Chapter 4
Sustainable Technologies for Solid Waste Monitoring and Treatment

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ABSTRACT

Municipal solid waste (MSW) is an energy source that should not go untapped or unutilized. The waste must be properly utilized through combustion, anaerobic digestion, and landfill gas acquisition, as it represents material and energy content. This will reduce the effects of global warming, which is as a result of high concentration of carbon dioxide, methane, and other greenhouse gases (GHGs), in the atmosphere. This chapter focuses on the technologies for solid waste management and the thermodynamics involved in the process for sustainable and cleaner energy. The equations presented represent the thermal efficiency, conversion efficiencies, as well as possible work that can be derived from a power plant utilizing MSW as fuel. It is important that countries in Sub-Saharan Africa vigorously pursue sustainable waste management technologies, especially recycling and landfilling, while exploring and investing in waste-to-energy technologies that will perform optimally using the composition of the waste in Sub-Saharan Africa in the design of the waste-to-energy technology.

INTRODUCTION

Waste management (WM) is the collection, transport, processing, recycling or disposal, and monitoring of waste materials. The term "waste" usually relates to materials which are produced by human activity and is generally undertaken to reduce their effect on health, the environment, or aesthetics (Ioana, 2010). Through WM, it is also possible to recover fuel and energy. Today, WM remains one of the major problems in megacities and in most metropolitan areas. Globally, about 1.3 billion tons of garbage is

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produced annually, but about 60% of it is not disposed of properly and ends up in landfills–yet, this is not a viable disposal method to the ever-increasing garbage disposal problems. As a result, solid wastes have become the biggest source of environmental pollution to soil, ground water, and air, due to increasing volumes of waste and absence of effective WM strategies. Whereas the technology of waste disposal has evolved during the past several decades, options are still limited, and many city administrators are indeed grappled with the challenge of raising the requisite financial resources towards WM services in a sustainable manner. The World Energy Council (2016) reported that, by 2025, global waste is estimated to reach 6 million tons per day.

Municipal solid waste (MSW) is composed of household, trade, and commercial waste. Wastes can also be categorized into biodegradable (food waste), recyclable (paper and glass bottles), inert (construction waste), electrical and electronic (computers screens), composite (toys and waste plastics), hazardous (paints and chemicals), toxic (pesticides and herbicides), and medical wastes (pharmaceutical drugs) (Dawei, 2015). It is called municipal waste because the municipality in which the waste is being generated is responsible for the disposal. Residential and institutional wastes are being disposed of by the local authorities in some capital cities in Sub-Saharan Africa (SSA). The disposal of industrial and commercial wastes which are generated in cities are not the responsibility of the local authorities, but of their generator. The composition and volume of MSW differs from location to location. In any waste-to-energy (WtE) conversion process, knowledge of energy content of wastes is important. Paper, plastics, and rubber have a high energy value and low moisture content, as compared to food waste with high moisture content and low energy value. Composition of paper in solid waste ranges from 1% to 5% in low income countries whereas, in high-income countries, it varies from 20% to 50%. Plastic composition in solid waste varies from 1% to 5% and 5% to 10% in low- and high-income countries, respectively (Sunil, 2016). Ash and fine material fractions in solid waste ranges from 15% to 60% and 3% to 10% in low- and high-income countries, respectively. In low-income countries, moisture content found in solid waste is around 30%–40% and, in high-income countries, it is 15%–30% (Sunil, 2016). The composition of MSW in SSA comprises over 50% in organic waste, and the trend will continue into 2025. Figure 1 shows the trends, constituents, and percentages of MSW in SSA. The generation of MSW is directly related to the level of socioeconomic development, as the development of a nation tends to increase waste generation. Other drivers of waste generation include population growth, urbanization and global trade.

In many SSA cities, waste collection is still overlooked with MSW collection rates ranging from 20% to 80% (Mohee & Bundhoo, 2015). There exist no proper waste treatment and disposal facilities and as a result, rudimentary and archaic waste disposal methods like illegal open dumping and uncontrolled burning practices are the day-to-day means employed to reduce the mountains of stinking refuse (Mohee & Bundhoo, 2015). Algeria, for example, dumps 80% of its MSW, while Egypt dumps 83.5% of generated MSW. Nigeria receives up to 2400 metric tonnes of waste each day at Olisosun landfill in an area of 42 hectares (Adegbola & Olawoyin, 2012).

Land filling is also commonly used, with Madagascar and Mauritius landfills accounting for 97% and 91% of their MSW respectively. Tunisia landfills 65% of its MSW (Hoornweg & Bhada-Tata, 2012) while Mauritania and Morroco landfill 37.3% and 28% of their MSW, respectively. This implies that a lot still needs to be done to encourage other options, such as composting and increased recycling, to minimize waste to the landfill sites (Sharholy, Ahmad, Mahmood & Trivedi, 2008, Chimuka & Ogola, 2015).

Apart from absence of proper waste treatment and disposal facilities, most cities in SSA countries lack appropriate policies and legislation that would support investments in waste recycling. In instances where these policies and legislative instruments exist, their application has proven to be inconsistent