"PRODUCTION OF ORGANIC FERTILIZER FROM ORGANIC MATERIALS"

BY

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A PROJECT REPORT

ON

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A PROJECT SUBMITTED TO THE DEPARTMENT OF CHEMICAL ENGINEERING, SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA,

IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR OF ENGINEERING, (B.ENG.)

MARCH 2000

DECLARATION

I, Opafemi, Bola Tunde declare that this project presented for the Award of Bachelor of Engineering in Chemical Engineering has not been presented either wholly or partially for any other degree elsewhere.

______________________________ ______________________________

Student **Date**

APPROVAL PAGE

This project is a research study approved by the Department of Chemical Engineering, Federal University of Technology, Minna. The Study was carried out in the University Engineering Laboratory under a careful supervision of Dr. J. O. Odigure.

CERTIFICATION

I certify that the research report presented here is a true handiwork of Mr. B. T. Opafemi. Having supervised and read through, I certify that the material is adequate in scope and quality, for the partial fulfilment of the award of bachelor in chemical engineering.

______________________	______________________
Dr. J. O. Odigure *Project Supervisor*	**Date**
______________________	______________________
Dr. J. O. Odigure *Head of Department*	**Date**
______________________	______________________
External Supervisor	**Date**

DEDICATION

My beloved mother, father, sister and brother
in partial recompense for their loss of attention while this project was on.

ACKNOWLEDGEMENT

My thanks go first to God Almighty for the divine help, provision, protection and guide throughout the duration of my study.

Also to my able supervisor Dr. J. O. Odigure for his patient and endurance towards me during the duration of this project.

This project would not have happened without the help of my vibrant Auty Bola and my parents for their financial and moral support.

ABSTRACT

This project is about the production of organic fertilizer from organic materials (cow dung, poultry waste, and saw dust), which has been regarded as waste material for the past many decades. The project work is to try to find out how possible is it to produce the organic fertilizer that is comparable to any inorganic fertilizer.

For this project temperature variations was used in determining the maturity of the fertilizer, also the CO_2 changes was also measured for the same above and comparison was made between the two.

Result obtain shown that most of the time the duration temperature of the composting material is between 56-60°C and also that changes in the rate of CO_2 indicates changes in the composition of the active microbial population.

It should be noted here that before the 43 days composting period, the composting materials undergoes rewetting each time there is a noticeable drop in the temperature which is caused by the reduction in water content which caused localised pH, therefore affecting the activities of the microbial and to bring the back to normal active scene, the decomposing material under goes rewetting.

CHAPTER ONE

1.0 INTRODUCTION

Composting is the decomposting of organic matter by a mixed population of micro organisms in a warm, moist, aerobic environment.

Considerable amount of organic material, produced annually in a nature are eventually takes place slowly on the surface of the ground at ambient temperature and mainly under aerobic conditions. The natural process of break down can be accelerated by gathering the material into heaps to conserve part of the evat of fermentation so that the temperature of the mass rises and faster reaction rates are obtained. This accelerated process is composting.

Wastes amenable to composting vary from the highly heterogeneous form the manures, crop residues and sewage sludge. During, composting process most of the oxygen demand of the waste is met, the organic materials are converted to none stable products such as the eumic acids, and carbon dioxide and water over evolved. An important consideration in increasing agricultural output is raising the level of soil facility.

A method of improving both soil structure and the supply of plant nutrients is the application to the humus, the and product of composting. This is particularly important in acid and semi-acid countries in which the rate of oxidation of soil is far higher than in temperature climes.

A global over view of consumption of fertiliser shows that much attentions hbeen a known in organic fertilizer is:

(i) Environmental friendly
(ii) Causes of water and air pollution
(iii) Uses organic wastes and refuses, there by removing health liazards in our cities.
(iv) No damage to soil and crops.
(v) The effect last longer than other fertilizer (at least for two cropping seasons).
(vi) All raw material needed are locally sourced and available nationwide
(vii) Suitable for different ecological zones.
(viii) Saves a lot of foreign exchange for the country, and
(ix) Relatively cheap and affordable.

The organic fertilizer has been proved to offer the following solution to soil fertility problems:

(i) Increase inorganic matter and soil buffeting capacity.
(ii) Slow release and increase in Nitrogen supply.
(iii) Availability of adequate phosphorus and potassium.
(iv) Nutrient balance.

There also has been effort intensifying on developing of methods of producing excellent composted fertilizer that is equal or surpass the nutrient value of existing inorganic fertilizer.

The developing of this technology which would enable production of fertilizer from organic source.

When organic waste like cow dung, chicken droppings, sawdust, municipal waste etc. is decomposed under certain condition, a kind of composted fertilizer which is:

(i) Odourless.

(ii) Easy to transport.

(iii) Provide no damage to soil and crop.

(iv) Free from pathogen disease.

(v) Compare favourably with the inorganic fertilizer, is produced.

The production of this kind of fertilizer is practised extensively in the U.S.A, U.K. and China.

Considering the ever increasing population and the low income of average farmers in Nigeria and the fact that, our country refineries that provide some of the raw materials needed in the production of the inorganic fertilizer has all almost packed up. Then there is need to encourage the production of organic fertilizer because it is:

(i) Cheaper. (ii) Affordable

to farmers than the inorganic fertilizer and these needs should be address as soon as possible, by the Government of the Federal Republic of Nigeria.

1.3 LIMITATION OF THE STUDY

The production of fertilizer is not problem free in the area of production or the reactor to give the effect production desire specification using the most economical and efficient way. The ease to condition the process to obtain maximum yield of the fertilizer is also a problem. It could be rightly concluded that production of organic fertilizer is not altogether a new field, but there has been some problems that is associated with the production of the final product like the:

(ii) offensive odour;

(iii) the difficulty in transporting the wet or bulky manure;

(iv) problem arising from storing;

(v) problem of packaging.

(vi) At time when apply to young plant in this condition (untreated form) the heat given out can kill the young plant.

(vii) Also decomposition is not without the attraction of some pathogens which can affect the growth of the plant.

1.4 OBJECTIVE

It is the purpose of this research work to produce a kind of organic (composted) fertilizer that will give a maximum crop yield and free from the following problems:

(i) the offensive odour

(ii) easy to transport

(iii) cheaper to afford

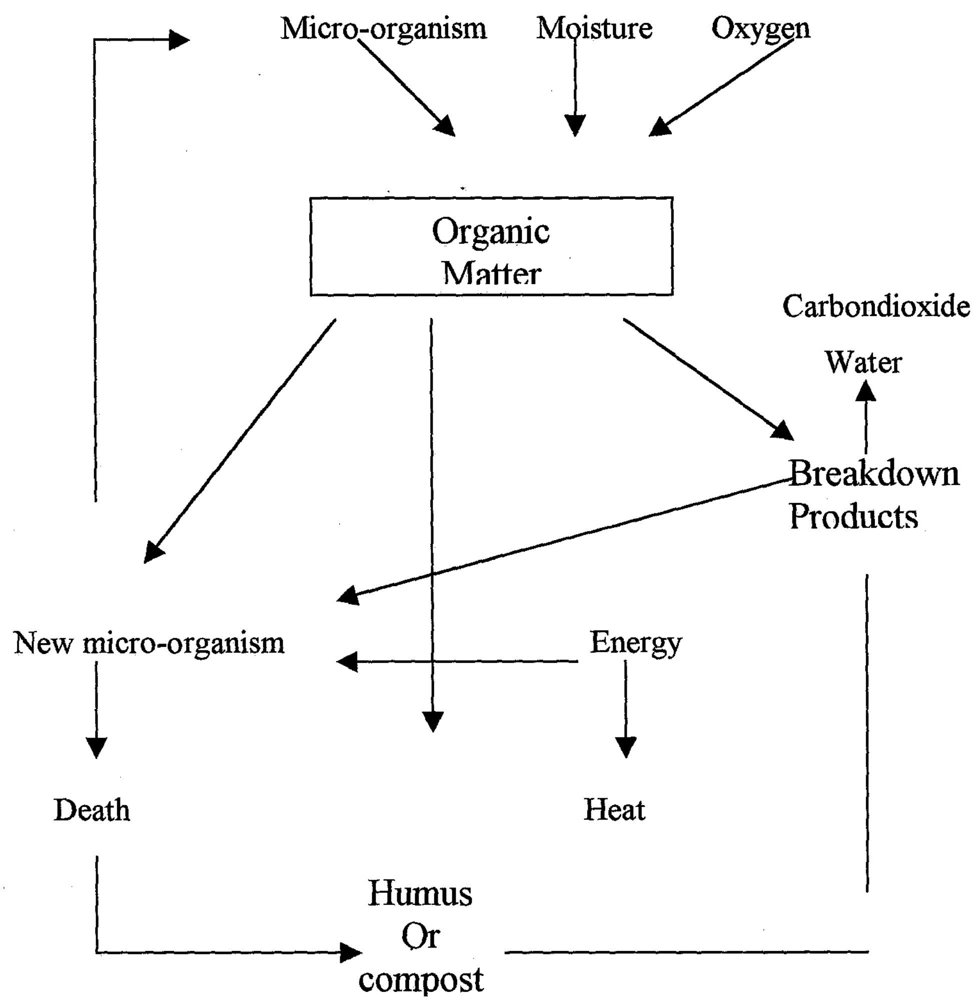
(iv) easy to package

(v) easy to produce on farm location.

CHAPTER TWO

2.0 SURVEY OF THE LITERATURE

Micro organisms, moisture and oxygen. The organic material will normally have an The process of composting involves an interaction between the organic waste, indigenous mixed population of micro organism derived from the atmosphere, water or soil when the moisture of the waste is brought to a suitable level and the mass aerated, microbial aeration speed up. As well as oxygen and moisture, the micro organism require for their growth and reproduction a source of carbon (the organic waste), macro nut rent such as nitrogen, phosphorus and potassium and certain trace elements. In attacking the organic matter the micro-organism reproduce themselves and liberated carbondioxide, water, the other organic product s and energy. Some of the energy is used in metabolism; the reminder is given off as heat. The end product, compost, is made up of the more resistant residues of the organic matter, brake down products, dead and some living microorganism, together with products from further chemical between these materials. The overall process is illustrated in Fig 1.



2.1 BIOCHEMICAL ASPECTS

Organic waste, whether of agricultural, industrials or urban origin, are mixtures of sugars, proteins, fats, hemicellose, cellose, ligin, and minerals in a wide variety of concentration, as shown in table 1. In animals the composition of manure depends upon the type of animal and its feed. In plants they depend very much upon the age of the plants as well as upon its type and environment. Fresh green materials, such as young grass, contains water –soluble matter, proteins and minerals .As the plant ages, minerals tends to return to the soil and low molecular weight compounds are converted to the higher molecular weights polymer, hemicelluloses, cellulose, and lignin. Composting is both break-down process and a building-up process .The key point is the cell wall of the micro-organism attacking the organic matter .Low molecular weight materials, the water soluble, can pass through the cell wall easily and take part in cell metabolism providing energy and being built up into larger molecules .The higher molecular weights components of the organic waste cannot pass through the cell wall and cannot be used without being broken down .In these case the micro-organisms can secrets extra cellular enzymes which hydrolyse the polymers into short length which are basic sugar units. Virtually all micro-organisms can assimilates the resulting fragments but only a proportion can carry out the hydrolysis.

Some indications of the extent of the biochemical changes taken place is given by the results of (Yung Chang 1967) on composting wheat straw amended with ammonium nitrate .The straw as lost over half of its dry weight after 60 days of composting with the majority of the lost in the first 34 days .The lost of the total dry weight could be accounted for almost completely by the lost in hemi cellulose and cellulose . Cellulose degradation slow down during the middle of the circle whilst the hemicelluloses were broken down fairly steadily. Hemicelloses are polysaccharides of about 1000 to 10,000 glucose units which is significantly more resistant . Lignin consist of a number of aromatic units linked by aliphatic side chains and is extremely

Table 1 : Composting of Organic Manure

	% in dry weights	
Fraction	**Plants**	**Manure**
Hot/Cold Water Solubles:		
Sugar, Starches, amino acids, Urea and ammonium Salts, aliphatic acids	5-30	2-20
Ether alcohol Solubles		
Fats, oils, waxes and resins	5-15	1-3
Proteins	5-40	5-30
Hemicellucose	10-30	15-25
Cellucose	15-60	10-25
Lignin	5-30	10-25
Minerals (ash)	1-13	5-20

resistance to enzyme attack ,being the last material degraded in composting. However, during composting the lignin molecule does become modified, losing some methos groups and aliphatic side chain and gaining carboxyl and phenolic hydroxyl groups (Alexander 1977) .

2.2 MICROBIOLOGY

Composting is a dynamic process brought about by the activities of a succession of mixed microbial population , each of which is suitable to an environment of relatively limited duration .

Table **2. Organisms involved in composting.**

	Genus	Number per g of moist Compost
Microflora	Bacteria	10^2-10^9
	Actinomycetes	10^5-10_8
	Fungi	10^4-10^6
	Algae	10^4
	Viruses	
Microflora	Protozoa	10^4-10^5
Macroflora	Fungi	
Macroflora	Mites, Springtails, ants Termites, millipedes, Centipedes, Spiders, Beetles, worms	

These organisms represent both the plant and animals kingdoms. Each named micro-floral is a genus within which are many different species, e.g. possibly 2,000 of bacterial and at least 50 of the fungi. Each species can be sub-divided according to the temperature ranges of their activity; physichrophiles prefers temperatures below 20, mesophiles 20 to 40, and thermophiles above 40. The macro flora and macro fauna which flourish during the final stage of composting are essentially mesophiles although presents in vast numbers the bacterial are very small size and form less than half of the total microbial protoplasm. Some species form endossporezs, which can withstand considerable heat and desiccation.

The actinomycetes develop far more slowly than most bacterial and fungi but become prominent at peak temperature and in the later stages of

Composting.

The thermopiles fungi are relatively well-defined group in composing. At least eight species of these fungi have been study which are capable of growing in the range 40 to 60 . they die out above 60 .Reappearing latter as the temperature fall . Studies on the population number of bacterial, actinomycetes and fungi during composting have been made by

(Yung Chang 1967) ,(Yung Chang and Hudson 1967) ,(Hayes and lim 1979) ,(Hedger 1972) .(Kiyohiko Nakasaki 1996) ,(Nabuyuki Uehara 1996), (Minora Kataoka 1996). (Hiroshi Kubota 1992) of the department of chemical Engineering, Faculty Of Engineering Swizuoka University. Hamatsu Japan.

Ounce the compost heap cools from its peak temperature its accessible to a wide range of soil macrofauna. These feed upon other animals etcetera and the plant remains. They normally required well-aerated conditions, adequate moisture and prefer temperature in the range 7-13 .
Many of the soil animal make a major contribution to break down in compost heap due to physical maceration; breaking the material into smaller particle exposes greater surface area for subsequent attack by the microfloral. They also make a contribution to the mixing of various constituents.

In temperate climates the earthworm plays a major role in the break down process in the compost heap and in the subsequent incorporation of organic matter into the soil; in arid and semi-arid climates this function is usually undertaking by termites (Edward 1974).
The biochemistry and microbiology of composting are covered in greater detail by (Gray et al 1971).

2.3 TEMPERATURE –TIME PLAN.

When organic wastes are gathered into heaps for composting, the insulating effect of the material leads to a conservation of heat and a marked rise in temperature. The subsequent composting process may conveniently be divided into four stages; mesophilic , thermophilic ,cooling down and maturing(Figure 2).

At the start of composting the wastes are at ambient temperature and are slightly acidic. During the mesophilic stage the indigenous micro-organism multiply rapidly, the temperature continues to rise and the thermophilic strains of organisms take over; the pH turns alkaline ads ammonia is librated during the break down of protein molecules.

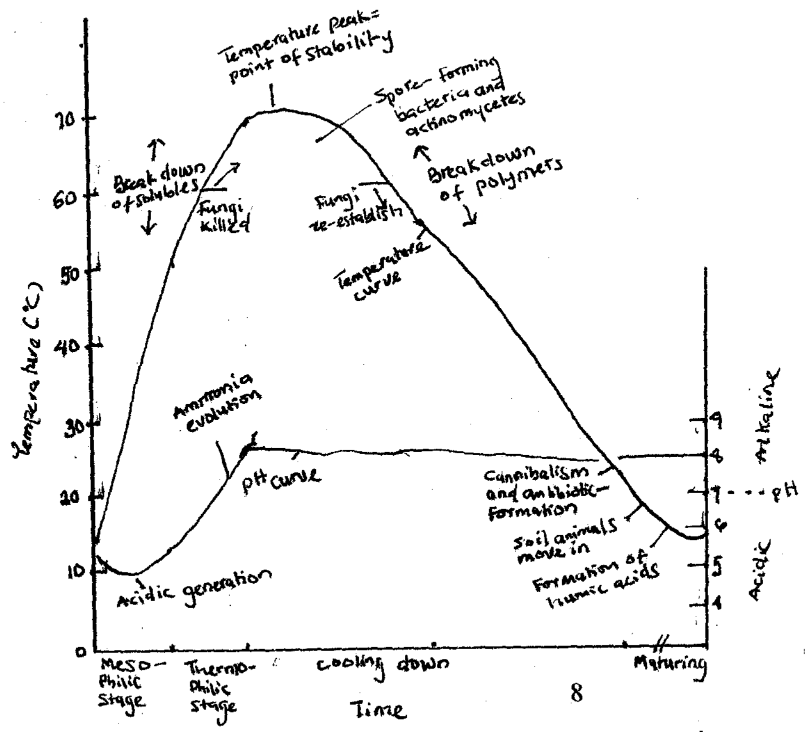


Figure 2 Temperature and pH variations with time.

By 60°C the thermophilic fungi cease activity and the reaction is kept going by the actinomycetes and the spore forming strains of bacteria. The reaction rate slows down and the temperature peak is reached: the rate of it heat generation then becomes equal to the rates of heat loss from heap surface. This marked the end of the thermophilic stage: a waste have reached stability at which the easily converted materials e.g. carbohydrates, fats and proteins, have been degraded and most the oxygen demand met. The wastes are now no longer attractive to flies and vermin and should not give off bad odours. The materials may now be put into heaps outside without causing major environmental pollution. The maximum temperature reached depends in the main on the quantity of material being processed. Following the temperature peak are the cooling down sage commences and the PH drops slightly but remains alkaline. When the temperature falls below 60°C the thermophile fungi re-invaded the mass and together with the actinomycetes attacks the long chain polysaccharides i.e. hemicelluloses and cellulose, breaking them down into simple sugars, which may then be utilise by wide range of micro- organisms. Following the break down of these polysaccharides the rate of energy evolved becomes very small and the temperature of the mass falls to ambient.

The process now entered the maturing stage in which heat evolution and weight loss are small. The macro flora and macro fauna now invade the heap. As the food supply becomes exhausted antagonism between the microorganism's breaks out and anti biotic are produced. Complex chemical reactions occur between the lignin residue of the original waste and the proteins from the dead microorganisms to form humic acid. By the end of maturing, which may take several months, the waste will heat up on turning nor go anaerobic in storage nor rob nitrogen from the soil on incorporation. The material has become humus or compost.

2.4 PROCESS FACTORS

The composting of organic wastes is a dynamic and complicated ecological process in which temperature. PH and food availability are constantly changing. In some consequences, the numbers and species of organism present also change markedly. The rate of progress toward the mature end product, humus is depended on several inter-related process factors. These include particle size, nutrient supply, structural strength of the material, moisture, aeration, agitation, PH and size of heap .T is desirable to adopt the best operating conditions allow by the economics of the operation. The complexity of the processing plant and the quality of the final product will depend upon the type of work and the level of investment available.

2.5 SEPARATION

The major use for soil compost is a soil conditioner/fertilizer in agriculture. Consequently the compost should have a high organic matter content with a minimum of mineral matter. This is of particular important when processing urban waste, the compost from which can contain significant quantities of trace metals such as **copper**, lead, nickel and zinc.

Accordingly, with urban refuse its desirable to remove as much glass, plastic and debris as is economically possible. There are a variety of devices available for such separation; air classifiers, Rotadisc Separators for plastics and ballistic separators for heavy particles. Where sewage sludge is used for composting, it should be mainly from domestic and not industrial waste.

2.6 PARTICLE SIZE

The smaller the size of the waste material, the greater is the surface area expose to the microbial attack, and theoretically, the greater is the rate of composting. However, very small particle pack tightly together, giving material with high bulk density having narrow pores and channels within it. This restrict the diffusion of air into the mass and carbon dioxide out of it, thereby inhibiting composting. The bulk density may also cause excessive loads on mechanized turning equipment, especially when the material are wet.

A compromise on particle size is therefore necessary; the refuse is shredded to approximately 50mm size for static heap and windrows. For mechanical plant 12.5mm is appropriate. Particle size reduction may be achieved using hammer mills, jaspers or by self-abrasion in rotary drums.

After composting and maturing the particles of the compost product should be below 2.5mm screen size.

2.7 NUTRIENTS.

The microorganisms involved in require a source of carbon to provide energy and material for new cells, plus a supply of nitrogen for cell proteins. To a lesser extent there is a requirement for phosphorus, potassium, calcium, magnesium, sulphur, iron and traces of other elements such as cobalt and zinc.

The subject is well discussed by (Alexander 1977). In most cases the requirement for nutrients is adequately met from the original organic wastes; only nitrogen and occasionally phosphorus may need adjustment. Chemically analyses of micro organism revealed that on average they contained 50% carbon C, 5% nitrogen N and .25-1.0% phosphorus P on a dry weight basis. This gives a ratio C/N of 10 : 1 and an N/P ratio of 5-20 :1. since approximately 50-60% of the organic carbon in the composting material is converted to carbon dioxide, an initial CN ratio of about 25:1 should be optimum if no nitrogen is lost A higher ratio involves the oxidation of excess carbon, the organism going through many life cycle to achieve a final CN ratio of 10:1. With CN ratio less than 25;1, as in the case of animal manures and sewage sledges, nitrogen will be lost as ammonia, often in considerable amounts. However, some carbon and nitrogenous compounds are fairly resistant to microbial attack and some nitrogen fixation from atmosphere may occur during composting. These factors make accurate prediction of initial CN requirement difficult: In practice a ratio in the range 30-35:1 has proved to be optimum

(University of California 1953). For low initial C/N ratio the loss of nitrogen as ammonia may be suppressed by the addition of extra phosphate.

2.8 OTHER ADDITIVES

The use of chemical and other additives and the addition of bacterial culture (innoculla) have been claimed mainly by the additives man8ufacturals, to increase the rate of composting. Apart from the possible need for extra nitrogen most compost able materials normally contained all the nutrients they required. The situation regarding is less clear. Laboratory scale work by (Nakasaki et al 1994) shows that innoculla has no effect further more the use of microbial inoculants in organic matter composting reduces the lag time typically observed clearly in the process, but negative effects have been observed by many researchers (De Bertoldi et al 1983; Faure and Deschamp 1991; finsteein kmorris 1975 ;Golueke 1977; Nnnakasaki et al 1985, 1988,1992,;Solbra 1984). For many year the positive effect of innoculla have really been observed except in raw materials of homogeneous composition such as straw or wood,(Gaur et al.1992 ; Matthur et al.1986; Yadav et al.1982) . Recently, the positive effects of seeding on composting by using commercial food dog as raw material consisting of variety of organic constituents(Kubota et al 1994). In addition thermophilic bacterium Bacillus Licheniform is HA-1 that was effective for composting material with a PH under 7.

When composting finely divided organic solids such as sewage sludge and animal manure slurries, bulking agent are normally necessary to ensure an open matrix for air diffusion. Wood chips have been the favoured bulking agent in the Beltsville aerated pilled system for sewage sludge (Epstein et al. ,1976; Higgins et al 1980)proposed pulverized tyres as an alternative;((Grayand Biddlestone 1975) use straw in the ARCUB process for manure slurries

2.9 MOISTURE CONTENT

Moisture is essentially to the composting process for the transportation of the materials to and from the micro-organisms. Below 30% of moisture on afresh weight basis the biological reaction slow down remarked. If the moisture content is too high the voids between the matrix become water logged, limiting access of oxygen to the micro organisms. Some materials, e.g. paper, readily lose structural strength when very wet; straw on the other hand can tolerate high moisture content. For refuse the optimum moisture content lies in the range 50-60%.

Water is produce during the composting process by microbial action and is lost by evaporation into the air stream, where force aeration is applied moisture loss can be excessive and additional water must be supply to the matrix. Problems of water loss are naturally more severe in hot climates. Urban refuse contains lipids (,Oils, Fats and waxes).Which are liquids at composting temperatures. (1957Willey) as suggested that the total liquid content should be used as a guide rather than the water content.

This is given by

$$\% \text{ Liquid} = \frac{100\ (\% \text{ moisture} - \% \text{ Lipids})}{(100\ \_\ \% \text{ ash})}$$

2.10 AERATION

Oxygen is essential to the metabolism of aerobic species of micro-organisms responsible for composting. Air may be introduced by several methods; by natural gaseous diffusion into the stationery pile, by turning the heap regularly with machine, or by forced aeration from a fan. Natural diffusion frequently fails to supply adequate oxygen at the start of composition, leading to aerobic conditions at the heap centre. Aeration has other functions in the composting process. It removes the carbon dioxide and moisture produced in the microbial reaction and may help to cool the heap by evaporative heat transfer. Oxygen requirements vary throughout the process, being low in the mesophilic stage, increasing to a maximum in the thermpophilivc stage, increasing and decreasing through the cooling down and maturing stage. While 1955 recommended aeration rates to supply 6-19mg O_2h^{-1} (g volatile solids in the composting mass)-1, it is possible to have too high an aeration rate which can lead to excessive cooling and desiccation of the wastes.

2.11 AGITATION

Agitation speeds up the composting process by improving aeration and by breaking up large piece of material thereby exposing fresh surfaces to microbial attack. However too much agitation can lead to excessive cooling and drying of the wastes and shearing of actinomycetes aid fungal mycelium. improving aeration and by breaking up large piece of material there by exposing fresh to microbial attack. However too much agitation can lead to excess cooling and drying of the waste and shearing of actinomycetes and fungal mycelium. (Flintoff 1976) considers that turning a windrow heap three or four times should be sufficient while (Gray et al 1971b) suggest that in mechanized plant short period of vigorous agitation should be alternated with periods of no agitation.

2.12 pH CONTROL

The PH changes from acid to alkaline during composting as shown in figure 2. Addition of chemical to control the ph has generally proved uneconomic in large scale composting plants.

2.13 CHANGE IN VOLUME.

In the research work carried out by Kiyohiko Nakasaki et al (1996) it was discovered that a piles having the same initial volumes and densities except treatments receiving large volume of compost activators such as mature compost, activator G, or topsoil. Volume was calculated at each sampling period by measuring the height at the four corners and the average surface area. Volume reduction was expressed as a percentage of the initial volume of each pile. Volume reduction was not monitored in the laboratory experiment.

All treatment showed a steady decrease in volume over the six weeks. Volume reduction was largest in the initial week. All commercial activator treatments had average volume reductions of 55-60 percent in six weeks. The means comparison of data obtained at the end of six weeks

Suggest no significant differences in volume reduction.

2.14 VOLATILE SOLID LOST

During composting, as organic material decomposes and CO2/H20 are lost to the atmosphere, the organic fraction that is composed of volatile solids decreases over time. There fore, the extent of decomposition also can be measured by monitoring the decrease in volatile solids. The greater the change in volatile solids per unit time the more efficient the composting process. Nobuyuki Uehara et al (1996).

2.15 HEAT PRODUCTION AND HEAP SIZE.

Wiley (1957) studied the heat production when pulverised refuse was composted and concluded that, over 8-10 days cycles, it amounted to approximately 7 x 10 Jkg^{-} of initial volatile solids. Mote and Griffins (1982) determined maximum heat production rates from composting two organic material obtaining values in the range 20-28Wkg-1 of initial dry mass.

By employing well-insulated compost heaps on large masses of wastes, such a heat production can lead to high temperatures in the range 80-90oc (Spown, 1970). Most experimental data, however, indicate that at such temperatures the reaction rate is very low. Optimum rate are obtained at temperatures of about 55oc.

Small masses of material, as in garden compost heaps, have high surface/ volume ratios and hence much of the material has to act as insulation. At least 1 tonne of wastes is reaches to ensure that a reasonable proportion of the heap reaches a satisfactory temperature. For heaps composting under natural aeration conditions the material should not be pilled over 1.5m high or 2.5m wide, other wise diffusion of oxygen to the centre will be impeded. The heap can be elongated into a windows of any convenient length.

2.16 SUMMARY OF IDEAL PROCESS CONDITION

There are adequate data in the literature on the microbiological, chemical and physical parameters of composting plants. A summary of the optimum values of the important parameters is given in Table 3.

The requirement is to translate these parameters into a low cost but reliable process plant. The complexity of the composting equipment and equipment the degree of approach to the optimum values of the process parameters vary considerably from the simple heap situation to the highly sophisticated mechanised urban plant.

Table 3: Composting Parameters

Parameters	Value
C:N ratio of feed	30-35:1
C:P ratio of feed	75-150:1
Particle size	12.5mm for agitated plants and forced aeration 50mm for windrows, unagitated plants and natural aeration.
Moisture content	50-60%
Air flow	0.6-1.8m3 air $d^{-1}Kg^{-1}$ volatile solids during thermophilic stage, being progressively decreased during cooling down and maturing.
Temperature	$55^{O}C$
Agitation	Short periods of vigorous agitation, alternating with periods of no agitation, which vary in length from minutes in the thermophilic stage to hours during maturing.
PH Control	Normal now desirable.
Heap Size	Any aught but not over 1.5m high or 2.5m wide for heaps and windrows using natural aeration. With forced aeration heap size depends on need to avoid overheating.

CHAPTER THREE

3.0 MATERIAL AND METHODS

3.1 Raw Material for Composting

A wide varieties of organic materials which are suitable for compose production are produced by human communities and agriculture. Table 4 list some of these wastes with very approximate values for % nitrogen and C/N ratio.

Table 4 : Composition of Materials suitable for Composting

Material	Nitrogen % Dry Weight Basis	C/NRatio
Urine	15 - 18	0.8
Dry blood	10 – 14	3
Night Soil. Dung, Sewage Sludge	5.5 – 6.5	6 - 10
Grass	4	20
Bone Meal	4	8
Farm Yard Manure	2.2	14
Refuse	1.1	34
Wheat Straw	0.6	80
Falling Leaves	0.4	45
Sawdust	0.1	500
Paper	0	∞

The above table shows the possible source of raw materials for producing fertilizer. For this particular research work farm yard manure and sawdust is chosen i.e.

(i) Farm yard manure (comprising chicken droppings and cow dung).

(ii) Sawdust.

3.2 Production Plant and Method

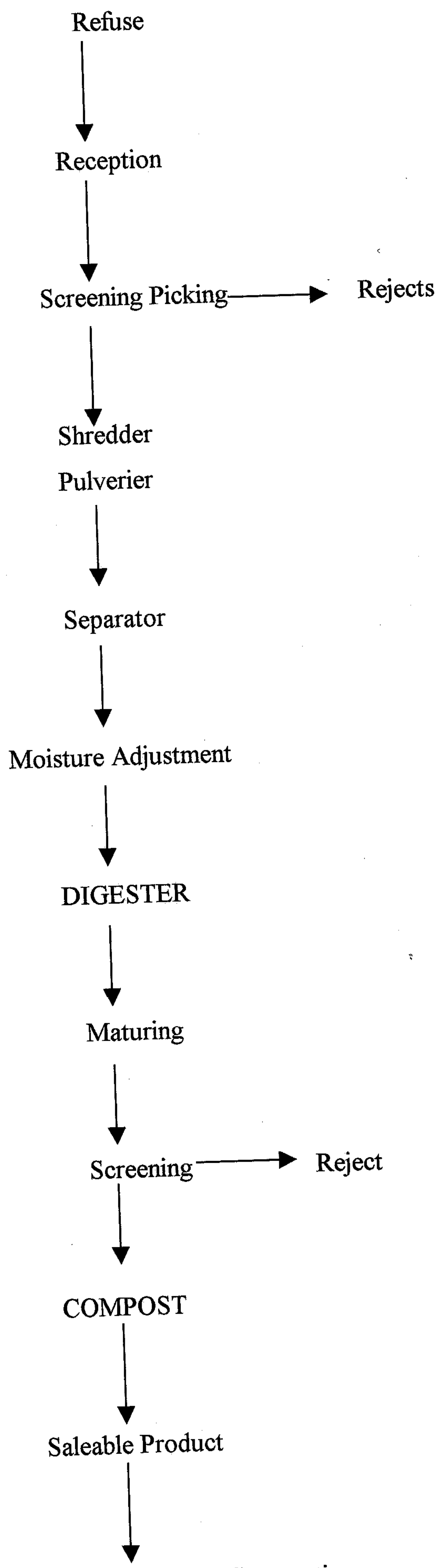
The composting unit usually comprises of

(i) Storage facilities

(ii) Feed preparations facilities

(iii) Composting stage

(iv) Final product upgrading



Process Flow Diagram for Composting.

Fig 3

3.2 PROCESS

The material for composting (saw dust source from a nearby sawmill and farm yard manure comprising of cow dung and chicken droppings source from a nearby farm) is conveyed by a pickup van into the factory. It then off-loaded into a flat concrete area within the factory. The material is then prepared by size reduction, separation of salvageable and unwanted materials and the adjustment of moisture, size reduction is achieved by using dry pulverizer, dry pulverizer of the hammer mills type is used. The power requirement of the pulverizer depends mainly upon the final size of outlet material and for this particular research work a size of 50mm is required for which a pulverizer of power $8Kwh^{-1}$is used.

Following the size reduction magnetic separator are used to remove ferrous metal prior to composting the moisture content of the material is adjusted, if necessary by adding water.

The biological degradation stage is carried out either in windroll heaps, accelerated windrolls or mechanised unit. In the case of my research work I used simple windrolls, in simple windrolls the prepared materials is placed into long heaps and the turn periodically by specially attached stirrer; composting requires several weeks, but for my research work it took six weeks. The product is upgraded using hammer milling to reduce glass and ceramic piece to harmless sand like particles and finally other additives like grounded chicken feather and bone were added to improve the calcium content of the composted fertilizer.

3.3 COMPOSITION

The composition of the produced fertilizer was found after carrying out of test on it to be Organic matter 77%, Carbon 45%, Nitrogen 3.5%, Phosphorus (as P_2O_5) 3.5% , Potassium (as K_2O) 1.8% and carbon (as CaO) 1.5%.

CHAPTER FOUR

4.0 RESULTS

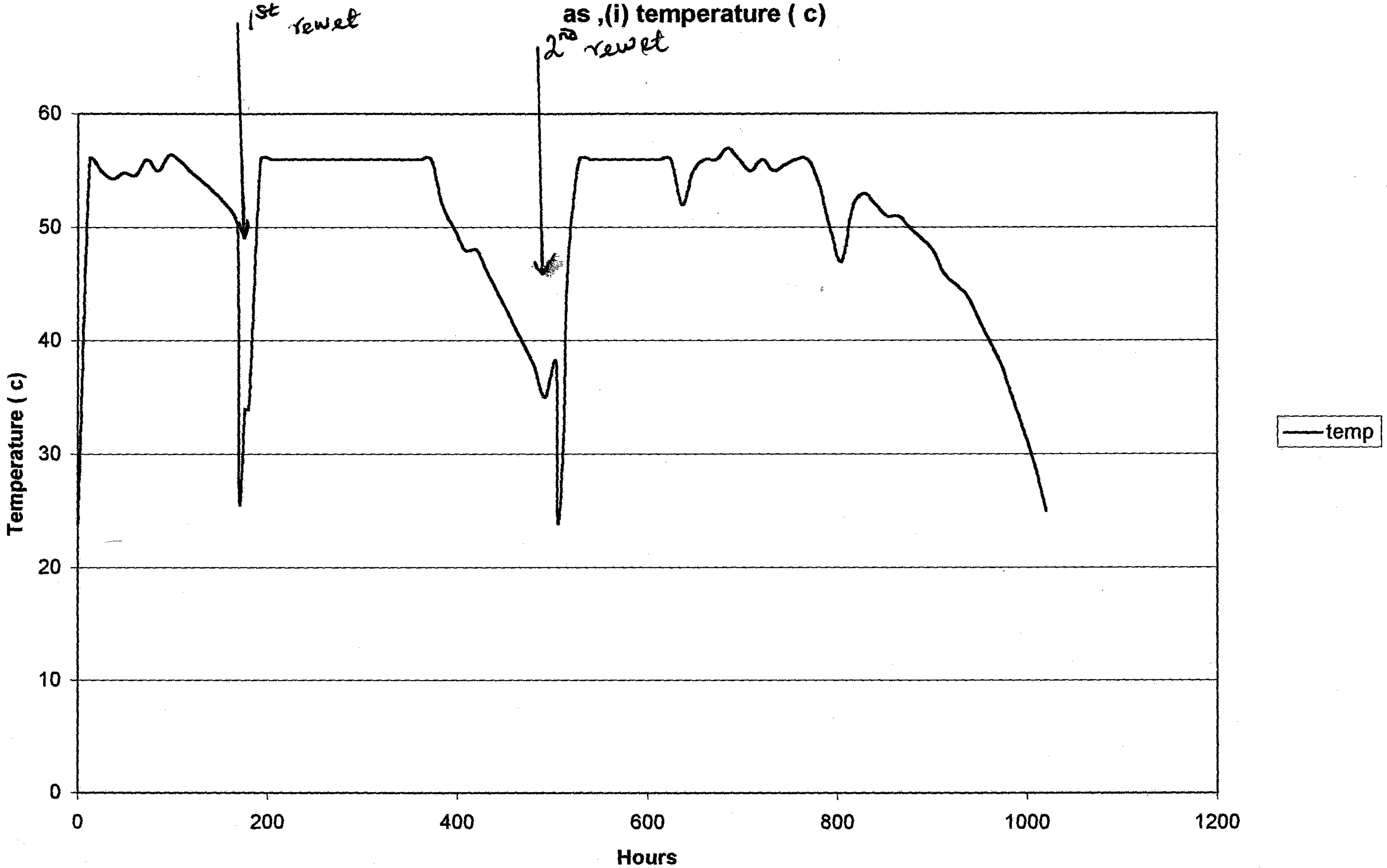
TABLE 4b: Showing the result of Temperature measured in the morning and the evening for the 43-day Composing Period.

Day	Morning C_d SC_h Temp ^oC	Evening C_d SC_h Temp ^oC	Day	Morning C_d SC_h Temp ^oC	Evening C_d SC_h Temp ^oC
1.	24.0	56.0	25	56.0	56.0
2.	55.0	54.3	26	56.0	56.0
3.	54.8	54.6	27	56.0	52.0
4..	56.0	55.0	28	56.0	56.0
5.	56.4	55.8	29	56.0	57.0
6.	54.8	54.0	30	56.0	55.0
7.	53.8	52.0	31	56.0	55.0
8.	50.0 b/4 rewel	34.0	32	55.5	56.0
	26.9 2hrs after		33	56.0	54.0
	43.0 6hrs after		34	50.0	47.0
9.	56.0	56.0	35	52.0	53.0
10.	56.0	56.0	36	52.0	51.0
11.	56.0	56.0	37	51.0	50.0
12.	56.0	56.0	38	49.0	48.0
13.	56.0	56.0	39	46.0	45.0
14.	56.0	56.0	40	44.0	42.0
15.	56.0	56.0	41	40.0	38.0
16.	56.0	56.0	42	35.0	32.0
17.	52.0	50.0	43	29.0	25.0
18.	48.0	46.0			
19.	46.0	44.0			
20.	42.0	40.0			
21.	38.0	35.0			
22.	38.0 b/4 rewel	46.0			
	24.0 2hrs after				
	32.0 6hrs after				
23.	56.0	56.0			
24.	56.0	56.0			

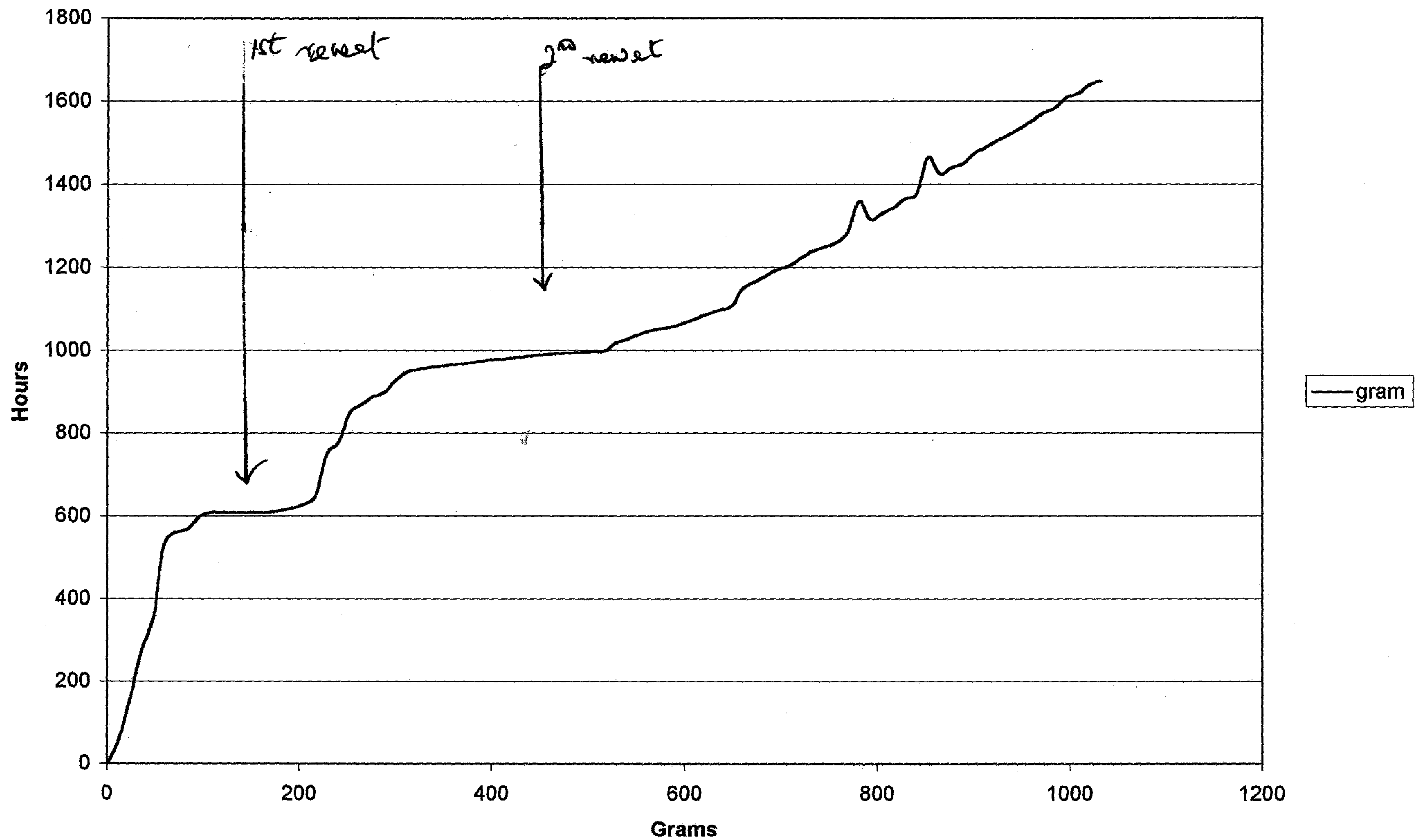
TABLE 5: **Showing various masses of CO_2 measured in the morning and evening for the 43 -day Composing Period.**

Day	Morning (in Grams)	Evening (in Grams)	Day	Morning (in Grams)	Evening (in Grams)
1.	0	60	24	1038	1048
2.	160	280	25	1058	1068
3.	360	540	26	1078	1088
4..	550	570	27	1098	1108
5.	600	610	28	1150	1065
6.	610	610	29	1180	1196
7.	610	610	30	1205	1223
8.	610	615	31	1240	1250
9.	620	630	32	1260	1285
10.	650	750	33	1360	1385
11.	780	860	34	1330	1345
12.	870	890	35	1366	1378
13.	900	930	36	1466	1425
14.	950	955	37	1441	1450
15.	960	963	38	1476	1490
16.	967	969	39	1506	1520
17.	973	977	40	1536	1553
18.	979	982	41	1573	1584
19.	985	988	42	1610	1620
20.	991	993	43	1640	1650
21.	994	996			
22.	997	998			
23	1018	1028			

Graph of representative profiles for farm yard manure during the 43-day composting period as ,(i) temperature (c)



A graph of cumulative CO_2 production



CHAPTER FIVE

5.0 DISCUSSION OF RESULTS

The temperature in the Bio-reactor i.e. the temperature of the composting material rose immediately to the thermophilic range after the initial mixing and first the wetting (fig 4 and 5). After second rewetting and mixing (day 22). Temperature increased to the thermophilic range, but at a slower rate.

CO_2 produced from the C S C fig 1 for the initial 8 – day run, first rewet and second rewet was 620g, 370g, 350g respectively, totalling 1,340g over the 43-day composting period.

The additional CO_2 produced after each rewet demonstrate that metabolic activity slow down before all of the readily degradable compounds were utilised. The overall moisture of the compost decrease from about 62 to about 45 percent during the first 8 days, which evenly distributed would not account for this decreases in metabolic rate activity (Forgiat and Tuodinen 1991). However, if most of the moisture lost occurred on surfaces of particle, then the observed decrease in metabolic activity could be expected. Rewetting and mixing would expose and rewet the surfaces, making more moisture available for microbial activity.

Two major peaks of CO_2 production may observed within the first 100 h days fig (5) which may reflect the transition from mesophilic to the thermophilic metabolic activity. Peak rates of CO_2 production were lowered after each rewetting and mixing, which suggest that mor slowly degradeable substrate were degrade. The changing respiratory quotients (RQs) also indicate a change in the nature of the substrate being degraded (Table 5). Changes in the rate of CO_2 production may also reflect changes in the composition of the active microbial population (Green et al. 1990). Forgaty and Tuovinen (1991), the kinds of dominant enzymatic activity within the compost (Diaz Ravina et al, 1989), changes in moisture content (Gavatta et al. 1993, Halletal 1993, Haug 1993), or changes in available substrates (Riffaldi et al. 1992).

5.1 COMPOSTING OF ORGANIC WASTE

The composting of farm waste, principally straw, manure and crop residue is normally only practised by the minority of the farmers practising organic farming. The production of animal manure slurries from intensive stock rearing as lead to environment problems particularly of small. The liquid composting of such slurries by forced aeration in enclosed vessel is being practised in various European countries. And alternative approach is conjoint composting of the manure slurries straw. This farm composting operation have potential for the recovery of the low graded heat. The whole subject of agricultural waste composting was reviewed by Gray and Biddlestone (1981).

The composting of garden waste is widely practised. The quantity of waste handled is invariably small i.e. 100 – 500kg per batch; consequently heat production is low, considerable care is taken to ensure that most of the waste reach a sufficient temperature for weed, seed and diversed materials to be killed; normally a bin overhead insulation is necessary (Gray and Biddlestone, 1976). Organic waste from various food manufacturing operations are also amendable to composting. Large particle materials from many fruits and vegetable canning operations can normally be composted alone while sludges need the addition of a bulking agent such as wood chips (Hyde and Conso Lazio 1982).

5.2 REACTION TIME AND COMPOST YIELD

The reaction rate during the biological stages of composting depends upon the process conditions whereas the final stage of maturing involves complex chemical reaction and appear to be largely independent of this process conditions. Urban waste tipped into heaps without pre-treatment or agitation takes 9 – 12 months to produce rough compost. When piled into windrow heaps with several turnings for agitation it takes about three months.

The percentage the composition during composting is normally in the region of 40 to 50 percent of the organic dry waste. Yung Chang (1967) found that with straw 50% of the dry waste was lost. The yield of useful product obtained from a composting reaction depends on several factors. These are percentage the composition of the organic matter. Thus, the amount of inorganic material in the field.

5.3 BIODEGRADABILITY COEFFICIENTS

The degradability of the composted material can be calculated (Atkinson et al. 1996a, b). However, when composting relatively small amount of material for short period of time, the amount of organic material lost is insufficient to be accurately determine by mass balance, therefore, an alternative method was developed, based on known empirical formulae for various materials (He et al, 1_992),

Table 5b

Biodegradability of volatile solid in C_dS C_h

	Total vs	RQ	CO_2 Produced(kg)	Substrate Lost(kg)	Biodeg. Coeff.
C_dS C_h					
Initial	18.0 0	5. 8 8	5. 3 1	2. 5 1	0 . 1 2
1st Rewet	15 9 2	7.4 6	3. 4 9	1. 7 0	0. 0 9
2nd Rewet	12.7 3	7. 5 4	3.4 1	1. 7 0	-0 1 4
Biodegradability (43 days).					0.35

The relationship between RQ, grams of substrates oxidized. The equation for the best fit line was calculated to be

$$RQ = 1.42 - 0.47x \quad \text{equation 1.0}$$

Where RQ, = the respiratory quotient (moles CO_2 produced/moles O_2 consumed).

X = g CO_2 produced/g compost oxidized

This equation was used to calculate grams of compost oxidized based on the RQ and CO_2 production as measured by Oxymax respirometry.

CHAPTER SIX

6.0 CONCLUSION

The production of organic fertilizer an alternative source of fertilizer from material matter can be rightly calculated to depend upon the following factors.

(i) The temperature of the composting substance
(ii) The moisture contact of the compost
(iii) Rewettability
(iv) Mixing
(v) The changing of respiratory quotients (RQS).

And that the change in the rate of CO_2 production may be brought about by the followings:

(i) Changes in the activities of microbial population
(ii) The kind of dominant enzyme activity within the compost
(iii) Changes in moisture content.
(iv) Changes in the available substrate.

This study shows that, organic waste, if properly conditioned can be used to produced composted organic fertilizer and carbon-diode and maintain as a by-product. The value specified for this process variable such factors as yield, purity reaction time etc. different value of the optimum condition of these parameters have been presented in the literature, although with negligible difference if any. The present study shows that for the production of composted fertilizer, the best optimum conditions are:

(i) Temperature of between 55-57°C
(ii) PH level of 7.3
(iii) Residence time of 43 days above
(iv) Moisture content of not less than between 50-60°C
(v) and intermittent rewetting and mixing of the composting material.

The above fact is in agreement with that present in the literature.

Detail comparison between the fertilizer produced and those produced elsewhere was found to be in agreement or have a bout the same property with the commercial fertilizer, and also comparison with literature standard reveal that the present work yield acceptable results for the composition reaction of C_dSC_h mixture to produce organic fertilizer.

It could be finally concluded that both thermophilic and mesophilic bacteria grew in the cultured medium with the former dominant as the composition process proceed and CO_2 at thermophilic temperature (56°C).

CHAPTER SEVEN

7.0 RECOMMENDATION FOR FURTHER WORK

The task for further research, which I would to suggest, based on the difficulties and problems encountered during this research work as well as for technological breakthrough in the area employed are the following:

(i) a more detailed information on the chemical composition of Biodegradation product

(ii) although the present study and work gave a clear cut indication that the fertilizer produce can be compared with others from else where, further study should be carried out to test the ability of the fertilizer on a farm or green house.

(iii) the degradation of the waste too a very long time which make the production not to be economical to operate. An investigation should be carried out with the aim of improving the method of treatment of the waste to optimise the residence time.

(vi) Organic matter is of diverse constituents, properties and nature, and different types are known to give different fertilizer of different chemical constituents at the same digest condition. A comprehensive study work on the best type of raw material with high chemical content that are compare to those of in-organic fertilizer should be carried out.

(v) Ways should be found in which to add in future study other additives, which will make the organic to compare favourably with the in-organic fertilizer.

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Chapter Two

(v) Additional micronutrient supply from organic sources (such as Zn).

(vi) Check on leaching and volatization losses.

(vii) In-situ clay addition to crop roots to enhance cation exchange capacity.

(viii) Optional yield of crops.

(ix) Increase water retention in soil.

1.1 STATEMENT OF RESEARCH PROBLEM

The rate at which inorganic fertilizer is being used in Nigeria now has reached an alarming scale and the after effect of its use over a long period of time is now showing its ugly teeth in many parts of the country, for the continuous or unchecked use of this inorganic fertilizer has given rise to the following problems.

And it is a known fact that inorganic fertilizer caused the following problem

i. Environmental unfriendly
ii. Causes water and air pollution
iii. Damage the top soil by loosen it thereby rendered it to the mercy of air. and water erosion.
iv. Causes leaking in soil.
v. Expensive and non affordable to most farmers.
vi. Deplete the countries foreign exchange reserve.
vii. Not suitable for different ecological zones.
viii. Raw material had to be sourced from abroad.
ix. The effect last only for a season or cropping season.

Apart from above it as been proved that drinking of water that has been contaminated by this inorganic fertilizer causes cancer and other skin diseases. Inorganic fertilizer have been proved to be free from all the above problem as been practiced in some countries like China, U.K and the U.S.A.

1.2 JUSTIFICATION FOR THE STUDY

In developing countries like Nigeria where commercial inorganic fertilizers are expensive, labour is cheap and implement are simple, however, composting (organic) fertilizer meet the need of the farmers and is a logical practice.

In a recent time there has been increase focus on the production of composted fertilizer as an alternative replacement for inorganic fertilizer, both at National and international level, and also has a means of prevention of erosion (because of its soil binding activity) and orevention of teaching in soil.