Integrated Solid Waste Management

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Abstract - Integrated Solid Waste Management is a comprehensive waste of a reuse, recycling, composting, and disposal program. Integrated solid waste management is an approach to manage the municipal waste to generate coordination of waste from one manner to become resources for another. The municipality can effectively manage waste by these processes monitoring, collection, transport, processing, recycling and disposal. Using the methods of waste reduction, reuse and recycling, it is beneficial to the environment. It is estimated that about 3,800 of Municipal Solid Waste is generated daily in the city. Per capita waste generation in major cities range for 0.20 Kg to 0.6 K.g. Generally the collection efficiency ranges between 70% to 90% in major metro cities whereas in several smaller cities the collection efficiency is below 50%. Windrow composting is the production of compost by piling organic matter or biodegradable waste, such as animal manure and crop residues, in long rows (windrows). This method is suited to producing large volumes of compost. The sludge composting facility is designed to achieve goals established for the advantage of climatic and other environmental factors unique to the site.A reactor process is was selected for the first stage of composting to reduce odour potential, assure pathogen destruction and improve process control, the circular, agitated bed reactor was selected to best meet site specifications and particular conditions for design.As the necessity for plastic bags as well as containers continues rising in various places such as grocery stores and retail stores, so do the requirements for the recycling of plastic products. Plastic products are now one of the most used materials in the world. The primary objective of landfill site design is to provide effective control measures to prevent or reduce as far as possible negative effects on the environment, in particular the pollution of surface water, ground water, soil and air, as well as the resulting risks to human health arising from land filling of waste.

Keywords: reuse, recycling, composting, and disposal

I. INTRODUCTION

Solid waste is the unwanted for some people and useful to many people and it is generated from residential, industrial and commercial activities in a specific area. It may be categorized according to its origin (domestic, industrial, commercial, institutional); according to its contents (organic material, glass, metal, plastic, paper etc.) Management of solid waste reduces adverse impacts on the environment and human health and supports economic development and improved quality of life. The sanitation goal will fail if the solid waste management aspect not gains proper attention. The municipality can effectively manage waste by these processes monitoring, collection, transport, processing, recycling and disposal. Using the methods of waste reduction, reuse and recycling, it is beneficial to the environment. Therefore, it is advisable that those methods should be adopted for a waste management plan. Definition of integrated solid waste management: Integrated Solid Waste Management is a comprehensive waste of a reuse, recycling, composting, and disposal program. Integrated solid waste management is an approach to manage the municipal waste to generate coordination of waste from one manner to become resources for another. (Integrated solid waste and resource management, Vancouver, 2010) Aim of this is reducing the amount of waste being disposed to landfill. In first aspect source reduction is preferred; we can utilize this by reuse of material. In second aspect recycling is there; we can utilize this by segregation of useful material like plastic, metal, glass, etc. In third aspect we can achieve recovery by composting of organic waste. In a fourth aspect after doing above treatments which material we can't recover or reuse that we can use for waste-to-energy plants. In last aspect left out waste material should be a disposed to landfill. Based on above aspects we have to choose appropriate technology to manage municipal solid waste.

II. LITERATURE REVIEW

The Concept of Solid Waste Management

Since the start of life in the world, history shows that waste control and management has never been is never and shall never be avoided. In this way, a number of ancient scholars and the modern scholars in environmental management, IT and many more have dwelt in waste management with the ever increasing industrialization activities anddoubling population afterevery century. According to Regional Centre for Urban and Environmental Studies (2014), Solid Waste Management (SWM) is a process that involves the collection, storage, transportation, processing and discarding of solid refuse residuals in an engineered sanitary landfill. This process is integrated and comprising of several collection methods, storage, various transportation equipment, recyclable material from recovery mechanisms, reduction of waste quantity and volume using approaches such as composting, waste-to-power and disposal in a designated engineered sanitary landfill.In his work entitled, "Waste Management Practices," Davidson (2011) started by giving a simple definition of the waste management idea and later on the brief history of the evolution of the waste management idea so that one can easily understand the concept. According to him, management of waste is the combination of undertakings that include: collecting, transporting, treating and disposing of waste; monitoring, controlling, and regulating of production, transport, collection, treatment and disposal of waste; and prevention of waste production through in- modification process, recycling and reuse.According to United Nations Environmental Programme (2013), management of waste is intentioned to minimize the effect of waste on environment, aesthetics, or health. Waste management include: waste generation, removal of waste, minimization of waste, transporting waste, treating waste, reusing and recycling, storing, collecting, landfill disposal, financial and marketing aspects, environmental considerations, policing and regulating, training and educating, implementation and planning.According toNational Waste & Recycling Association (2013), during the course of history, the quantity of waste than humans have generated wasn't significant as a result of the low density and low levels of societal exploitation of natural resources. Waste that was frequently produced during pre-modern times was mainly human biodegradable waste and ashes, and these got released back locally into the ground, to result to lessening of the environmental impact.

Unlike developed countries, a study by Mutai&Njoroge (2012) shows that in most developing countries it is the urban authorities that is responsible for waste management. Waste management is one of the most visible urban services whose effectiveness and sustainability serves as an indicator for good local governance, sound municipal management and successful urban reforms. Waste management therefore is a very good indicator of performance of a municipality and in most case has been valued as an indicator I political swing waves inAfrica. management of waste in town centers in East African region has been centralized for a long time **(Napoleon, Momodu& Joan, 2011)**, imported refuse truck are used **(Oyeniyi, 2011)** that collect wastes from transfer points or from sources and transfer to designated waste dumps. Municipal solid waste management (MSWM) system in East Africa that has changed from the colonial days in the 40s, 50s and early 60s when it was efficient due to the lower urban population and the adequate resources **(Oyeniyi, 2011)** to the current status that shows inefficiencies.

The storage, collection, transportation and final treatment/disposal of wastes are reported to have become a major problem in urban centers (ADB 2002 cited in Willy **Kipkoech, 2014).** The composition of wastes generated by the East African urban centers is mainly decomposable organic materials based on the urban community consumption that generates much kitchen wastes, compound wastes and floor sweepings (Stringer, 2014). This calls for efficient collection system to avoid health, aesthetics and environmental impacts. the global trend of increased use of electrical and electronic goods is also evident in eac where e-waste is becoming a significant threat to the environment and human health in eac urban centers.

Employment Opportunities and Welfare of the LocalCommunity.

NehaGupta(July 2015)This review presents an overview of current status of solid waste management in India which can help the competent authorities responsible for municipal solid waste management and researchers to prepare more efficient plans. **Hans-Joachim Gehrmann (Oct 2017)**In This study elucidates evaluation methods for waste treatment processes for the comparison of ecological and economic aspects such as material flow analysis, statistical entropy analysis, energetic and exergetic assessment, cumulative energy demand, and life cycle assessment. A comparison of two thermal waste treatment plants with different process designs and energy recovery systems was performed with the described evaluation methods. The results are mainly influenced by the type of energy recovery, where the waste-to-energy plant providing district heat and process steam emerged to be beneficial in most aspects.

AlhassanSulemana (Oct 2018) This reviews the effect of applying optimization methods on the collection process of solid waste, with particular interest in mathematical programming and geographic information system approaches in developing countries. Mathematical programming approaches maximize or minimize an objective function for improvement in procedure, to ensure operational efficiency and also serve as decision support tools. For enhanced efficiency of the vehicle routing systems, studies should further focus on incorporating all network constraints, environmental pollution considerations, and impact of land use changes on routing.G. KalyanChakravarthi, D. Satish Chandra, SS. Asadi, (April 2019)In their study a different scheme on smart waste management using Radio-Frequency identification devices(RFID),Machine to machine(M2M), pneumatic system, Internet of things(IOT), plasma technology are explained in detail and the best method of treating solid waste using smart solid waste management techniques is suggested basing upon the Summary of the data collected from Tullur, Rayapudi, Velagapudi, Nelapadu villages respectively, Where one of these new systems is implemented.

Functional elements of solid waste management:

The activities associated with the management of solid waste from the point of generation to final disposal can be grouped into the six functional elements: (a) waste generation ; (b) waste handling and sorting, storage, and processing at the source; (c) collection; (d) sorting, processing and transformation; (e) transfer and transport; and (f) disposal.

(a) Waste generation:

Waste generation encompasses activities in which materials are identified as no longer being of value(in their present form) and are either thrown away or gathered for disposal. Waste generation is at present an activity that is not very controllable. In the future, however, more control is likely to be exercised over the generation of wastes. Reduction of waste at source, although not controlled by solid waste managers, is now include in system in evalauations as a method of limiting the quantity of waste generated.

(b) Waste handling, sorting, storage, and processing at the source:

The second of the six functional elements in the solid waste management system is waste handling, sorting, storage, and processing at the source. Waste handling and sorting involves the activities associated with the management of wastes until they are placed in storage containers for collection. Handling also encompasses the movement of loaded containers to the point of collection. Sorting of waste components is an important step in the handling and storage of solid waste at the source. For example, the best place to separate waste materials for reuse and recycling is at the source of generation. Households are becoming more aware of the importance of separating newspaper and cardboard, bottles/glass, kitchen wastes and ferrous and non-ferrous materials.

(c) *Collection:*

The functional element of collection includes not only the gathering of solid wastes and recyclable materials, but also the transport of these materials, after collection, to the location where the collection vehicle is emptied. This location may be a material processing facility, a transfer station Or a landfill disposal site.

(d) Sorting, processing and transformation of solid waste:

The sorting, processing and transformation of solid waste materials is the fourth of the functional elements, the recovery of sorted material, processing of solid waste and transformation of solid waste that occurs primarily in locations away from the source of waste generation are encompassed by this functional element. Sorting of commingled (mixed) wastes usually occurs at a materials recovery facility, transfer stations, combustion facilities, and disposal sites. Sorting often includes the separation of bulk items, separation of waste components by size using screens, manual separation of waste components, and separation of ferrous and non-ferrous materials.

Waste process is undertaken to recover conversion product and energy. The organic fraction of municipal solid waste can be transformed by a variety of biological and thermal processes. The most commonly used biological transformation process is aerobic composting. The most commonly used thermal transformation process in incineration.

Waste transformation is undertaken to reduce the volume, weight, size or toxicity of waste without resource recovery, transformation ma, transformation ma be done by a variety of mechanical (eg shredding), thermal(e.g. incineration without energy recovery) or chemical (e.g. encapsulation) techniques.

(e) Transfer and transport:

The functional element of transfer and transport involves two steps: (i) the transfer of wastes from the smaller collection vehicle to the larger transport equipment and (ii) the subsequent transport of the wastes, usually over long distances, to a processing or disposal site. The transfer usually takes place at a transfer station.

(f) *Disposal:*

The final functional element in the solid waste management system is disposal. Today the disposal of waste by land filling or uncontrolled dumping is the ultimate fate of all solid waste, whether they are residential waste collected and transported directly to a landfill site, residual materials from materials recovery facilities(MRFs), residue from the combustion of solid waste, rejects of composting, or other substances from various solid waste-processing facilities. A municipal solid waste landfill plant is an engineered facility used for disposing of solid wastes on land or within the earth's mantle without creating nuisance or hazards to public health or safety, such as breeding if rodents and insects and contamination of groundwater.

The hierarchy of solid waste management:

Windrow composting

In India, 50-60% of municipal solid waste is organic waste. Considering the climatic conditions and other factors, composting of organic waste is excellently suited for India for India and windrows composting is the best option to deal with the huge volume of bio-degradable waste. Windrow composting is the available best model for stabilization of the biodegradable portion of the MSW. In addition to a plant, a landfill site for non-biodegradables, leachate treatment plant and RDF to handle slow degrading but energy yielding substances are usually integrated in a windrow compost plant.

Windrow composting is the production of compost by piling organic matter or biodegradable waste, such as animal manure and crop residues, in long rows (windrows). This method is suited to producing large volumes of compost Compost process control parameters commonly include initial ratios of carbo**n** and nitrogen rich materials, amount of bulking agents, air porosity, pile size, moisture content and turning frequency. The temperature of the windrows must be measured and logged constantly to determine the optimum time to turn the windrows for quicker compost production.

III. WINDROW FORMATION

After 35 days, the degraded wastes are sent to the feeder conveyor for sieving and composting. The remaining composting activities will be at two levels: Level 1:

At this level mechanical sieving is done with the help of trommel and the main components of the plant used at this stage are: • Feeder conveyor (feeding compartment that leads the waste to the trommel)

•Primary separation units(first trommel)

a) First rejection belt

b) First product conveyor

• Refining trommel (second trommel)

a) Second rejection belt

b) Second product conveyor

• Common rejection belt

•Hydraulic power packs

Feeder conveyor or feeding compartment:

The partially degraded waste is fed into the feeder conveyor, using back hole loader. The feeder conveyor is 15 m long and 0.85 m wide. It is rectangle in shape and has an under carriage conveyor. The top of the feeder conveyor is open. The inner side has two metallic sheets which are fabricated in a fixed manner. The waste loading end is closed and other end is open to the primary separation unit (firsttrammel). The conveyor is attached to a chain and the chain is operated by hydraulic power pack, hydro motor and reduction gear. When power pack is operated, the conveyor of the feeding compartment is directed towards the opening of the first trommel, where sieving starts.

Primary separation unit (firsttrammel)

A trommel(dutch word for ' drum') is a mesh-type cylinder used to separate materials by size. The first trommel is 6m long, 2m dia, 36mm mesh size, 8mm thick wire meshed barrel. It has two pull rings at both ends.

The configuration of the barrel is:

• 90 mm mild steel of "C" class, extruding pipes or seamless pipes (6 nos)
• 80*40*3mm rectangular pipes (6 nos.)
• 65*65*6 mm M.S angle (6 nos)
• 100*8 mm flange over the barrel (3 nos

Feeding MSW

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It is placed over 4 nos. of press on tyre, 2 nos. each at both pull rings at two ends of the barrel. The barrel is placed at an inclination of 40, this inclination is for the movement of garbage to the other end of the barrel while rotating. Barrel is supported by two trommel stoppers at both ends. The sieving of the degraded MSW is done by rotating the barrel and the materials that is passed through the mesh are collected in an under carriage conveyor and carries the materials that is passed through the mesh are collected in an under carriage conveyor and carries the material to the 2nd trommel. The materials that are retained in the trommel are directed to another conveyor belt, i.e first rejection belt. The screening efficiency of the sieve is mainly dependent on the moisture content of the materials. Dry material can be sieved efficiently through finer or lesser mesh size.

Second trommel(refiningtrommel)

This trommel is similar to the first trommel but for its 16mm mesh size. The trommel is fabricated using:

- 65mm M.S, “C” class extruding pipes or seamless pipes (6 nos).
- 65*65*6mm angle (6 nos)
- 100mm*8 MS flange over the barrel (3nos).
- 80*40*3 mm rectangular pipe (6nos)

Mechanical sieving in level 1

Maturation of semi product:

The product obtained from the second trommel(known as semi product) is dumped at a specified area for achieving maximum decomposition, for a period of 3-4 weeks (depending on the climatic variations). This is the end of level 1 activity starts with final sieving that converts it as the final product.

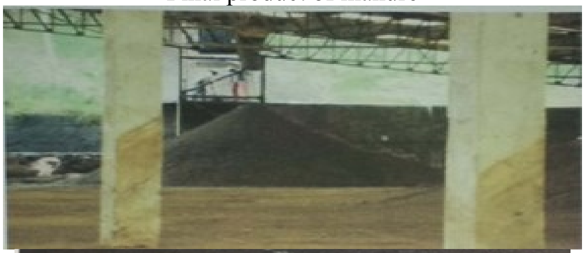
Final sieving for conversion of semi product as final product

This is the second level activity. At this level the matured semi product is fed through a hopper ti the final trommel of S.S 304.3mm having 4mm mesh size, which removes any metal/glass particles or other unsuitable items that may get mixed with the raw wastes. The products from the trommelis conveyed to the manure yard, where it undergoes maturation and then to the packing yard, where final products is stored before packing.

Sale of manure:

Based on the requirement, manure is packed by manual or automatic packing machine in convenient packs like 1kg, 2kg, 5kg and 50kg bags. Use environment friendly packing materials. There should be facility for storing at least 3 months compost should be arranged.

Final product of manure



Bags packed

Active composting stage

*Oxygen***:**

When the windrow is formed micro organisms consume oxygen (aerobic decomposition). As oxygen is used up aerobic decomposition slows down.

Temperature:

Temperature increases due to microbial activity in the windrow. They rapidly increases to 40-60^{0}c and are maintained for several weeks.

As aerobic decomposition slows the temperature drops off.

Temperature will fall if the oxygen decreases too much and can get too high thus killing the microorganisms.

Aerating the windrows help to control the temperatures. Evaporation is the windrows primary source of heat loss, by maintaining the moisture levels between levels between 50 and 60% and agitation the windrows temperature will be under control.

Curing stage:

When the aerobic decomposition has slowed the curing phase has begun. Oxygen usage is so slow the windrows don't need to be agitated anymore. As the temperature drops to that of ambient air the compost is done.

Utilization

To properly use a compost windrow turner, it is ideal to compost on a hard surface pad. Heavy-duty compost windrow turners allow the user to obtain optimum results with the aerobic hot composting process. By using four wheel drive or tracks the windrow turner is capable of turning compost in windrow turner to convert itself into a trailer to be pulled by a semi-truck tractor. These two options combined allow the compost windrow turner to be easily hauled anywhere and to work compost windrows in muddy and wet locations

Design process

The sludge composting facility is designed to achieve goals established for the advantage of climatic and other environmental factors unique to the site..

A reactor process is was selected for the first stage of composting to reduce odour potential, assure pathogen destruction and improve process control, the circular, agitated bed reactor was selected to best meet site specifications and particular conditions for design.

Air drying of wet sludge cake will be sued during arid months to reduce amendment requirements and equalize peak loadings. Reducing amendment use is a project goal which will be achieved by maximizing dewatered cake solids, air drying of dewatered cake, air drying during windrow curing, and use of locally available waste materials.

Affects during composting process:

The main affects taken into consideration are oxygen, temperature, time, nutrients, moisture, pH, particle size.

Oxygen:

Windrows without sufficient oxygen have degradation speed that is slowing down. Oxygen must be added to ensure aerobic decomposition.

Temperature

Active composting takes place between 40-60^{0}C.if the temperature is allowed to go above the range microorganisms begin to die slowing the composting process. If the temperature is lower than this aerobic decomposition slows.

Time

Composting time depends on many factors within the windrows. If a proper moisture content, carbon to nitrogen ratio, aeration, oxygen content, and temperature are maintained the shortest possible compost period is ensured. The intended use of the compost will have an effect on the composting time.

Nutrients

Nitrogen, phosphorus, carbon and potassium are required by the organisms and plants. A carbon to nitrogen ratio of 25: 1 to 30: 1 is ideal for composting. An insufficient ratio allows excess nitrogen to be released to the atmosphere. A higher ratio requires a longer composting time.

Moisture

Water is required to allow chemical reactions, transport nutrients, and allows microorganisms to move within the windrow. The moisture content should be maintained between 50-60%. If levels are too high the water takes the place of the oxygen slowing down decomposition. When levels are too low the microbial activity slows.

pH

A mixture of materials with a pH level between 6.5-8 have a better chance of being effective than materials outside the range. But, if the material has a high nitrogen content then pH levels above 8.5 increase the ammonia loss.

Particle size

Particle size and structure affect the natural aeration of the windrow. The smaller the particle size the greater the aerobic decomposition because of the increased area .particle that have good structure prevent the settling of materials which reduces porosity

IV. CONCLUSION

Recycling is a process using materials (waste) into new products to prevent waste of potentially useful materials, reduce the consumption of fresh raw materials, reduce energy usage, reduce air pollution (from incineration) and water pollution (from land filling) by reducing the need for “conventional” waste disposal. Recyclable materials include many kinds of glass, paper, metal, plastic textiles, and electronics. During periods when resources were scare, archaeological studies of ancient waste dumps show less household waste (such as ash, broken tools and pottery)- implying more waste was being recycled in the absence of new material. Recycling of bio degradable waste can be done by breaking down waste materials by aerobic process and practiced best in household. Recycling decrease the use of matter and energy resources and reduces pollution and natural capital degradation; recycling does so to a lesser degree

It is recommended that the leachate collection and removal system be kept anaerobic for the following reasons:

- Reduced clogging may be expected under anaerobic rather than aerobic conditions.
- There is less microbial aggregations and slimes produced under anaerobic conditions, and
- Chemical precipitation of carbonates, sulphates and iron oxides which can commonly cause clogging is much less prevalent under anaerobic and reduced conditions.

It is recommended that air be excluded from the leachate collection and removal system. At sites where the base of the cell is designed to be drained of all leachate, this may be done by leachate removal via a permanently wet sump. Maintenance of a limited leachate head to ensure that the leachate collection system is permanently saturated would also have this effect.

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