

An overview of utilisation of landfill gas as a source of energy generation



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ABSTRACT

Energy crisis is one of the major problem in developing countries like India, which affects Industrial sector as well as human comforts. It's impact is increasing continuously along with the time, which is only the reason brought all researchers to concentrate on new ways of energy production, among those different kinds of energy generation ways, electricity generation by using landfill gas as source is one of the technology which is proving, itself by all means. Landfill gas can be defined as; it is gas containing major constituents as Methane, Carbon dioxide, Nitrogen and trace constituents as acetone, benzene e.t.c generated from landfills due to decomposition of organic matter. This article discusses about the, source for landfill gas generation, necessity of utilization of landfill gas in present scenario and some common technologies used in producing power by using land fill gas.

Keywords: Gas turbine, Energy, Landfill gas, Municipal Solid Waste management, sanitary land filling.

1. INTRODUCTION

Generally land fill gas can be defined as, gas resulted by the decomposition of organic waste from the municipal solid wastes, with the major constituents as methane, carbon dioxide, nitrogen e.t.c and also benzene, acetone as the trace constituents. Generally the production in land fill sites takes place at higher temperatures and the gas will invariably saturated with water vapor. It is an expectation that normally the land fill gas have a calorific value of 15 to 21 MJ/m³ (Half that of natural gas) [1]. As we all know that generally now a day's one of the common problem all over the world for developing countries like India is energy crisis, one has to overcome in any way to improve quality of life, as well as to bring better changes in industrial and agricultural sectors. Especially in countries like India agriculture is one of the major source of income for non skilled labour, it is observed from so many areas that due to lack of sufficient energy resources and un offered price of electric power people are unable to cultivate their fields up to the mark. From the

source [2] Ministry of Statistics and Programme Implementation that major share of power produced was occupied by the Industries, next to agriculture such a 45%, 18% respectively.

As mentioned above even though most parts of the India is based on the agriculture on the name of urbanization and industrialization we are diverting the energy sources to industries & commercial activities, in future also this trend may continues, which indirectly indicates it is not possible to allocate sufficient power to agricultural sector, we can consider this type of situations as a sign of energy crisis. This is all because of limited coal reservoirs, and while coming to hydro power plants it is having a highest efficiency 85-90% but purely dependent on season. Other remaining ways of power production generally now a day's all the countries in the world are following, is solar and wind they also have their problems in continuous encouragement as factors like economics, land utilization are concerned. One of the oldest ways in power generation is utilization of oil resources that also now a day's fall in threat because of the rapid increase of their utilization in transportation sector, now a days if we observe everyone is using individual vehicles, no one is interested in using of public transportation. It is noticed that from assessment of IPCC (International Panel on Climate Change) that global oil demand will rise by 60% from 75Mb/d in 2000 to 120 Mb/d in 2030. These all reasons made researchers to think over the different ways of energy production.

2. SOURCE OF LANDFILL GAS GENERATION:

As it is known fact that generally landfill gas (LFG) will be evolved from the municipal solid waste decomposition or digestion, generally as there are many resources available to researchers to generate energy, even though some of the reasons made to concentrate on LFG is abundant availability of municipal solid waste. There are so many studies were done on the municipal solid waste generation and its disposal, among the all available methods of maintaining of municipal solid waste land filling is one of the cheapest method, as developing countries like India it is really a suitable option. Basically for developed countries there might be problem of

land, but in India it is not a problem at present, as availability of empty lands is concerned. From the sources [3] it is absorbed that the average utilization amount of municipal solid waste (MSW) in Malaysia is reached 0.5–0.8 kg/person/day and it number was almost doubled, that is 1.7 kg/person/day in major cities. It is estimated that an average of 2500 tons per day (TPD) of municipal solid waste (MSW) is generated from the one of the major city like Kuala Lumpur in Malaysia and is being dumped by using sanitary land filling (Scientific way of disposal of Municipal solid waste). Because of continuous developments, and lack of space for maintaining of new landfills, people in Malaysia were switching to options of Incineration. But in India there is no problem of space as mentioned above, while coming MSW utilization rates in India, here also we can observe a lot, while coming to characteristics of LFG, we can observe from table: 1 as follows, extracted from the literature [4].

Table: 1: Composition of Landfill Gas

Constituent Range	Percentage or Concentration
Major Constituents	
Methane	30 to 60 %
Carbon Dioxide	34 to 60 %
Nitrogen	1 to 21 %
Oxygen	0.1 to 2 %
Hydrogen Sulphide	0 to 1 %
Carbon Monoxide	0 to 0.2 %
Hydrogen	0 to 0.2 %
Ammonia	0.1 to 1 %
Trace Constituents	
Acetone	0 to 240 ppm
Benzene	0 to 39 ppm
Vinyl Chloride	0 to 44 ppm
Toluene	8 to 280 ppm
Chloroform	0 to 12 ppm
Dichloromethane	1 to 620 ppm
Diethylene Chloride	0 to 20 ppm
Vinyl Acetate	0 to 240 ppm
Trichloroethane	0 to 13 ppm

3. AVILABILITY OF MSW:

Municipal solid waste is generally contains waste which was refused from your common daily activities, it contains vegetable, garden waste and others like paper, cloth and e.t.c. It contains a lot of organic waste, which leads to generation of landfill gas, from the source [5] it is absorbed the general composition of MSW was as follows biodegradable of 50% , recyclables 20%, Inerts 22%, others 8% in India. And it is also absorbed that the solid waste generation rates were 0.1kg,

0.3-0.4 kg, and 0.5kg per capita per day in small, medium, and large cities and towns respectively. Urban local bodies (ULB) are spending around Rs.500 to Rs.1500 per ton on solid waste management, out of which 60-70% of the amount is spent for collection and 20-30% is for transportation. It is also estimated that there will be chance of annual increase of waste generation rates will be as 1.33% per year per capita. In some cities, best example is Hyderabad, waste disposal is done by public private partnership. In most of the cities they are encouraging door to door collection, street sweeping and e.t.c. This much of care is taken in aspect of MSW from the ULB's is only for the purpose of sanitation. This is one of the key factor has to address as quality of life and developments of civic services are concerned, otherwise people normally will encourage open dumping or open firing as shown in figures.



Figure: 1 Open dumping of Municipal solid Waste



Figure: 2 Open firing of Municipal solid Waste

As we all know that due to rapid urbanization and increase in standards of living, lead to utilization of lot of municipal solid waste, as stated above day by day the trends shows drastic increase in the MSW utilization, this statement can justified if we closely observe the following numbers formulated in table 2 the same we can observe in the bar chart,

these are statistics of India in connection with MSW utilization, by the survey conducted by central pollution control board (CPCB)[6], through EPTRI (1999-2000), National Environmental Engineering Research Institute (NEERI) - Nagpur (2004-2005), central institute of Plastics Engineering and technology (CIPET) during 2010-11 in some of the well known cities. And as reported by State pollution control board (SPCB) and PCC to CPCB, the total estimated quantity was 127485.107 MT/ day during period of 2009-12. By the end of 2015 or even in upcoming years also if we observe the reports that number may still increase, much higher than what we expect, so from these we can easily conclude that there is no problem of availability of MSW, and it is compulsory to ULB to dispose in scientific way so there is lot of scope of getting LFG, as source for power production

Table: 2: M.S.W utilization in some of the major cities of India

	Name of City	Municipal Solid Waste (TPD)		
		1999-2000	2004-05	2010-11
1	Coimbatore	350	530	700
2	Surat	900	1000	1200
3	Pune	700	1175	1300
4	Hyderabad	1566	2187	4200
5	Mumbai	5355	5320	6500
6	Delhi	4000	5922	6800

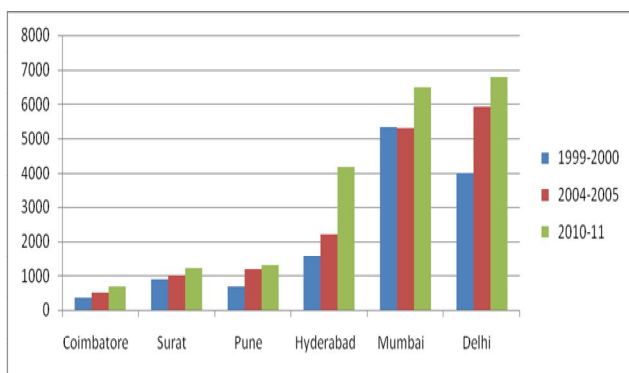


Figure 3: Municipal solid waste utilization in some of the major cities of India

4. LANDFILL GAS RECOVERY:

Landfill gas recovery is the one of the major issue has to be taken care while starting a project based on landfill gas to energy conversion, normally it is recommended to select the municipal solid waste dumping sites which has almost one million tons of waste, and age of the site which is less than 10

years is preferable, such type of sites are good enough to generate required amount of gas, generally the tapping of gas was done by using the network of vertical or horizontal piping systems, the most common type is vertical type of gas wells, they generally prepared by perforated high density poly ethylene or poly vinyl ethylene. The dimensions of wells normally consists of 50 to 300 mm diameter, surrounded by gravel of 25-35 mm size up to 300mm. Commonly the gas wells are arranged up to the height 80% of the height of the landfill. Finally the networks of pipes were connected by a main collection header and they will be passed through the moisture trapping system, and gas cleaning units [4].

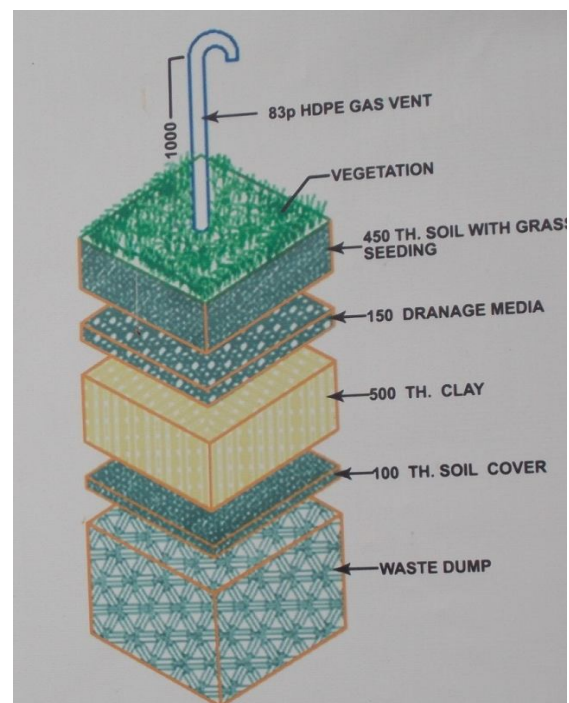


Figure4: Tapping of landfill gas through gas vents

5. POWER PRODUCTION BY USING LAND FILL GAS:

The operation of power generation by using landfill gas source, is similar to the gas power plant, where LFG volumes are in higher rates in such type of conditions we can implement, the use of gas turbines, generally these generate minimum of 3 to 5MW. According to the size of the gas turbine the cost per kW gets reduced [7]. For lower percent of methane (Nearly 35%), and also for places of availability of LFG less than 300cfm we can implement the use of micro turbines, they will play a very crucial role at low gas availability situations [8]. The views of gas turbine as well as micro turbine can be seen as follows.



Figure 5: Gas turbine

[Source: LFG Energy Project Development Handbook]



Figure 6: Micro gas turbine

Simple gas cycle turbines working with fluid as Landfill gas typically have an efficiency of 20 to 28 percent at full load, but at the conditions of partial loads we can observe drop in the efficiency. However in the case of combined cycle configurations (which recovers the waste heat in the gas turbine to produce electricity) we can achieve an efficiency of 40 percent. But one of the primary disadvantages of the gas turbine is that they require high gas compression, causing high load loss of parasitic power [7].

6. CONCLUSIONS:

As it is a known fact to all of us due to continuous developments in the living style of peoples we can conclude utilization of municipal solid waste will increase

continuously without any doubt, this conclusion made not only from the present trends of India, and also observations from the already developed countries, as we all aware that sanitary land filling is only cheapest technique till today for better way of MSW management ,In India as we luckily blessed with a lot of geographical area we can encourage land filling and we can go for trapping of landfill gas, so that we can utilize that landfill gas as a source of energy production, by encouraging these projects, it is expected that this way of projects bring very good results in the field of waste to energy conversion, and it is also expected that continuous developments in this area will bring energy production technologies in to your hand with low cost and high flexibility.

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