than 5000 kcal/kg are used.

As combustion performance is directly related to fuel dosing accuracy and dosing system reaction time to control settings, cement kilns perform best when fed with homogeneous RDF composition that is uniform not only in shape and size but also in calorific value. In terms of uniform size, it is generally required that waste has to go through an adequate process of size reduction to make it reusable as a quality RDF. The material has to be uniform in size to facilitate its transportation and in many cases must be selected by a screen to obtain the optimal final size for the kilns depending on the feeding location. In terms of uniform heating value, it is important to guarantee homogeneous composition of waste allowing the material to burn releasing the same constant quantity of heat. It is therefore important to blend the different material types before the size reduction process or when the final material is in a pit.

Nevertheless, waste and residues could not be used without special care. There are contaminants that can be extremely damaging to the kiln operation, such as chloride, fluoride and moisture content. The most important recirculation substances that can affect the operation of a cement kiln system are alkali sulfates and alkali chlorides. Secondary fuel made from MSW has a natural chlorine content of >0.4% resulting from natrium chlorides (cooking salt). As sodium chlorides in the raw materials (especially lime and clay) are already quite high, this may result in operational problems. Chloride is a powerful oxidant that can corrode plates and, in addition, cause the gas circuit to block, and especially the smoke chamber. Fluoride, on the other hand, is a strong flux that can bring down coatings. Moreover, water, which is always in RDF up to 25%, reduces the available gas volume in the kiln, and additional energy is required to destroy the water content of RDF, thus causing energy losses. The water evaporated from the residues considerably increases the volume of exhaust gases, and a decrease of production might be expected in order to maintain the O_2 levels at the smoke chamber and at the exhaust of the cyclone tower.

Special computer programmes with the most appropriate configuration should be used for simulation of a cement kiln to calculate the approximate amount of solid residues or waste that could be injected into the kiln for safe operation.

The investment involved and the long payback periods for process modifications also make the cement industry very cautious when opting for new alternative fuel

technologies. Even if the raw material (waste) is available free of charge, production of alternative fuel is not. It requires painstaking sorting/separating of the calorific rich content, additional comminution, foreign-matter release (metals, stones, etc.), homogenising, storage, transport and feeding in the cement plant. Meanwhile, no disposal fees are offered by the government for accepting the waste. In fact, the MSW in Pakistan is considered property of Municipal Authorities, which intend to generate some revenue by selling it on to interested parties.

Conclusion

The cement industry in Pakistan can play a significant role in the country's sustainable development with regard to waste disposal. Although the use of RDF in the cement manufacturing process contributes positively to the principles of sustainable development, this cause involves local as well as global issues and it is not the same in all countries, or in all businesses. Depending upon different local circumstances like emphasis on economic growth, social progress and environmental management, sustainable development can vary considerably. This explains why the use of RDF in Pakistan's cement sector is more appealing to cement manufacturers in terms of its cost reduction benefits than for its environmental advantages. Therefore, attractive packages and suitable framework conditions need to be created first by the government. Considerable waste volumes, even defined and suitable special waste, such as oil sludge, dried sewage sludge and others, can be recycled in an environmentally-friendly way in the cement industry. The use of alternative fuel depends a lot on the distance between the end-user and the point of waste generation; the government should therefore encourage and provide MSW processing facilities for cement manufacturers at landfill sites. Cement manufacturers should also explore other forms of alternative fuels to feed their energy-hungry cement units. Scrap tyres, for example, which contain high calorific value and are an important form of alternative fuel, are yet to find use in Pakistan's cement industry.

Apart from immense savings potential for landfill capacity, damaging emissions are avoided and valuable energy resources are saved. Also, from a socio-economic point of view, the transformation of such an 'environmental' concept makes sense: currency for fuel import is saved; new jobs are created in the collection, transport and processing of waste. However, all this costs money, and these costs cannot simply be added to the cement industry's burden. The city municipal authorities must play their part in the costs involved in such an environmentally-friendly concept to create a win-win situation.

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