EMERGING ASIAN TREND IN COMMERCIAL POWER GENERATION FROM MSW

By

Dr. P.K. Balasankari, B.E., M.Engg., Ph.D.
Executive Director
Renewable Cogen Asia
balasankari@rcogenasia.com

Arul Joe Mathias, B.E., M.Engg., M.B.A.
Managing Director
Renewable Cogen Asia
aruljoe.mathias@rcogenasia.com

Introduction

Municipal solid waste (MSW) comprises of domestic wastes and commercial wastes collected within an area. MSW includes biodegradable waste, recyclable material, inert waste and hazardous waste. With the increasing rate of MSW generation many Asian cities are finding it a great menace to deal with. With the ever increasing demand of electricity on one hand and the waste disposal problem on the other hand, the power generation from MSW offers the best solution for both the problems.

Current Practice in Asian Countries

Among Asian countries, only few countries such as Singapore, Thailand, Korea and Japan have been following much more advanced MSW management practices for more than 2 decades. All these countries use MSW incineration plants to get rid of the MSW. Singapore follows the concept of "reduce-reuse-recycle" and the Government is keen in creating awareness among the public in this regard.

In other Asian countries, MSW management started picking up only after 2000, especially after the development of CDM concept. Before 2000, landfilling was the most common practice to manage MSW. Most of the recent landfill sites are engineered properly to assist better landfill gas recovery and separation of leachate.

The incineration concept is slowly picking up in Asia. New concepts like segregating biodegradable wastes from MSW and producing biogas in anaerobic digesters are also getting popular. Such biogas power plants are already in operation in Singapore, Thailand, India, etc.

Use of advanced technologies such as incineration, RDF combustion, biogas generation and LFG to power for MSW management in Asian cities looks brighter. Though development has taken place in MSW management in Asian cities, still it is far away from perfection.

Landfilling and LFG Recovery

Landfill gas (LFG) is a by-product of decomposition of MSW. Only when the CDM concept got matured, so many project developers started hunting for landfill sites to develop landfill gas recovery projects. Most of the sites in Asia were of open dump type. However, recently engineered landfill sites have been prepared for MSW waste disposal and collection of LFG.

LFG production depends upon the waste composition, weather condition and landfill management. For good LFG generation, the amount of waste dumped should be greater than 1 million tonne in a site with a depth of more than 10 m, preferably without any major fire accident.

The landfill gas can be recovered using a network of perforated gas collection pipes and the gas can be used for power generation. As the CDM methodology got stringent these days, the project developers are going in for closed flare system, where the project emission is minimal when compared to that of the open flares.

The production of LFG starts in a landfill site within a few months of waste disposal and lasts for about 10 years or more depending upon the composition of waste, its availability and moisture content. Generally depth of the landfill gas well is 80% of the height of the landfill.

The gas is usually pumped out using a blower and the moisture is removed in the moisture trap and then cleaned using SO_2 scrubber before passing it to the engine, to produce electricity.

Landfill is the least cost option for MSW management. However, there is risk of soil and ground water contamination during rainfall in the absence of proper leachate treatment system. In addition, it requires large space which is another hindrance for Landfill projects.

MSW to biogas

MSW to biogas is one of the new concepts in the management of MSW. Developed countries have taken the lead to treat the bio-degradable MSW through anaerobic digestion. The sludge from anaerobic digestion can be sold as manure. Other major advantage of MSW to biogas is the reduced land requirement. Compared to landfill, the size of MSW biogas plant is very small.

This approach involves segregation of biodegradable waste such as vegetable wastes, food wastes, etc. from MSW and using it in a biogas reactor to produce biogas. In a typical Asian city such as Beijing, Mumbai, Bangkok, etc., organic material accounts for 80% of the MSW. The net biogas production ranges from 100-120 m^3 per tonne of organic MSW and the compost generation is around 500 kg.

There will be ferrous and glass removal systems before the biodegradable waste enters the digester. Separate MSW collection system from vegetable, food and fruit markets will be helpful in the separation of biodegradable waste for biogas generation.

H_2S, CO_2 and moisture have to be removed if the biogas is to be used in engines for power generation. If the biogas generation is expected to fluctuate, then it is better to have a gas holder. Some of the cities like Singapore, Bangkok and Chennai have modern power plants operating with biogas generated from MSW.

Incineration

Incineration involves the combustion of Municipal Solid Waste (MSW) without any pre-treatment (also called mass burning). Mass burning has been in practice in developed countries for more than 100 years. More than 600 mass burning plants are in operation around the world.

Volume reduction of MSW for about 90% is possible with incineration plants, thereby resulting in considerable reduction in land required for disposing the 90% MSW

In MSW mass burn system there is no pre-treatment except the removal of visible bulk items. However, some of the wastes such as construction debris, earth, concrete, stones, chemical waste, explosive or highly flammable waste, carbon fibres, insulation materials, Polyvinyl Chloride (PVC) etc., are not suitable for mass burn. It is also advisable to separate the biodegradable wastes from MSW to use in digesters so that the biogas from the digester can be used to generate power using gas engines.

Only few countries in Asia have a long history of proper management of MSW using incineration power plants. As of now, there are 4 power plants of sizes ranging from 30 MW to 80 MW are in operation (for more than 25 years) in Singapore and one more plant is under commissioning. A 2.5 MW incineration plant is in operation in Phuket, Thailand.

For the mass burn facilities, the minimum calorific value requirement is 7 MJ/kg on an annual average basis. The moisture content and percentage combustible are also important parameters in MSW mass burn technologies. The impact of MSW scavenging on LHV should also be taken into account.

The investment cost and annual O&M costs for MSW based power plants are much higher than biomass projects. SOx, NOx, dioxin, heavy metals, HCl and air born particulates, fly ash and bottom ash are the pollutants from mass burn power plants. The devices/processes commonly used for effective removal of pollutants include electrostatic precipitators, fabric filters, scrubber & lime injection system and activated carbon injection system.

With the use of modern technologies, it is also possible to minimise water pollution, odour and noise problems. It is also possible to recover ferrous metals from the ash which provides additional revenue.

Japan, China, Korea and Taiwan too have implemented many incineration plants in the recent years. The potential for incineration plants in Asia is high. Among all MSW management systems, incineration to power is more popular in Asian cities because, it eliminates the need of land requirement for landfilling.

RDF Combustion

Refuse Derived Fuel (RDF) is a method of pre-processing the waste in order to use it as a fuel in boilers. This technology involves various processes to improve physical and chemical properties of solid waste. Basically, RDF systems are used to recover recyclable materials and to separate MSW into combustible and non-combustible fractions. The combustible material is called RDF and can be used in boilers. Typically the volume of waste is reduced to 20 to 30%. RDF has a higher calorific value when compared to that of MSW.

Waste sorting includes primary and secondary trommel screens which mechanically separate the dry fraction from the organic one, magnetic and induction-type separators for metals recovery, a glass recovery system and a shredder.

Due to reduction in fuel particle size and reduction in non-combustible material, RDF fuels are more homogeneous and easier to burn when compared to the MSW feedstock.

Emission characteristics of RDF are superior due to less NO_X, SO_X, CO and CO_2. The advantage of the refuse-derived fuel plant type is the relatively higher energy content of the RDF fuel.

Several RDF plants are in various stages of implementation in Asia. In India, an RDF fired MSW plant is in operation for quite a few years.

The investment cost of RDF based power plants is higher when compared to that of biomass plants. Implementing such projects take more time when compared to that of biomass power plant projects.

CDM and MSW management

Until 2000, not much importance was given to the management of MSW in Asia. But, once CDM activities started began, the project developers started paying attention to MSW projects for the benefit of revenue from CER sales which would make the project feasible. CER credits can be obtained from two streams: a) from avoidance of methane and b) from electricity generation.

Several CDM project developers were attracted with the MSW landfill sites in Asian cities that were in operation. These sites provide excellent opportunity to recover methane at low cost and then to produce electricity using gas engines.

Although MSW power plants are eligible under Clean Development Mechanism, there are certain restrictions in selection of technology and usage of MSW. Therefore, the project developer should not neglect these aspects while developing the projects to get CDM CER revenue.

Implementing MSW power plants

Implementing MSW incineration projects are more time consuming when compared to that of biomass power plants as they require a very careful preparatory work. Otherwise, the chances of failure for such plants are high. There are several failure plants which have been sold as scrap. Hence, project developers should pay adequate attention and do the necessary preparatory works before implementing these projects. It may also be worthwhile to engage qualified expert to study all modern concepts and innovative technologies. But the technology selection should be done carefully.

Plant Economics

As of now, the total investment cost of MSW incineration plant is on the higher side. The higher cost of the MSW projects is due to the requirement of anti-corrosive materials in the construction of the plants, comparatively bigger size of the boiler and complex environmental controls. Also the heterogeneity in the MSW characteristics warrants the flexibility in MSW plant design which increases the cost.

The revenue generation from the sale of electricity alone is not sufficient to make the project commercially attractive. Other parameters such as tipping fee, CDM CER revenue and compost sales are also needed to make the project commercially attractive.

The total investment cost for landfill sites with power generation and MSW biogas plants are also on the higher side. But in several situations, CDM revenue plays an important role in the realisation of the project.

Future trend

In future, MSW incineration plants will be the preferred choice for the MSW management as it mainly solves the land issues and other environmental issues related to landfilling, apart from generating electricity.