



Waste to energy technologies for municipal solid waste management in Gaziantep



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ABSTRACT

Landfill gas (LFG) which is produced by means of municipal solid waste (MSW) treatment activities can be considered as a source of greenhouse gases, including mostly methane. Therefore its management plays an important role. During the process of methane production in MSW plants, LFG is collected, treated and then used for power production purposes. Although there have been many technologies existed, incineration and landfilling methods are mostly preferred all over the world today due to their high energy production potentials. The increasing amount of solid waste arising from municipalities and other sources and its consequent disposal have been the major environmental and economic problems in Turkey. Furthermore, providing more effective and eco-friendly solutions has been a key point for Turkey while being a candidate country for European Union (EU) accession. In this paper, a brief overview on recent technologies and methods applied to MSW management in the world is presented. Current research studies accessed on the literature on MSW are outlined. Moreover, recent MSW management in Gaziantep metropolitan city is displayed with the existing method which produces LFG for power production. Some concluding remarks and recommendations are presented for future developments in MSW management.

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1. Introduction

Municipal Solid Waste (MSW) known as trash or garbage consists of food waste, paper, cardboard, plastics, PET, glass, textiles, metals, wood and leather, nappies, slug, ash, etc. Urbanization level, population growth and technological changes support

to increase MSW generation in developing countries. Landfill gas (LFG) which is produced by means of MSW treatment activities can be considered as a source of greenhouse gases, including mostly methane. Thus, all treatment activities of MSW can also be turned into an opportunity for a sustainable production of energy which is known as "waste-to-energy" (WTE). Due to the moisture content of MSW, its lower heating value varies between 5 and 20 MJ/kg. In the same manner, International Energy Agency (IEA) reported that a ton of MSW should have a calorific value between 8 and 12 MJ/kg for an effective energy generation [1].

In previous years, unsanitary landfill activities, open dumping and open incineration methods were common solutions to remove

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MSW from city centers without considering their energy potential and environmental impact. Rapid increase in population and industrial developments has led to findings of new technologies alternatively to these conventional insufficient methods for disposal of MSW. Besides, WTE technologies have become popular research area for governments, researchers and entrepreneurs.

There are three fundamental types of WTE technologies [2]: (i) thermal conversion methods (incineration, pyrolysis, and gasification), (ii) biochemical conversion, (iii) landfill. In thermal conversion technology, the mostly used method is incineration. “Incineration” method is mainly the waste destruction in a furnace by controlling combustion at high temperatures. By the incineration method, approximately 70% of total waste mass and thus 90% of total volume can be reduced [3]. Incineration process is completed in three steps which are incineration, energy recovery and air pollution. After incineration process, air pollutants such as SO_x , CO_x , and NO_x which are harmful for human health occur. The process is performed between 750 and 1000 °C. “Pyrolysis” is another method in which thermal waste treatment is taken place in an oxygen free environment. There are three types of pyrolysis methods which are conventional pyrolysis (550–900 K), fast pyrolysis (850–1250 K), and flash pyrolysis (1050–1300 K). The third thermal conversion method, “gasification”, is a process that converts MSW into CO_2 , CO and H_2O , which occurs by reacting MSW at high temperatures ($> 700^\circ\text{C}$), without combustion, with a controlled amount of oxygen and/or steam [2]. Due to reactor design and operational parameters, gasification process generates other higher hydrocarbons (HC) besides methane. The obtained combustible gas includes CO, CO_2 , CH_4 , H_2 , H_2O , some inert gases, trace amounts of higher HCs and various contaminants such as small char particles, tars and ash.

The second main group of WTE technology is biochemical conversion. It is much more eco-friendly when compared with others. Biochemical conversion is primarily based on the reaction of microorganism enzymes. Biochemical conversion method is divided into two subgroups as “Anaerobic Digestion” and “Composting” [2]. In “Anaerobic Digestion”, MSW is collected in an oxygen free environment, which is a combination of series of biological processes in which microorganisms break down to biodegradable material. This process which occurs at almost 65 °C decreases the amount of waste and produces biogas for combined heat and power or as a transport fuel. The rest of the production such as inorganic and the inert waste are either incinerated or gasified. By means of this process, 2–4 times as much methane may be produced in 3 weeks when compared with methane production with landfill process in which 6–7 years are needed for 1 t of MSW. On the other hand, “Composting” is a biological decomposition of biodegradable solid waste under predominantly aerobic conditions. It is a natural process of recycling decomposed organic materials into a rich soil known as compost [2].

One of the mostly used and practical technology, a third main group, for WTE today is “Landfilling” which is a soil-based waste disposal technique that uses engineering principles to confine solid waste to smallest area possible and reduce it to the lowest allowable volume in sanitary landfill [4]. Sanitary landfill can be defined as a scientific dumping of MSW using an engineering facility which requires detailed planning and specifications, careful construction and efficient operation [5]. The schematic representation of a typical landfilling process with its steps [3] is shown in Fig. 1.

Although landfill is the most common waste treatment techniques in the world, the developed countries prefer to reduce their MSW by using incineration technology due to reduction of approximately 70% of total waste mass and thus 90% of total volume. However, it is a fact that mass burning of MSW creates major environmental problems due to pollutant discharges.

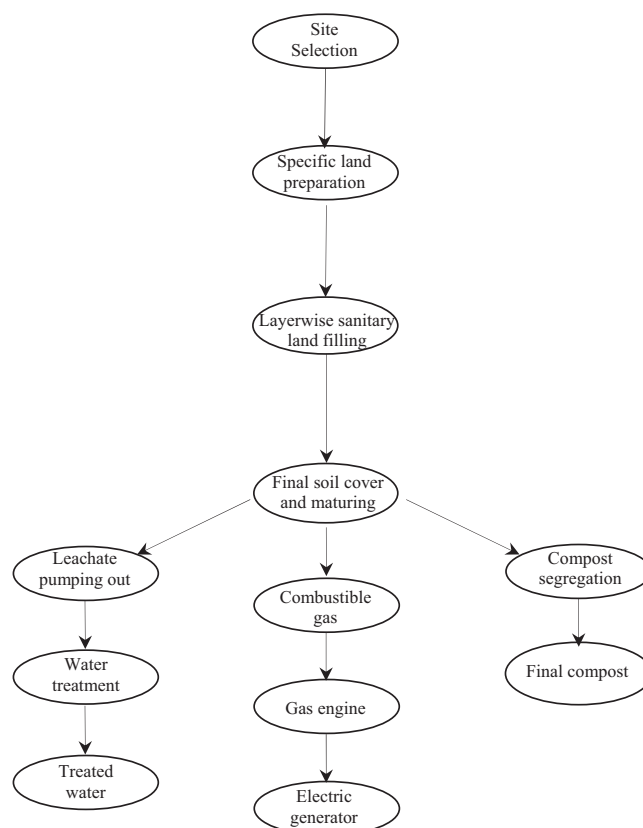


Fig. 1. Flow diagram of MSW plant based on sanitary landfill [3].

Therefore the best alternative technique for energy recovery for MSW is controlled methane production at landfills. The more details about the advantages and disadvantages of WTE technologies are given in Table 1.

In this paper, an overview about WTE technology in the world as well as that in Turkey is presented. Some important current studies on MSW management are outlined. Then, recent MSW management in Gaziantep metropolitan city is displayed with the current WTE technology applied, giving some concluding remarks and recommendations for future developments in MSW management.

2. Recent studies on MSW management

Despite of these WTE plants operated for many years, there are still several MSW management problems in the world and the current technology is needed to be developed. For this reason, many investigations are performed to improve the current WTE technologies to increase the amount of generated energy as well as decreasing the amount of MSW. MSW management is crucially important to organize the current WTE plants efficiently and ecofriendly. In this respect, there are also many studies on MSW management for local regions. Many of these studies are related with MSW management and policy of existing systems in local regions presenting the recent portrait and giving further recommendations for developments and/or modifications.

Metin et al. [6] presented a general overview of MSW management in Turkey during the last decade. They indicated that the composition of recovered material shows some variations depending on the source (commercial, residential and mixed) and the season of the year, and the majority of the material collected. They clarified that initial investment to set up large-scale collection and recovery schemes still remained to be the major barrier that the municipalities have to overcome.

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