*International Journal of Engineering Inventions*
*e-ISSN: 2278-7461, p-ISSN: 2319-6491*
*Volume 7, Issue 9 [September 2018] PP: 09-18*

# Design And Study For Composting Process Site

Shuokr Qarani Aziz [1]*, Imad Ali Omar [1,2], Jwan Sabah Mustafa[3]
*1 Department of Civil Engineering, College of Engineering, Salahaddin University-Erbil, Iraq;*
*2 Ministry of Municipality and tourism, General Directorate of Water and Sewerage-Erbil, Iraq*
*3 Ministry of Agriculture and Water Resources, General Directorate of Dams and Reservoirs, Erbil, Iraq.*
**Corresponding Author:Shuokr.aziz@su.edu.krd; shoker71@yahoo.com*
*Phone No.: 00964 750 462 54 26*

***ABSTRACT:****This paper presented composting process of the organic wastes, which are easily biodegradable. These organic wastes are generated from many sources compiles; municipal solid waste (MSW), food, markets, kitchens and agricultural wastes. Due to improper MSW management, it causes many environmental problems. The methods to be used include reducing the amount of waste produced as well as recycling, reusing, and composting waste materials. Which those leading to safe for environment and it can be more economically and cost effective for the proposed area. The Composting process is used, which is one of the technological options for the processing of MSWs. Leaves and grasses waste were selected by applying mixture designs of aerobic windrow system. Cross- sectional areas of triangular, trapezoidal, and semicircle sections for windrows were selected as variables. Results revealed that the areas for triangular, trapezoidal, and semicircle sections were 57846 $m^2$, 38550 $m^2$, and 49002 $m^2$, respectively. The trapezoidal section with area of 38550 $m^2$ was nominated as an economic design for the composting site. It can yield 7500 to 9000 \$/day form composting of organic materials. The accurate design and control of the composting process may lead to the desired quality and capability for recycling of nutrients and waste minimization with least environmental problems.*

---

Date of Submission: 18-10-2018 Date of acceptance:04-11-2018

---

## I. INTRODUCTION

Landfilling is used widely for treatment of municipal solid waste (MSW). Biodegradation of buried organic matters in landfilling process causes formation of landfill leachate and methane gas (Worrell and Vesilind, 2012; Aziz and Mustafa, 2018). Normally, the amount of organic waste is large, which directly affects on the environment. There are several treatment methods MSW treatment, composting is one of the most important alternative for organic wastes. It can be used for the recycling of the garbage into useful products, it also used to overcome increase of waste (Tchobanoglous, 2002). The problem is that large amounts of biodegradable organic waste are being produces in cities and countries, without proper solution. For instance, daily grocery stores products like fruits, vegetables, bread, milk products, fish and other frozen products. So, composting is one of most common technologies to treat organic wastes in more economical way.

Solid waste management is a massive challenge in developing countries mainly due to factors such as population increase, poverty, and the lack of adequate investment by the respective governments (Jara-Samaniego et al., 2017). This rapid growth in developing countries connected with lack of infrastructure for proper solid waste treatment and indiscriminate disposal of waste, results in accumulation of waste in large quantities (Shekha, 2011). Organic solid waste poses a serious threat to the environment as the world struggles to keep up with its quick generation (Lim et al., 2016). There are many type of solid waste that produced from the city, some of them recyclable, but the largest amount is organic material. The total generated waste in Erbil City-Iraq of domestic solid waste components were: food (79.34%), plastic (6.28%), paper (5.9%), metals (3.6%), glass (3.42%), and cloth (1.45%) (Aziz et al., 2011). The amount of organic wastes in southern Asia Nations were varies from 41% to 62% (Ngoc and Schnitzer, 2009). The huge amount of organic matters needs appropriate treatment process such as composting process.

The amount of organic wastes generated by people continues to increase along with pollution growth. These wastes have a considerable role in environmental pollution if not treated properly. Besides landfilling, incineration and pyrolysis, biogas process and composting are used to dispose organic wastes. The advantages of last two processes are that they reduce damage to the environment and produce economically valuable products from the wastes (Rasapoor et al., 2009).

Biological waste treatment technologies such as composting and vermicomposting are widely regarded as a clean and sustainable method to manage organic waste (Lim et al., 2016).

The focuses of the present work were to: 1) demonstration detailed description of the composting processes such systems, phases etc., 2) design a composting site area as a means to recover nutrients from the organic waste and returning them to the environment, and 3) study the environmental impact and economic analysis of the composting process. In the current work, amount of disposed wastes in Erbil City-Iraq was used in design and analysis for composting site area. Using different scenarios for selection composting process site and analysis are not available in literature.

## II. INTEGRATED WASTE MANAGEMENT

Currently, the study associated municipal solid waste management (MSWM) problems, due to rapid increasing population growth and waste generation by human activities. However, in the study area focused on the problems of poor management survive, and the lack from disposed solid waste. It is necessary to select a suitable solution to approach proper integrated MSWM.

Integrated waste management (IWM) can be defined as the selection and application of appropriate techniques, technologies, and management programs to obtain specific waste management objectives and goals. Environmental Protection Agency (EPA) has identified four basic management options (strategies) for IWM: (1) source reduction, (2) recycling and composting, (3) combustion (waste-to-energy facilities), and (4) landfills. As proposed by the U.S. EPA, these strategies are meant to be interactive, as illustrated in (Fig.1a). It should be noted that the management options in a hierarchical order (Fig.1b). For example, recycling can be considered only after all that can be done to minimize the quantity of waste at the source has been done (Tchobaonglous, 2002).

### Composting

Composting is a form of recycling of organic materials, which involves biological decomposition of the organic wastes. Erbil's MSW is suitable for composting due to its high organic and moisture contents. Actually there is no plant for composting in Erbil city. Nowadays, many private companies come to invest the cities sectors, but the sectors faced to many problems from those: financial supports, quality of wastes, and appropriate technology, and proper location.

Composting is the biodegradation of the organic constituents in wastes (solid wastes and wastewater sludge's). Through the microbial activity taking place during composting, organic matter is decomposed into a stable, humus-like substance. At the same time the heat produced can result in pathogen destruction. Composting is an ancient practice whereby farmers have converted organic wastes into soil amendments. These amendments were used to stabilize soils from erosion, provide nutrients, and replenish depleted organic matter that was lost through intensive farming. Composting is one element of an integrated solid waste management strategy that can be applied to mixed MSW or to separately collected leaves, yard wastes, and food wastes (Diaz et al., 2002). Yard waste composting is a relativelysimple open-air process. The first step is to "chip" the yard waste to reduce the particle size and promote the breakdown of organic matter. This kind of study has not carried out in Erbil City-Iraq, and it was often promoted a (natural) process of solid management and Composts enhance soil fertility.

### Composting systems

There are three main systems of centralized composting, that is, aerated static-pile system, enclosed system, and the windrow system.

### Aerated static-pile system

In this system, piles of organic waste are formed, which are sometimes covered with screened compost to reduce odors and to maintain a high temperature inside the pile. Aeration is provided through blowers and air diffusers. These types of piles are usually employed for the homogeneous materials (e.g., sludge) and are not appropriate for heterogeneous materials (e.g., MSW).

### Enclosed system

The enclosed system is either a silo type or an agitated bed type. The enclosed container ensures control of temperature, oxygen concentration, and odors. Because of the high cost of enclosed systems, this system is adopted only when the compost is required to be used for soil application. The vessel can be in the form of a silo or a concrete lined trench. The silo-type system allows the composting material to move with gravity through the vessel, while in the agitated bed system, the material undergoing composting is moved through the vessel by mixing, thus combining the advantages of both the windrow and the aerated static-pile system.

### Windrow system

Windrow is simply a pile of waste material subjected to decomposition. It is the common way to produce compost from organic wastes. It required handling the amount of organic wastes in proper way that generated due to highly increasing population growth. On the other hand, increasing the efficiency of composting method can save costs (Avnimelech et al. 2004). In cross section, the shape of a windrow varies from rectangular to trapezoidal to triangular, depending largely on characteristics of the composting material and equipment used for turning. Aeration of the composting mass is achieved by frequent turning. In large systems, windrows are turned at regular intervals by turning and aeration machines. Sometimes the temperature of the composting mass is used as a turning indicator, so that windrows are turned when a certain temperature range (usually 55°C to 60°C) is reached (Kumar, 2011). Windrow composting is relatively low in cost as the aeration of the composting mass is achieved by the use of mechanical equipment. The height, width, and length of windrows depend on the nature of the input material and the type of equipment used for turning. Periodic agitation by turning is used to control the temperature.

**Compost Phases**

Composting phases are comprised of lag, active, and maturation or curing phases as given follow:

**Lag Phase**

The lag phase begins as soon as composting conditions are established. It is a period of adaptation of the microbes characteristically present in the waste. Microbes begin to proliferate, by using sugars, starches, simple celluloses, and amino acids present in the raw waste. Breakdown of waste to release nutrients begins. Because of the accelerating activity, temperature begins to rise in the mass (Tchobaonglous, 2002).

**Active Phase**

The transition from lag phase to active phase is marked by an exponential increase in microbial numbers and a corresponding intensification of microbial activity. This activity is manifested by a precipitous and uninterrupted rise in the temperature of the composting mass (Fig.4). The rise continues until the concentration of easily decomposable waste remains great enough to support the microbial expansion and intense activity. Unless countermeasures are taken, the temperature may peak at 70°C or higher (Tchobaonglous, 2002).

**Maturation or Curing Phase**

Eventually, the supply of easily decomposable material is depleted, and the maturation stage begins. In the maturation phase, the proportion of material that is resistant steadily rises and microbial proliferation correspondingly declines. Temperature begins an inexorable decline, which persists until ambient temperature is reached. The time involved in maturation is a function of substrate and environmental and operational conditions (Tchobaonglous, 2002).

**Design Considerations and Composting Process Parameters**

**Site**

The two most important site considerations are location and land availability. Ideally, the composting site should be located near a landfill or, in the case of sludge, adjacent to awastewater treatment plant. This will reduce materials handling and facilitate operations. Proximity to residences or industry impact the facilities required and costs. As mentioned, data on Erbil MSW and Erbil Landfill Site (ELS) were used for design and analysis composting process site area.

Erbil Landfill Site (ELS) is located on the left side of Erbil-Mosul main road close to Kani-Qrzhala Sub-district in Erbil City, Iraq (Fig. 3). The geographical coordinates of Latitude and longitude are 36°10'23" N and 43°35'32" E, respectively. It was opened in 2001, and it is about 15 km far from Erbil City centre. The total site area of ELS is about 37 hectares. Most part of the ELS area has been used. In 2017, the site receives about 2000 tons daily of mixed MSW (PEM, 2017). It is proposed to design the composting area close to ELS.

The selection of the composting system and the design of facilities depend on such aspects as the site of operations, climate, sludge and solid waste characteristics, and types of bulking material available (Tchobaonglous, 2002).

**Solid Waste Characteristics**

Solid waste consisting of paper, metals, garbage, glass, and plastics needs to be ground. The finer the particle size, the faster and more efficient is the composting process. Separation of materials reduces materials handling and results in a better product. Some processes first separate while others compost and then screen. The former is preferable.

Municipal or industrial waste composting is essentially materials handling that must be cognizant of the biological requirements of the system. Mixing is best done by auger feed mixers or pug mills. Based on the study conducted by Erbil Municipality-Iraq in 2016, the percentage amount for plastic, food waste, paper, other organics, wood, diapers, other in-organics, ferrous, glass, and aluminium are 34%, 27%, 14%, 7%, 6%, 5%, 2%, 2%, 2%, and 1%, respectively (Aziz and Mustafa, 2018).

**Bulking Materials**

Bulking materials serve three functions. They adjust the moisture content of the mass, adjust the C/N ratio, and provide structure or porosity to the mass. Important characteristics are particle size, moisture content, and absorbency. Bulking materials also affect the processing time, materials handling facilities, and product characteristics. High carbonaceous or cellulitis materials generally require long curing periods and large particles need to be ground. In the windrow pile system, the preferred particle size is (3.8cm to 7.6 cm).

**Operation and Performance Parameters**

Commonly used operational parameters include these eight: oxygen uptake, temperature, moisture content, pH, odour, colour, destruction of volatile matter, and stability. With respect to the first four, the distinction between their status as environmental factor and that as operational parameter is very difficult to define because the two overlap in that operational parameters evolve from environmental factors.

**Environmental Factors and Parameters Nutrients and Substrate**

In composting, substrate and nutrient supply are synonymous because the substrate is the source of nutrients. In the composting of yard waste and MSW, the biologically originated organic fraction of the wastes is the substrate. The specification “biologically originated” eliminates synthetic organic wastes. The exclusion of synthetic organics has a very practical significance because it eliminates many types of plastics. Wastes of biological origin differ from synthetic organic wastes in terms of molecular structure and arrangement. Examples of organic wastes of biological origin are wood, paper, and plant and crop debris. Plastics and vehicle tires are examples of synthetic organic materials (Tchobaonglous, 2002).

**Chemical Elements**

The major nutrient elements (“macronutrients”) are carbon (C), nitrogen (N), phosphorus (P), and potassium (K). Among the nutrient elements used in minute amounts (“micronutrients” or “trace elements”) are cobalt (Co), manganese (Mn), magnesium (Mg), and copper (Cu). Calcium (Ca) falls between macro and micronutrients. Carbon is oxidized (respired) to produce energy and metabolized to synthesize cellular constituents. Nitrogen is an important constituent of protoplasm, proteins, and amino acids.

**Availability of Nutrients**

An aspect of nutrition is that the mere presence of a nutrient element in a substrate does not suffice. To be utilized, the element must be in a form that can be assimilated by the organism. In short, the element must be “available” to the organism. This applies even to sugars and starches, most of which are readily decomposed.

**Carbon-to-Nitrogen Ratio**

The available carbon to available nitrogen ratio (C/N) is the most important of the nutritional factors, inasmuch as experience shows that most organic wastes contain the othernutrients in the required amounts and ratios for composting. The ideal ratio is about 20 to 25 parts of available carbon to 1 of available nitrogen. The concentration of nitrogen in MSW compost has been seen to increase with composting time as carbon is utilized by microorganisms (Wolkowski, 2003)

**pH effects**

Increased soil pH is regarded as a major advantage when MSW compost is used. These increases were usually proportional to the application rate. The increase in the pH of soil may be due to the mineralization of carbon and the subsequent production of $OH^-$ ions by ligand exchange as well as the introduction of basic cations, such as $K^+$, $Ca^{2+}$, and $Mg^{2+}$ (Hargreaves et al., 2008).

Both aerobic and anaerobic reactors started off in acidic conditions in the beginning of the experiment. However, the acidic pH in aerobic reactor increased to neutral values in a few days and was measured between 7.5 and 8.0 after day 35 until the very end (Erses et al., 2008).

**Calculation of Total Area of Windrow Pad**

A variety of factors combine to determine the dimensions of the area requirement. Among them are total volume of material to be accommodated during all stages of the compost process, i.e., from the construction of the windrows through disposal of the stored product, the configuration of the windrows, space required for the associated materials handling equipment and the manoeuvring thereof, and the aeration system (forced or turning).

Leaves and grass means plant material, except woody material, from any public or private landscapes. Examples include leaves, grass clippings, sea weed, and plants. This subtype does not include woody material or material from agricultural sources, and it was about 1.5% from all solid waste (Brown et al., 2006)

**Windrow Construction**

A windrow is constructed by stacking the prepared feedstock in the form of an elongated pile. The procedure involved in stacking the material is influenced by the volume and nature of the feedstock, the design and capacity of the available materials handling equipment, and the physical layout of the windrow pad. If more than one feedstock is involved (e.g., composting sewage sludge and MSW, or yard waste and food waste), or an additive is to be employed, the incorporation would take place at this time. If composting or additives are not involved, the windrows are set up directly after pre-processing is completed. If composting is involved, one approach is to build up the windrow by alternating layers of one of the feed stocks with layers of the other feedstock or doses of the additive. The first and subsequent turning accomplishes the necessary mixing of the components. If turning is not the method ofaeration, necessary mixing is done immediately prior to constructing the windrow. Conventional materials handling equipment such as a bulldozer or a bucket loader can be used for windrow construction. An alternative approach involves the use of a conveyor belt as follows: directly after having been pre-processed, the feedstock is transferred to the windrow pad by way of a conveyor belt, the discharge end of which has been adjusted to the height intended for the completed windrow (Tchobaonglous, 2002).

Three key factors enter into the determination of windrow dimensions, namely, (1) aeration requirements, (2) efficient utilization of land area, and (3) the structural strength and size of the feedstock particles. Structural strength, in turn, is a key factor in the maintenance of the interstitial integrity needed to ensure a sufficient oxygen supply. All dimensions could be expanded during winter to enhance self-insulation. In windy regions, the dimensions can also be expanded so as to minimize moisture loss through evaporation, see (Fig.4).

Blowers shall be used to inject fresh air into the windrow. The design shall be equipped with a sprinkler system to allow the addition of water or the recirculation of leachate into the composted material. The details of the site for composting process are shown in Fig.4

**Windrow dimension**

Three key factors enter into the determination of windrow dimensions, namely, 1) aeration requirements, 2) efficient utilization of land area, and 3) the structural strength and size of the feedstock particles. Structural strength, in turn, is a key factor in the maintenance of the interstitial integrity needed to ensure a sufficient oxygen supply. All dimensions could be expanded during winter to enhance self-insulation. In windy regions, the dimensions can also be expanded so as to minimize moisture loss through evaporation (Tchobaonglous, 2002).

**Height**

Interstitial integrity and height of the windrow are closely related, because the higher the pile,the greater is the compressive weight on the particles.Hence,the greater the structural strength,the higher is the permissible height. With the organic fraction of municipal refuse, the height is on the order of 1.5 to 1.8 m. Depending upon the size of the shrubbery trimmings fraction,it can be slightly higher with yard waste.In practice,the actual height is determined by the type of equipment used to aerate the composting mass. It generally is lower than the maximum permissible height.

**Width**

Other than its determination of the ratio of surface area exposed to inward diffusion of air width has little effect on aeration. However, the amount of inward air diffusion usually is negligible. In summary, width is dictated by convenience.If other factors do not intervene, a width of about 2.4 to 2.7 m is suitable.

**Windrow Geometry**

Windrow geometry should be geared to climatic conditions and efficient use of pad area. However, in practice, the determinant is the type of windrow construction and turning equipment, principally the latter. For example, as was indicated in the section on calculation of pad dimensions, cross-sectional configuration exerts a significant impact on the ratio of windrow volume to area and, hence, on efficient use of land area. However, in regions in which rains are frequent or heavy and the windrows are not sheltered, the cross-sectional configuration should be conical in order to shed water. On the other hand, a flattened top (square or rectangular configuration) is appropriate where rainfall is not a problem. With such a configuration, heat loss is less and windrow volume per unit pad area is greatest.

## III. RESULTS AND DISCUSSION

**In MSW characteristics in Erbil City-Iraq**

MSW characteristics in Erbil city-Iraq according to the data from directorate of services and environmental protection are as shown in (Fig.5):

From the Figure, it is clear that there are no yard waste alone, but it is with wood and the total amount is 5.57%, so it cannot depend on this data exactly, but in other study and data there are the accurate portion of yard waste and it is 1.5% of the total waste (Brown et al., 2006). So in this design the amount of 1.5% will be conceder.

**Design of Composting Site**

The average uncompacted density of leaves and grass means plant material was 104 kg/m$^3$ (Davis and Cornwell, 2006), the total amount of collected solid waste management in Erbil City was 2000 ton/day (PEM, 2017). In the current design, the collected leaves and yard wastes was 1.5% of the total MSW (Brown et al., 2006).

So, 1.5% x 2000 = 30 ton/day = 30000 kg/day

Volume of waste = mass/density

V = 30000 kg / 104 kg/m$^3$ = 288.48 m$^3$/d

The total pad area is the sum of the area required for the windrows plus that needed for manoeuvring the material (e.g., constructing windrows, turning the composting mass, water trucks, force aeration equipment, etc.).

It is emphasized that the calculations do not allow for the shrinking of the piles that will occur due to destruction of volatile matter and loss of moisture. Because of the variation in percentage loss due to differences in nature of feedstock and compost system applied, it is impractical to apply a single shrinkage value to all situations. Therefore, the value calculated for the total area will be the maximum value (i.e., the maximum requirement). For this design, three different scenarios were selected for windrow section as following:

**First scenario for designing with triangle windrow section**

1. Volume of material to be composted = 288.48 m$^3$/day
2. Composting period (detention time) = 60 days (Tchobaonglous, 2002).
3. Total volume of material on pad = 60 days x 288.48 m$^3$/days = 17308 m$^3$
4. Assume dimensions of windrow: length = 50 m, height = 1.8 m, and width = 2.7m
5. Volume of windrow: triangle section V = 1⁄2 × (2.7 × 1.8) × 50 m=121.5 m$^3$ (Fig.6 A).
6. Number of windrows = total volume of material/volume of windrow 17308/121.5 = 142.45 ≈ 143
7. Distance between windrows = 4 m
8. Space around perimeter of composting area = 5 m
9. Length of composting area = windrow length and perimeter space = 50 m + 2(5) = 60 m
10. Width of composting area: width of windrows + distances between windrows + perimeter Space = (143 × 2.7) + (142 × 4) + (2 × 5) = 386.1 + 568 + 10 = 964.1 m
11. Area required = length × width = 60 × 964.1 = 57846 m$^2$ for triangle section of windrow

Second scenario for designing with trapezoidal windrow section

Steps 1, 2, 3, and 4 are the same as mentioned for the first scenario.

5. Cross-sectional area (m$^2$) = 1⁄2 (width1 + width$^2$) (m) × height (m) (Fig. 6B).

When width1= 2.7m

Width2 = 1.35m

Then:

V = 1⁄2 × (2.7 + 1.35) × 1.8×50 m = 182.25 m$^3$

6. Number of windrows = total volume of material/volume of windrow

17308/182.25 = 94.96≈95 No.

7. Distance between windrows =4 m
8. Space around perimeter of composting area = 5 m
9. Length of composting area = windrow length and perimeter space = 50 m + 2(5) = 60 m
10. Width of composting area: width of windrows + distances between windrows + perimeter Space = (95× 2.7) + (94× 4) + (2 × 5) = 256.5 +376 + 10 = 642.5m
11. Area required = length × width = 60 × 642.5= 38550 m$^2$ for trapezoidal section.

**Third scenario for designing with semicircle windrow section**
Steps 1, 2, 3, and 4 are the same as illustrated for the first and second scenario.
5. Cross-sectional area When b = 2.7m
And h = 1.35m
Then: Cross-sectional area ($m^2$) = $\pi/4 \times b\ (m) \times h\ (m)$ (Figure 6 C).
$V = \pi/4 \times 2.7 \times 1.35 \times 50 = 143.13 m^3$
6. Number of windrows = total volume of material/volume of windrow
17308/143.13 = 120.9≈121 No.
7. Distance between windrows = 4 m
8. Space around perimeter of composting area = 5 m
9. Length of composting area = windrow length and perimeter space = 50 m + 2(5) = 60 m
10. Width of composting area: width of windrows + distances between windrows + perimeter
Space = (121 × 2.7) + (120 × 4) + (2 × 5) = 326.7 + 480 + 10 = 816.7 m
11. Area required = length × width = 60 × 816.7 = 49002 $m^2$ for semicircle section.

Different sections of windrow were selected for the design of windrow, triangle, trapezoidal, and semicircle. The obtained area for triangle section was 57846 $m^2$, while the needed area to the compost in trapezoidal and semicircle were 38550$m^2$, and 49002$m^2$ respectively. So, the trapezoidal section was chosen for the design of composting site area; because it needs smaller area (642.5m x 60m) and it is economical design for the project (Fig. 7).

**Economical Analysis**

For the design of windrow different sections of windrow were studied (triangle, trapezoidal, and semicircle). The obtained area of triangle section was 57846 $m^2$, whereas the needed for the trapezoidal and semicircle sections were 38550 $m^2$, and 49002 $m^2$, respectively. So, the trapezoidal section was selected for the design area because it needs smaller area than other section, due to the results trapezoidal section is economical design for the project. The dimensions and areas for the proposed areas for composting process s are given in (Table 1).

Composting of MSW has potential as a beneficial recycling tool. It's safe use in agriculture, however, depends on the production of good quality compost, specifically, compost that is mature and sufficiently low in metals and salt content. Composting will be a financial source, the price for one ton of compost in Erbil-City Iraq is about 250$ to 300$. Early source separation, perhaps requiring separation to occur before or at curb side collection.

The amount of composting in Erbil City which was equal to 30 000 kg/ day (30 tons/day). It can achieve 7500 to 9000 $/day from composting process in Erbil City.

the presentexperimental work, the following working parameterswere considered:The mass flow rate of hot saline water and the effect of the spherical dome curvature on fresh water productivity versus the day time (8.0 am – 5.0 pm),With reference to Fig.6, one can find that the increase in the intensity of the sun leads to an increase in fresh water productivity at the same time and the same dome is equal to 10 cm. This is due to the increase in the temperature of salts that cause more evaporation of salt water and increase the flow rate of mass of salt water, and as a result, productivity increases. Also, in Fig.7 and Fig.8, the productivity of fresh water was observed at the same time and the same height dome 18 cm and 40 cm respectively,

## IV. CONCLUSION

Economic Analysis for design of composting area by using different procedures may be helpful for selecting the adequate method for the area of work, because of the problems associated with the land disposal of MSW. In the present research, different sections of windrow were selected (triangle, trapezoidal, and semicircle). Calculated areas for the triangle, trapezoidal, and semicircle sections were 57846 $m^2$, 38550 $m^2$, and 49002 $m^2$ respectively. The trapezoidal section was selected for the design area because it was economical design for the project and need less land. It can achieve 7500 to 9000 $/day from composting of disposed organic materials. Composting is environmentally safe way inspite of directly dumped into soil. It is a useful method to convert biodegradable waste products, which has many benefits such as reducing landfill area, reduce groundwater contamination, and reduce methane gas emissions, minimize cost of transportation, eliminate air pollution during burning wastes, achieve proper waste management system, enhance recycling of materials, which can be carried out a capital cost.

solar desalination system based on free jet-humidification with an auxiliary cold water system was carried out at Suez city, Egypt 29.9668°N, 32.5498°E. The main conclusions items can be briefly systemized as the following:

1. Spherical dome heights 40 cm produce the highest fresh water productivity at the same condition.
2. Increase the condensation surface will be increase the fresh water productivity
3. Increase the salinemass flow rate will be increase the fresh water productivity
4. The system productivity is (2.68 L/$m^2$), the estimated cost is (0.12 $/L) and the efficiency is 61 %.

## REFRENCES

[1]. AZIZ, S. Q., AZIZ, H. A., BASHIR, M. J. & YUSOFF, M. S. 2011. Appraisal of domestic solid waste generation, components, and the feasibility of recycling in Erbil, Iraq. Waste Management & Research, 29, 880-887.

[2]. DIAZ, L. F., SAVAGE, G. M. & GOLUEKE, C. G. 2002. Composting of municipal solid wastes. Handbook of solid waste management, 2, 423-492.

[3]. ERSES, A. S., ONAY, T. T. & YENIGUN, O. 2008. Comparison of aerobic and anaerobic degradation of municipal solid waste in bioreactor landfills. Bioresource technology, 99, 5418-5426.

[4]. HARGREAVES, J., ADL, M. & WARMAN, P. 2008. A review of the use of composted municipal solid waste in agriculture. Agriculture, Ecosystems & Environment, 123, 1-14.

[5]. JARA-SAMANIEGO, J., PÉREZ-MURCIA, M., BUSTAMANTE, M., PÉREZ-ESPINOSA, A., PAREDES, C., LÓPEZ, M., LÓPEZ-LLUCH, D., GAVILANES-TERÁN, I. & MORAL, R. 2017. Composting as sustainable strategy for municipal solid waste management in the Chimborazo Region, Ecuador: Suitability of the obtained composts for seedling production. Journal of Cleaner Production, 141, 1349-1358.

[6]. KUMAR, S. 2011. Composting of municipal solid waste. Critical reviews in biotechnology, 31, 112-136.

[7]. LIM, S. L., LEE, L. H. & WU, T. Y. 2016. Sustainability of using composting and vermicomposting technologies for organic solid waste biotransformation: recent overview, greenhouse gases emissions and economic analysis. Journal of Cleaner Production, 111, 262-278.

[8]. RASAPOOR, M., NASRABADI, T., KAMALI, M. & HOVEIDI, H. 2009. The effects of aeration rate on generated compost quality, using aerated static pile method. Waste Management, 29, 570-573.

[9]. SHEKHA, Y. A. 2011. Household Solid Waste Content in Erbil City, Iraq Kurdistan Region, Iraq. Zanco Journal of Pure and Applied Science, 23, 1-8.

[10]. WOLKOWSKI, R. P. 2003. Nitrogen management considerations for landspreading municipal solid waste compost. Journal of environmental quality, 32, 1844-1850.

[11]. TCHOBANOGLOUS, G. 2002. Handbook of solid waste management. George Tchobanoglous, Frank Kreith. New York: McGraw-Hill.

[12]. Worrell, W.A. and Vesilind, P.A. 2012. Solid Waste Engineering. Second edition, Publisher, Global Engineering: Christopher M. Shortt.

### List of Tables

**Table (1). Results of the different scenario for composting process**

| Item | Triangle section | Trapezoidal section | Semicircle section |
|---|---|---|---|
| Length | 50m | 50m | 50m |
| Width | 2.7m | 2.7m | 2.7m |
| Height | 1.8m | 1.8m | 1.35m |
| Area | 57846$m^2$ | 38550$m^2$ | 49002$m^2$ |

### List of Figures

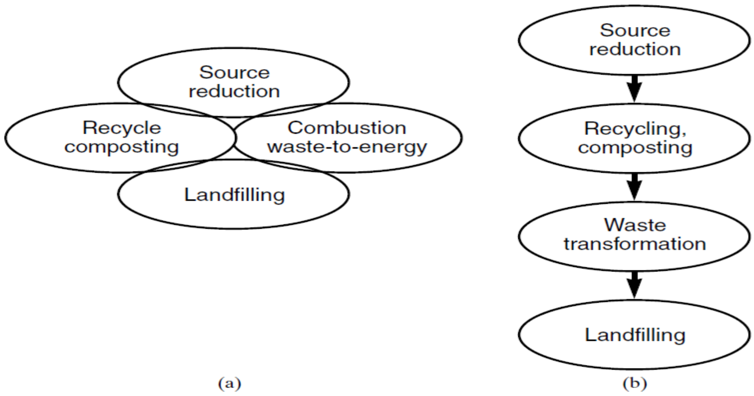


**Figure 1. Relationships between the management options comprising integrated waste management: (a) Interactive and (b) hierarchical.**

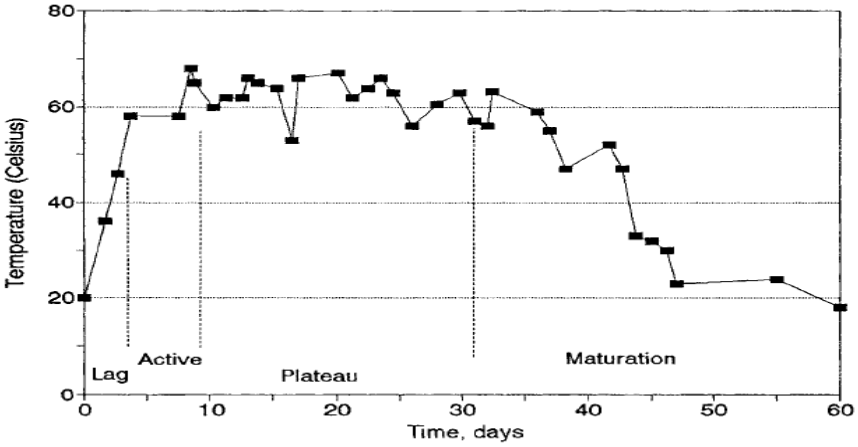


**Figure 2. Typical temperature curve observed during the various compost phases (Tchobaonglous, 2002).**


**Figure 3. Satellite image of Erbil Landfill site.**

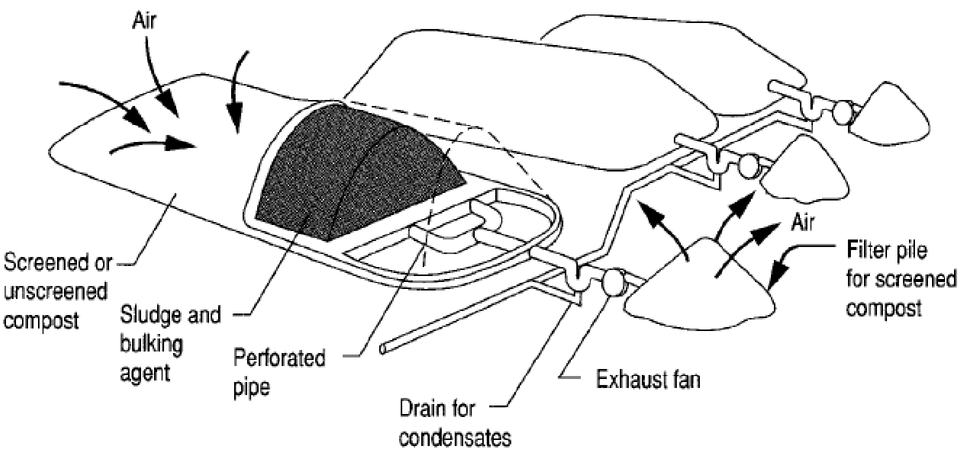


**Figure 4. Windrow arrangement for forced aeration (Tchobaonglous, 2002)**

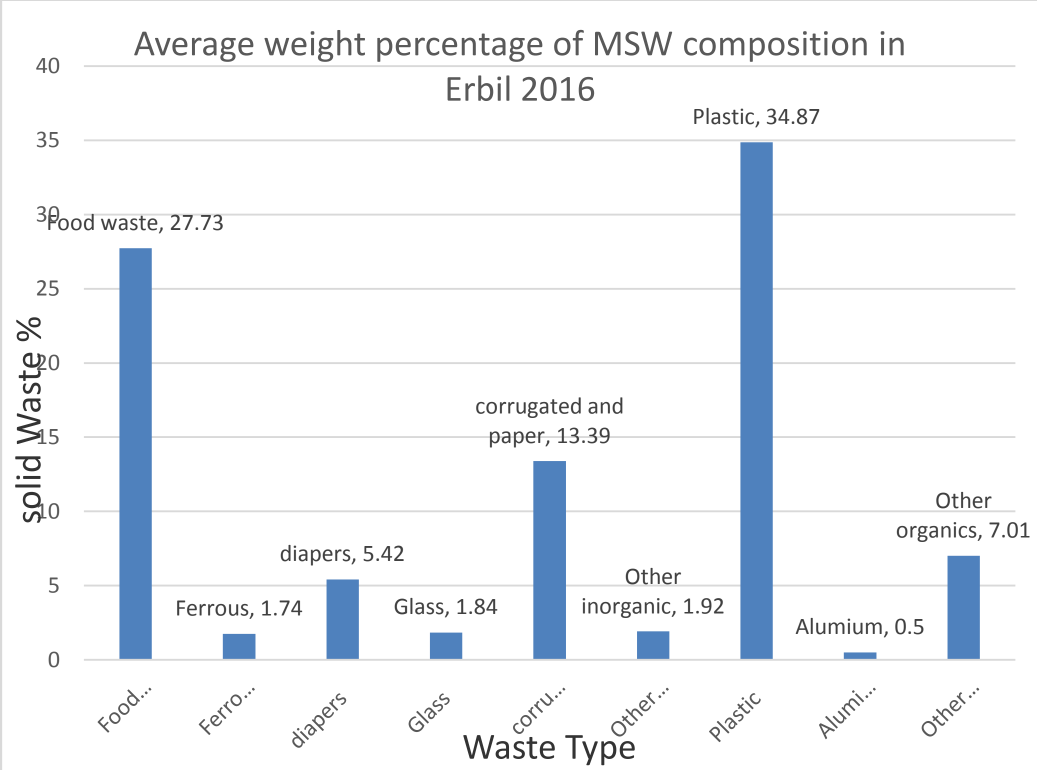


**Figure 5. Average weight percentage of MSW composition in Erbil 2016.**

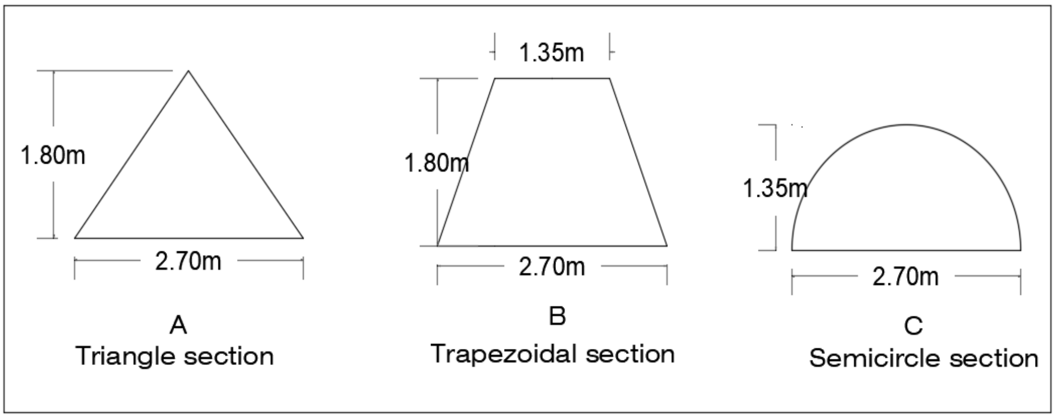


**Figure 6. Cross sections for windrow compost pile**

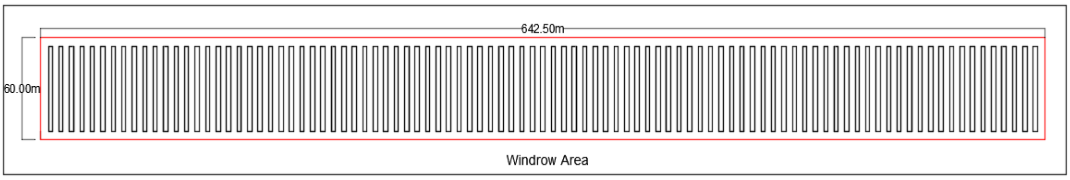


**Figure 7. Windrow Area for second scenario (trapezoidal section)**

Shukor Qarani Aziz "Design And Study For Composting Process Site ""International Journal Of Engineering Inventions, Vol. 07, No. 09, 2018, pp.09-18