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Popular Article

Article: RT592

Biotica Research Today

Vol 3:5 2021 357/359

Solid Waste and Management

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Open Access

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Keywords

3R's, Compost, Pyrolysis, Solid waste management

Article History

Received in 23rd May 2021

Received in revised form 24th May 2021

Accepted in final form 25th May 2021

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How to cite this article?

Nair *et al.*, 2021. Solid Waste and Management. Biotica Research Today 3(5): 357-359.

Abstract

Waste generation is at alarming rate and is one of the most discussing topics around the world. The waste material in environment reduces the quality of surroundings. Solid waste is any unwanted or discarded material that is not liquid or gas. Solid waste is broadly classified into industrial solid waste and municipal solid waste. The fastest growing solid waste problem in world is e-waste. Waste management involves integrated waste management technique where variety of strategies for both waste reduction and management is involved. The 3R's resource use is widely used for waste management. The 3R's includes Reduce, Reuse and Recycle. Landfills, pyrolysis and compost are the common methods to handle waste. Reduction of waste generation and proper handling of generated waste is the need of today's era.

Introduction

Solid waste is any unwanted or discarded material that is not liquid or gas. Solid waste can be broadly divided into two types. They are industrial solid waste and municipal solid waste. The industrial solid wastes are produced by mines, agriculture and other industries. Municipal solid waste (MSW) is often called garbage or trash, which consists of combined solid waste produced by homes and workplace. Municipal solid waste includes paper, food wastes, plastics, glass, metals, rubber, leather, textile *etc*. In other school of thought, solid waste can be classified into three. They are biodegradable, recyclable and non-biodegradable. It is important to sort the wastes once it is generated for the further handling (Figure 1).

Figure 1: Dumping of solid waste from town in village

The wastes generated from hospital are called bio medical wastes. They are hazardous in nature contains disinfectants, harmful chemicals and pathogenic microorganisms. Bio medical wastes require careful treatment and disposal. The use of incinerators is crucial to disposal of hospital wastes (Beigl, 2008).

The fastest growing solid waste problem in world is e-waste. This includes discarded television, cell phones, computers, e-toys and other electronic devices (Kumar *et al.,* 2017).

E-wastes are rich source for high quality plastics, valuable metals and hazardous pollutants including Polyvinyl chloride (PVC), brominated flame retardants, lead and mercury. E-wastes are buried in landfills or incinerated. Over half of the e-wastes generated in developed worlds are exported to developing worlds, where recycling and recovery of valuable metals has been doing either mechanically or manually.

Ahmed Khan, a plastic sack manufacturer in Bangalore has found an ideal solution to the ever-increasing problem of accumulating plastic wastes. His company developed a fine powder of recycled modified plastics, Polyblend. Polyblend is mixed with bituminous and used to lay roads.

Nuclear energy is considered under hazardous waste category. Initially nuclear energy is hailed as a non-polluting way for generating electricity. But later realized that the use of nuclear energy has two very serious inherent problem. The first is accidental leakage and second is safe disposal of radioactive wastes. Three-mile island and Chernobyl incidents are due to leakage of radioactive wastes. Radiation given off by nuclear waste is extremely toxic pollutant. So, it has been recommended that storage of nuclear waste after sufficient pre-treatment should be done in suitably shielded containers buried within the rocks, about 500 m deep below the earth's surface.

Another important category of hazardous waste includes organic wastes and non-degradable toxic heavy metals. Hazardous organic wastes include solvents, pesticides, PCBs and dioxins. Non-degradable toxic heavy metals include lead, mercury and arsenic. Recommendation includes physical methods and chemical methods.

Waste Management

Waste management involves integrated waste management technique where variety of strategies for both waste reduction and management is involved. The 3R's resource concept (Reduce, Recycle and Reuse) is used widely for waste management. Reduce is consume less and live a simpler life style. Reuse rely more on items that can be used repeatedly instead of Throw away items. Recycle involves separate and recycle paper, glass, cans, plastic, metals and other items and buy products made from recycled materials. Recycling involves reprocessing discarded solid materials into new useful products. Paper products, glass, aluminium, steel and some plastics are common items that can be recycled. Two types of recycling are there. First one is primary and next is secondary recycling (Figure 2).

Landfills

Landfills are the major aspect of waste management system. There are two types of landfills. They are open dumps and sanitary landfills. Open dumps are seen in developing countries where garbage is deposited in an open hole and sometimes burned. Sanitary landfills are solid wastes that are spread out in thin layers, compacted and covered daily

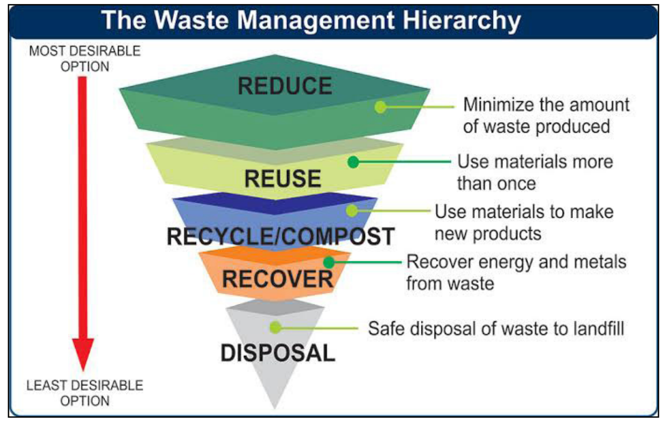

Figure 2: Waste management hierarchy

with a fresh layer of clay or plastic foam, which helps to keep the material dry and reduce leakage of contaminated water.

Collection, waste handling and separation, storage and processing at the source, segregation, processing and transformation of solid wastes, transfer and transport, disposal, reusing, landfills and energy generation are the major components of solid waste management. Energy recovery from waste is the conversion of non-recyclable waste material into usable heat, electricity, or fuel through a variety of processes including combustion, gasification, anaerobic digestion and landfill gas recovery. This process is often called waste to energy.

Pyrolysis

Pyrolysis is the thermal decomposition of materials at elevated temperature in an inert atmosphere such as vacuum gas. The word "pyrolysis" derived from a Greek word (pyro meaning fire and lysis meaning separating). Pyrolysis is most commonly applied to the treatment of organic materials. It is the process involved in charring wood, starting at 200-300 °C. In general, pyrolysis of organic substances produces volatile products and leaves a solid residue enriched in carbon called char. Pyrolysis differs from other processes like combustion and hydrolysis in that it usually does not involve the addition of other reagents such as oxygen or water. Pyrolysis is used to produce ethylene on the largest scale industrially. In this process, hydrocarbons from petroleum are heated to around 600 °C in the presence of steam (Steam cracking). Pyrolysis can also be used to treat the plastic waste. Therefore, pyrolysis is a process of chemical decomposition of matter brought about by heat. In this process, the material is heated in absence of air until the molecule thermally breaks down to become gas comprising smaller molecule, collectively known as syngas. Gasification can also take place as a result of partial combustion of organic matter in presence of restricted quantity of oxygen or air. The gas so produced is known as producer gas (Abarca Guerrero *et al*., 2013).

Plasma pyrolysis or plasma gasification is a waste treatment technology that gasifies the matter in an oxygen starved environment to decompose waste material into its basic molecular structure. The incineration of solid waste involves combustion of waste leading to volume reduction (90-95%) and recovery of heat to produce steam that in turn produces power through steam turbines. Basically, it is a furnace for burning wastes and converts waste into ash, gaseous and particulate emission and heat energy. The gaseous products derived from the combustion of waste may include carbon dioxide, water, oxygen, nitrogen oxides, sulphur and dioxide.

Dioxin and Furans

The most publicized concerns from environmentalists about the incineration of waste involve the fear that it produces significant amount of dioxin and furans. The breakdown of dioxin requires exposure of the molecular ring to a sufficiently high temperature so as to trigger thermal breakdown of the strong molecular bonds holding it together. Modern incinerators are designed to provide high temperatures.

Composting

Composting is controlled decomposition and the natural breakdown process of organic residues. Composting transforms new organic waste material into biologically stable, humic substances that make excellent soil amendments.

Composting occurs through the activity of microorganisms naturally found in soils. Under natural conditions, earthworms, nematodes and soil insects do most of the initial mechanical breakdown of organic material into smaller particles. Once optimal physical conditions are established, soil bacteria, fungi, actinomycetes and protozoa colonize the organic material and initiate the composting processes.

The active phase of composting is also known as thermophilic stage of composting. The temperature in compost pile typically increases rapidly to 130-150 °F within 24-72 hours of pile formation, which is maintained for several weeks. As temperature increases, thermophiles take over. This temperature is high enough to kill pathogens, weed seeds and to break down phytotoxic compounds. Common pathogens killed in this phase are *E. coli*, *Staphylococcus aureus*, *Bacillus subtillus* and *Clostridium botulinum*. During this stage, oxygen must be replenished through passive or forced aeration.

As the active composting phase subsides, temperature gradually decline around 100 °F. This is called curing phase. This is critical and often neglected stage of compost. The rate of oxygen consumption declines to the point where compost can be stock piled without turning. During curing, organic materials continue to decompose and are converted to biologically stable humic substances. This is called mature or finished compost. Immature compost can contain high levels of organic acids, high C:N ratios, extreme pH values or high salt contents, all of which can damage or kill plants if the compost is amended to container mixes or the soil.

C:N ratio is one of the most important factors affecting composting process. Microorganisms in compost digest carbon as energy source and ingest nitrogen for protein synthesis. Ideally C:N ratio should be 30:1 for efficient composting processes. But the range of C:N ratio in the range of 25:1 to 40:1 is also resulting in efficient composting processes. For initiation of compost, 30:1 ratio should be there. C:N ratio during the maturity of compost is between the range of 18 to 20:1.

Microbial activity can be increased by increasing surface area by grinding, chopping or shredding of waste material. Temperature is other important factor determining the efficiency of composting. The higher the temperature, the greater the oxygen uptake and the faster the rate of decomposition. Therefore, the optimum temperature range between 32 °C and 60 °C need to be maintained. The compost process is more or less adversely affected at temperatures above 65 °C. The pH level of the composting mass typically varies with the passage of time. The level usually drops at the onset of compost process and it soon begins to rise to levels as high as pH 9.0. The initial drop reflects the synthesis of organic acids and subsequent rise reflects the utilization of acids by microbes. Lime can be used in compost pit as buffering agent to improve physical condition of soil and as moisture absorber. Optimum moisture for composting is between 40% and 60%. Proper aeration is needed to replaces oxygen deficient air in the centre of the compost pile with fresh air. Regular mixing of the pile, referred to as turning enhances aeration in the compost pile. Excessive shredding can also impede air circulation by creating smaller particles and pores. Adequate levels of phosphorous and potassium are also important in the composting process and are normally present in farm organic residues. The mature compost once applied to soil enhances the quality of soil and prevent the soil from degradation.

Conclusion

Production of wastes becomes a part of today's life style. So, we need to adopt a management strategy integrating waste reduction, reuse, recycling to handle the waste generated and to improve the quality of soil.

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