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FABRICATION AND ASSEMBLY OF A SIMPLE UNIT FOR COMPOST PELLETING

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ABSTRACT: Compost considers is an important resource for agriculture fertilization, because it contains a high level of nutrients and organic matter. The compost was produced from different agriculture wastes and some additionals like water and animal poultry residues. In this study, experiments were conducted to optimize some operating and engineering parameters affecting the performance of disk pelleting machine. The parameters under this study were four different rolls speeds of 175, 225, 275 and 325 rpm., four different die profile of Die -A (18.8 mm land length with 13.5 mm entry diameter), Die-B (20.3 mm land length with 13.5 mm entry diameter), Die-C (18.8 mm land length with 14.2 mm entry diameter) and Die –D (20.3 mm land length with 14.2 mm entry diameter) four different compost raw martial moisture contents of (15, 20, 25 and 30%) Wb. The obtained results revealed that pelleting machine has a high efficiency and maximum pellets quality under conditions of 20% compost raw material moisture content, 275rpm, rollers speed and die profile C of (18.8 mm land length with 14.2 mm entry diameter), the optimum results were 287.79 kg/h production rate, 19.81 kW.h/ton energy requirement, 93.68% pellets durability and 108.31 LE/ton cost per mass unit.

Key words: Pelleting, diskpelleter, die, rollers, retention time.

INTRODUCTION

Agricultural wastes in Egypt are composed of wood, maize cob, straw, and rice straw. Sugar cane and beet wastes and vegetables and fruits wastes, all equal to about 16 million ton yearly. (Abou-Akkada and Nour 1985). There are anther different types for agricultural wastes as follows: 1- animal waste: (blood - meat – loonds - stomach contents - feather), farms wastes (poultry and litter animal dung and urine), processing and marketing fish wastes and dairy factory wastes. 2-Plants wastes: farm wastes (stubble crops, wood, shopped straw) processing product waste of vegetables fruits and crops (straws, gluten, oilseeds crust, wastes of canning, buiceing freezing, and drying the vegetables such as potato, pea, onion carrots and fruits like citrus, peanut peeling, bagasse, molasses, venasse, sugar beet bulb) and several markets waste beside weed and moos see. 3- Mixture wastes: as restaurants and kitchen wastes. 4- Creative wastes: as urea, ammonia and its salts, and 5-cereal wastes: as maize and wheat (Nour, 1988).

Greer and Firchild (1999) found that the moisture in feed mash affects pellets quality and production rates. Moisture in feed mash comes from two sources: bound moisture present in the feeds ingredients and added moisture from water and steam addition. The moisture of cold feed entering the conditioner limits the amount of steam that can be added to the mash during conditioning.

Bhienki (2000) decreasing the particle size of ingredients dail to a greater surface area to volume ratio. Smaller particles will have a greater number of contact points within a pellet matrix as compared to larger particles.

Ismael (2001) mentioned that the most popular source of plant wastes is the crop field wastes, the food processing wastes and the wastes of restaurants and human houses. In fact, since thousands of years ago ‹man had used the plant wastes in manufacturing paper and woods, polishing materials. Also, these wastes are used as a partial substitution to petroleum as a source of energy by producing biogas the agriculture wastes are also used in animal feeding.

David (2003A) mentioned that understanding the terminology used to describe dies is important when choosing die specifications different feed and ingredients require specific amounts of time in the die hole-die retention time-to be able to bind together to form a pellet. Larger die working areas provide more retention time to from pellets, reduce power consumption per ton of feed pelleted and improve production efficiencies. He illustrated that the alloy dies are made of medium-grad carbon steel. He was designed heavily abrasive applications and typically are the most breakageresistant dies available. Generally, alloy dies are less expensive than stainless steel or high chromic dies. Stan less steel dies provide corrosion resistance and good wear resistance for moderately abrasive materials. High chromic dies provide the most corrosion resistance of different die materials. Because of the chrome content, they usually start up very easily and allow high pelleting production rates. However, high chrome dies typically provide less resistance feed moves through the die holes and the effective thickness of the die may need to be increased to achieve desired pellet quality.

David (2003B) reported that the L/D ratios is the effective length of die divided by the hole diameter, high L/d ratio provide a high pellet die resistance as feed moves through the hole while the low L/D ratios provide less resistance. Each materials has one L/d ratio requirement to form the material into pellet. He also, illustrates the terminology used to describe the characteristics and dimensions of die holes the most important terms to understand when selecting a pellet die are : D = Hole diameter : Typical hole diameter can range from 3/32nd to 3/4th inch. L = Effective length: The effective length is the die thickness that actually performs work on the feed. L/D ratio: The L/D ratio is the effective length divided by the hole diameter.

He add the pellets quality is dependent upon several factors: (1) feed formulation; (2) feed particle size; (3) mash moisture content; (4) conditioning; (5) die specifications; (6) cooling. The following are some considerations for each of these factors. Generally, increasing the conditioner retention time

Hasting (2003) limited the operating conditions which affected the quality of pellets feed as follows, pellet die thickness as related to diameter of hole is factor in pelleted quality, speed of ration should be also considered for each die thickens/hole diameter combination.

Jennifer (2004) reported that the durability of the pellets from poultry litter varied form about 28 to 46% within a moisture content range of 6.0% to 22.2% w.b. Durability of the pellets increased initially with moisture content reaching a maximum at 10.4%. Further increase in moisture content of reduced durability. The subsequent increase in volume of the pellets due to increased moisture content was not sufficient to offset these binding forces. Pellets hardness was a more sensitive to moisture change than pellet durability. Absorbed moisture decreased the strength of bonds holding the pellet particles together thus making the pellets more friable. Also, he showed that bulk density and particle density of the pelleted litter, respectively decreased and increased moisture with increase in moisture content. The force required to rupture the pellets varied from 350N at 6.0% moisture to 50N at 22.0% w.b. temperature of the pellets exiting the die increased to 85 °C ± 2 °C after pelleting, the pellets were cooled in an environmental chamber set at 22°C and 40% relative humidity. The binding quality of pellets, durability is a major research development priority for commercial scale.

Hara (2005) said that, the maturity of compost is difficult to define and a special machine is needed for spreading the compost. Finally a large storage escapees needed and transport costs are a high because the specific gravity of compost is low and moisture content is usually high such factors limit the recycling of compost over wide areas and discourage farmers from applying composted livestock manure so solutions to these problems quality must meet the following criteria if high quality compost is to be produced. 1) The production of high quality animal waste compost must meet the needs of arable farms by: quarantining the quality and also fertilizer efficiency and adjusting the nutrient content of the compost produced according to the nutrient requirement of the crop. 2) The production of animal waste compost must be made suitable for distribution over a wide by: decreasing the volume of the compost and thus moisture content of compost. 3) Crop producers need to be able to apply compost easily. For this, they need a formulation suited to mechanized application. 4) Extension manuals are needed to show crop producers how to use the compose as fertilizer.

He mentioned that in the disk pelleter or extruder, the moisture content of compost is most important factors. This greatly influences the strength and processing speed of the pellet. The best moisture content is about 40% for an extruder, and about 20-25% for disc pelleter. The fluidity of compost falls with a lower moisture content, and friction resistance increases as the compost passes through the holes of the die.

Shehab *et al.* (2005) found that the operation of the majority of current pellet mills is based on pressing the material through open-ended holes (dies) built in the periphery of a rotating ring die. Depending upon the design, one to three smaller rolls push the feed material into the die holes from inside of the ring towards outside of it. The skin direction between the feed particles and the wall of the die resists the free flow of feed and thus, the particles are compressed against each other inside the die. The compressed feed traveled through the die continuously. The pellets are cut into preset lengths using a knife.

Kaddour *et al.* (2006) said that geometrical dimensions of die holes reference the most important factors influencing in extruder machine efficiency and pellets quality. Producing 12mm diameter high quality of large animal feed pellets rely the ration components attributes, for that the high quality extruded pellets mode from residues need different die hole specification comparing with that made from standard components. Results show that the optimum machine efficiency appraised by machine productivity, energy requirements and total losses and appraised for pellets quality by pellets durability, pellets bulk density, and pellets hardness. Results were obtained using L/D ratio of 1.67 hole entry diameter of 20mm, output area percent of 2.66% and 35mm total thickness, they were 0.3058 t/h productivity, 153.10 kW.h/t energy requirement, 5.38% total losses, 90.35% durability, 1.1109 g/ cm^3bulk density, and 170.11 N/ cm^2 strength.

MATERIALS AND METHOD

Materials

Composition and Chemical Analyses of the Experimental Compost Row Material

The mash compost which used in this study was produced by Sharkia Company in Belbess city. This compost is produced from different agriculture wastes and some additional like water and animal poultry residues. The final moisture contents of Sharkia compost ranged for 20 to 25% at maturity. The chemical analyses of compost row materials shown in Table 1.

Table 1. Composition and chemicals analyses of mash compost

Composition	Unit	Values
Density .	Kg/m^3	650
Moisture contents	%	33
PH (10 : 1)		7.91
EC (10 : 1)	Ds/m	3.47
Ammonium nitrogen .	ppm	6.4
Nitration nitrogen	ppm	38
Total nitrogen	%	1
Organic matter	%	33.2
Organic carbon	%	19.3
Ash	%	66.8
C/N. Ratio.		1 : 19.3
Total phosphoric .	%	0.54
Total potassium	%	0.78
Grass seeds	%	0.00

Specifications of Disk Pelleter Machine

Disk pelleter machine (flat die) is one kind of pelleting system which including ring die pelleting. The diameter of compost pellets which produced in this work was10 mm. The disk pelletet consists of the following parts:

Feeding unit

The feeding unit made from metal sheet has thickness of 2 mm cylindrical shape to be a feeding hopper of pelleting machine the feeding hopper has dimension of 301.2 mm diameter and 500 mm hight.

The forming unit (Die)

The die considers the most important part in disk pelleter and sensitivity at pelleting operation system. It is responsible forming a mash compost to compost pellet. Die is a disk metal made from hard steed 52 carbon with dimension 300 mm diameter, 35.5 mm thickness as show in (Fig. 1 A). The die fixed on the main base without motion and the main shaft passing from die center with the conic bearing, which fixed inter the die. The hole configuration consists of two levels the first level is a conical shape (entry) has diameter bigger than the output diameter (Land Length) which effective on pelleting operation (Fig. 1 B). In preset study, fabricated four dies and each die has different profile to study the influencing of geometrical dimension of dies profile on machine efficiency and pellets quality. Each die profile has working area of 60 mm width at the middle track surface of the die face. This working area content a lot different number of holes depends on dies profile and this holes configuration between dies and due to entry diameter and died area between each holes .

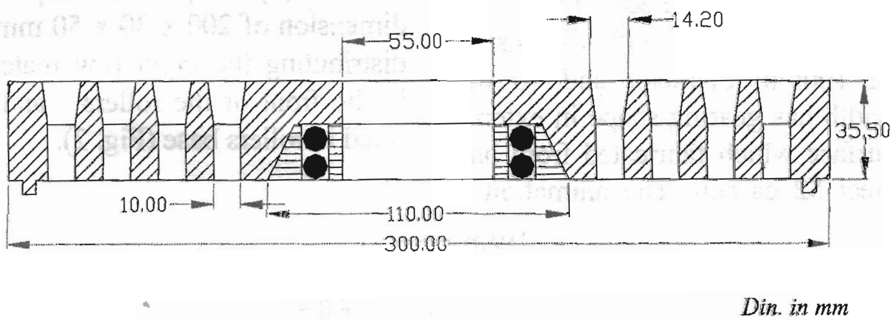

Fig. 1-A. Vertical section of the die

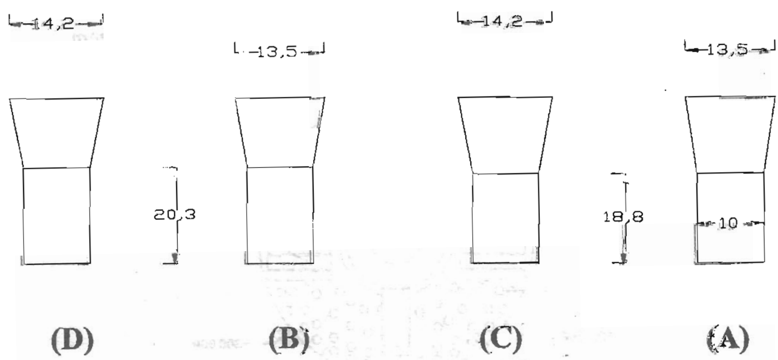

Fig. 1-B. Die holes profile dimensio

The compressing unit (Rollers)

It's clear to know that the rollers were responsible compressing and pelleteing the mash compost through die hollers. The rollres consist of two units, each unit constructed on horizontal bar by conical bearings .This horizontal bar fixed on the end of main moving shaft. Each roller has cylindrical shape with dimensions of 100mm diameter and 60 mm width has gearing shape in external surface which fabricated from hard steel 52 carbon. The animation of rollers has stable motion around horizontal bare which yields from the main shaft speed. There is clearance between of die and rollers very narrow and extended according to physical motion rolls around horizontal bar to agree with a capacity of row materials forced pressing through die holes. There are two (u) scraper bar shape has dimension of 200 x 30 x 50 mm to distributing the input row material in the front of the rollers and its fixed in rollers base (Fig. 2).

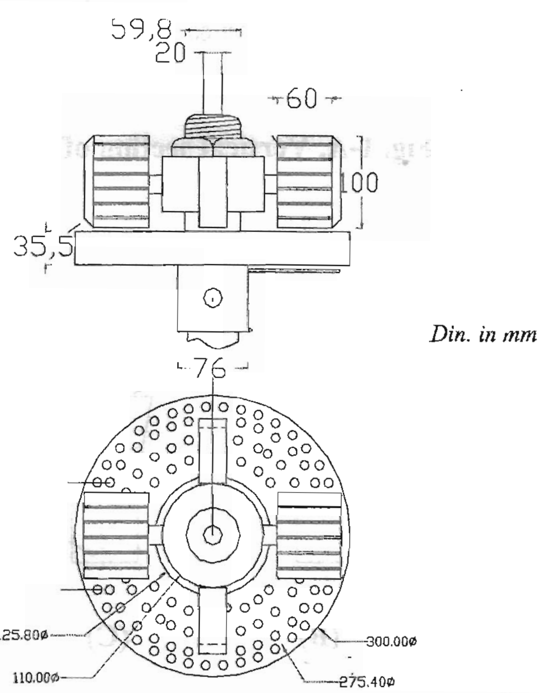

Fig. 2. Elevation and plan of compressing unit (Rollers)

The main shaft

The main shaft was fixed in a vertical postion to transfer power from the gearbox which contacted with electric motor to rollers. It was fabricated from hard steel 52 carbon and there are central hole has diameter of 10 mm through the shaft length. The main shaft has dimention of 65.07 mm length, four levels of diameter (35, 45, 55and 60 mm). Main shaft constructed by three bearings, conical bearing fixed in the die center, another fixed in the oil chamber and surface bearing in the middle and shaft passing from its end by rollers units. There are gear box constructed on the main base under main shaft and contacted by it.

Cooling system

In this type of disk pelleter which is the rollers motion, generated quantity of heat for this the cooling system was a very important in this type of disk pellter which generated mor heet according to the motion of roller. Cooling system consists of oil tank, oil pump and tubs ending by nozzle at the end of main shaft for close system during shaft hol. Cooling system transfer oil from the oil tank to the main shaft and colling it.

Cutter knife

Cutter knife made from stainless steel 37 carbon with dimension of 120 mm in length and 5 mm in thickness .The cutter knife constructed on main Shaft under the die directly by cylinder cal beas and can changing the number of knife to change the product lingth . It is single knife and it motion taken from main shaft speed.

Electric motor and power transmission

A electrical motor has output of (20 Hp, 14.7 kW) and 22 A was used. The rolling speed of motor shaft is 1400 rpm, reducing to 175, 225, 275 and 325 rpm at main shaft using 7:1 gearbox. The power transmitte from the motor shaft through four different pulleys having diameters of (7, 9, 11 and 13 cm) to gear box having pulley of 8 cm in diameter using V belts (Fig. 3).

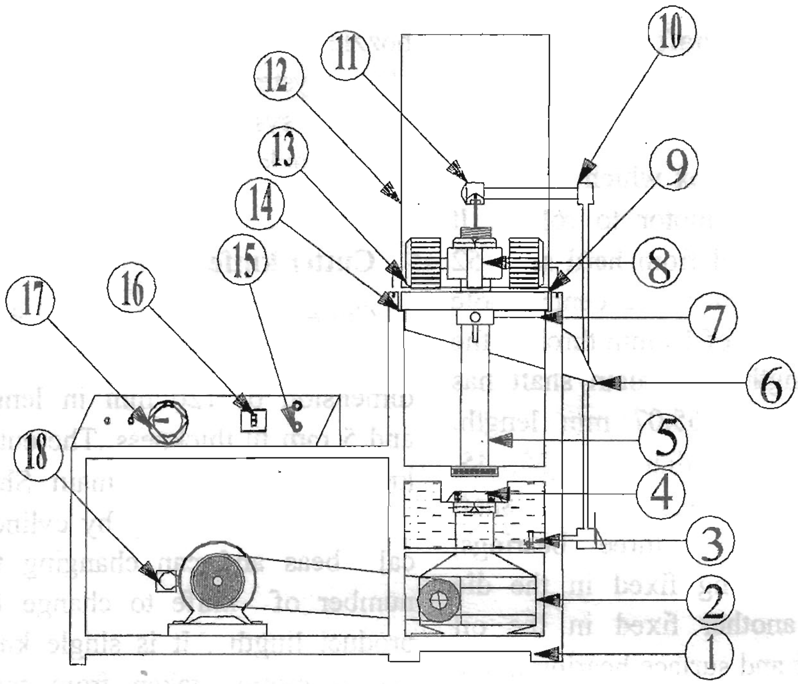

Fig. 3. Disk pelleter lay out and main motor and power

1	The main base	7	The cutter knife	13	Compression rolls
2	Vertical gear box	8	Scraper bar	14	Die base
3	Oil pump	9	The die	15	Indicator lamp
4	The main bearing	10	Oil pipe	16	Motor switch
5	The main shaft	11	Main shaft End	17	Motor amber
6	The output pellet	12	Feeding hopper	18	Electric motor

Methods

In this study, a disk pelleter machine was fabricated and assembled in a local workshop to produced different agriculture machines at Sharkia Government Zagazig City.Experiments were conducted to optimize some operationd and engineering parameters affecting the performance of disk pelleting machine. The experimental groups named I, II and III.

I- The first groups of tests were run under four different rolls speeds of (175, 225, 275 and 325 rpm).

II- The second group of tests were carried out under four different die profile of :

- Die- A (18.8 mm land length with 13.5 mm entry diameter)
- Die- B (20.3 mm land length with 13.5 mm entry diameter)
- Die -C (18.8 mm land length with 14.2 mm entry diameter)
- Die -D (20.3 mm land length with 14.2 mm entry diameter)

II- The third group of tests was conducted under four different moisture contents of (15, 20, 25 and 30%) Wb.

Disk Pelleter Productivity

Disc pelleter productivity (kg/h)

$$= \frac{W_P}{T} \times 3.6$$

Wp: pellets mass (g)

T: consumed time (s)

Pellets Durability

$$\text{Durability (\%)} \frac{Wa}{Wb} X\ 100$$

Wa : pellets mass after treatment (g.) Wb: pellets mass before treatment (g.)

Energy Requirement

$$\text{Energy requirement (kW.h/t)} = \frac{\text{Power (kW)}}{\text{Production rate (t/h)}}$$

Compost Pelleting Cost

Compost pelleting cost (L.E./MG) =

$$\frac{Machine\,cost (L.E/h)}{Disk\ pelleter\ productivity (MG/h)}$$

RESULTS AND DISCUSSION

The Effect of Physical and Mechanical Factors on Disk Pelleter Compost Productivity

Effect of compost moisture content

Relating to the effect of compost moisture content on disk pelleter productivity, results in Fig. 4 showed the increasing compost moisture content from 15% to 20% increased the machine production rate by 1.17, 1.21, 1.16 and 1.20% using roller speed of 175 rpm, by1.11, 1.16, 1.10 and 1.14% using rolling speed of 225 rpm, by1.06, 1.09, 1.05 and 1.09% using roller speed of 275rpm and by1.01, 1.04, 1.01 and 1.04% using roller speed of 325 rpm, under die profile of A, respectively.

The increased in machine productivity by increasing the compost moisture content from 15% to 20% was be due to the decrease in treatment consumed time by the easy flow of the compost material through the die holes resulting from low friction for material and die holes.

While increase the compost moisture content from 20% to 25 and 30% decreased the production rate by 2.88, and 11.62%, 2.72 and 10.93%, 2.60 and 10.41 and, 2.50 and 9.85% using die profile A, and by, 2.99 and 12.11%, 2.82 and 11.35%, 2.69and 10.88% and, 2.55 and 10.28% using die profile B and by, 2.96 and 11.57%, 2.71 and 10.97%, 2.68 and 10.46% and, 2.55 and 9.81%, using die profile C and by, 3.86 and 12.04%, 2.81and 11.38%, 2.77 and 10.75% and, 2,54 and 10.15% using die profile D using roller speed of 175, 225, 275 and 325 rpm, respectively.

The decrease in machine production rate by increasing the compost moisture content from 15 to 25 and 30% could be due to the increase in formula viscosity because it's including high percentage of clay, that make the formula flow through the die holes very low, and increase the treatment consumed time.

Effect of die profile

Viewing to the effect of die holes profile on disk pelleter production rate, results in Fig. 4 showed that changing the die holes profile from Die A to Die B and Die D decreased the machine production rate by 3.69 and 3.26%using compost moisture content of 15%, 3.65 and 3.22% using compost moisture content of 20%, 3.80 and 3.35% using compost moisture content of 25% and 4.14and 3.65% using compost moisture content of 30%, and by3.49 and 3.07%using compost moisture content of 15%, 3.45 and 3.04% using compost moisture content of 20%, 3.58 and 3.16% using compost moisture content of 25% and 3.88 and 3.42% using compost moisture content of 30%, and by3.33 and 2.94% using compost moisture content of 15%, 3.38 and 2.91% using compost moisture content of 20%, 3.42 and 3.02% using compost moisture content of 25% and 3.69 and 2.79% using compost moisture content of 30%,and by3.16 and 2.76% using compost moisture content of 15%, 3.13 and 2.76% using compost moisture content of 20%, 3.24 and 2.86% using compost moisture content of 25% and 3.48 and 3.07% using compost moisture content of 30% using roller speed of 175, 225, 275 and 325 rpm, respectively.

The clear decrease in machine production rate by changed the die holes profile from A to B and D could be due to the increase in die hole land length, that make the compost raw material take more time in the die hole

On another hand changing the die holes profile from Die A to die

C increased the disk pelleter production rate by 0.38, 0.37, 0.39 and 0.42% using roller speed of 175 rpm,. 36, 0.35, 0.37and 0.39% using roller speed of 225 rpm, 0.34, 0.34, 0.35 and 0.37% using roller speed of 275rpm,and by 0.33,0.32,0.34and 0.36% using roller speed of 325 rpm, under compost moisture content of15, 20, 25 and 30% respectively.

The slow increase in production rate by changing the die profile from die A to die C could be due to the increase in die hole entry diameter , that make the compost raw material flow through the die hole easily and decrease slowly the treatment consumed time.

Effect of roller speed

Viewing to the effect of roller speed on disk pelleter production rate. Data in Fig. 4 showed that, increasing the rollers speed from 175 to 225, 275 and 325 rpm decreased the machine productivity by 5.42%, 9.47and 13.91% using die profile A, 5.54%, 9.68 and 14.19% using die profile B, 5.34%, 9.34 and 13.72% using die profile C and 5.58%, 9.75 and 14.29% using die profile D under compost moisture content of 15%, 5.36%, 9.37 and 13.76% using die profile A, 5.54%, 9.68 and 14.20% using die profile B, 5.34%, 9.34 and 13.72% using die profile C and by 5.52%, 9.64 and 14.14% using die profile D, under compost moisture content of 20%, 5.56%, 9.72 and 14.25% using die profile A, 5.76%, 10.05 and 14.71% using die profile B (20.3 mm land length with 13.5 mm entry diameter), 5.54%, 9.68 and 14.20% using die profile C and 4.53%, 10.01 and 14.65% using die profile D, under compost moisture content of 25%, and 6.00%, 10.46 and 15.27% using die profile A, 6.24%, 10.84 and 15.81% using die profile B, 5.98%, 10.42 and 15.22% using die profile C and 6.21%, 10.8 and 15.74% using die profile D, under compost moisture content of 30%

The decrease in disk pelleter production rate by increasing the rollers speed from 175 to 225, 275 and 325 could be due to the decrease in treatment consumed time of sample mass.

The Effect of Physical and Mechanical Factors on Disk Pelleter Compost Pellets Durability

Effect of compost moisture content

Viewing to the effect of compost moisture content on disk pelleter productivity, results in Fig. 5 showed that increasing compost moisture content from 15% to 20% increased the pellets durability by 0.644, 0.619, 0.638 and 0.617% using roller speed of 175 rpm, by 0.620, 0.597, 0.615 and 0.596% using roller speed of 225 rpm by 0.613, 0.591, 0.608 and 0.589% using roller speed of 275 rpm and by 0.604, 0.583, 0.599 and 0.581% using roller speed of 325 rpm, under die profile of A, B, C and D respectively.

The increased in pellets durability by increasing the compost moisture content from 15% to 20%could be due to the increase in granules surface covered by water film that produce high hardness pellets after drying .

While increase the compost moisture content from 15% to 25 and 30% decreased pellets durability by 2.41, and 4.17%, 2.31 and 4.00%, 2.29 and 3.96 and , 2.26 and 3.90% using die profile A and by, 2.31, and 4.00%, 2.23 and 3.85%, 2.20 and 3.81 and, 2.17 and 3.75% using die profile B and by, 2.39, and 4.13%, 2.29 and 3.97%, 2.27 and 3.92 and, 2.23 and 3.86% using die profile C and by, 2.31, and 3.99%, 2.22 and 3.84%, 2.20 and 3.80 and, 2.17 and 3.74%using die profile D using roller speed of 175, 225, 275 and 325 rpm, respectively.

The decrease in pellets durability by increasing the compost moisture content from 15 to 25 and 30% could be due to the increase in formula viscosity and the water film covered the compost granules that increase the air cells between the granules after drying so increase the pellets cracks and decrease the pellets durability.

Effect of die profile

The effect of die holes profile on disk pelleter pellets durability, results in Fig. 5 showed that changing the die holes profile from die A to die B, die C and die D increased the pellets durability by 3.78, 0.83 and 4.14%, 3.76,0.82 and 4.12%, 3.87, 0.85 and 4.24% and by 3.94, 0.87 and 4.31% using roller speed of 175 rpm, by 3.65, 0.80 and 3.99%, 3.62,0.79 and 3.97%, 3.73, 0.82 and 4.08% and by 3.79, 0.83 and 4.15% using roller speed of 225 rpm, by 3.16, 0.79 and 3.95%, 3.58,0.79 and 3.92%, 3.69, 0.81 and 4.04% and by 3.75, 0.82 and 4.10% using roller speed of 275 rpm, and by 3.56, 0.78and 3.89%, 3.54,0.77 and 3.87%, 3.64, 0.80 and 3.97% and by 3.69, 0.76 and 4.04% using roller speed of 325 rpm, under compost moisture content of 15, 20, 25 and 30% respectively.

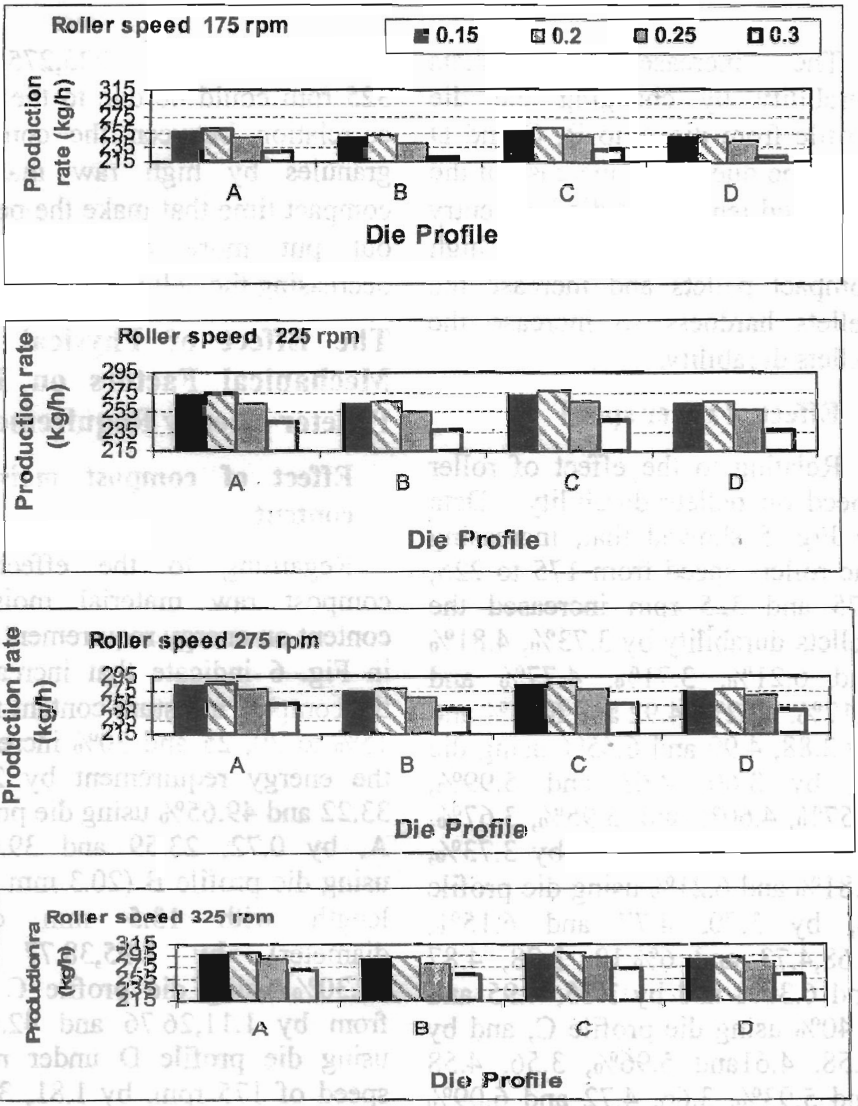

Fig. 4. The effect of compost moisture content on disk pelleter production rate using different die profile of (A, B, C and D) under rollers speed of 175, 225, 275and 325 rpm

- Die- A (18.8 mm land length with 13.5 mm entry diameter)
- Die- B (20.3 mm land length with 13.5 mm entry diameter)
- Die- C (18.8 mm land length with 14.2 mm entry diameter)
- Die –D (20.3 mm land length with 14.2 mm entry diameter)

The increase in pellets durability by changing the die profile from die A to B, C and D could be due to the increase in die hole land length and die hole entry diameter, that produce high compact pellets and increase the pellets hardness so increase the pellets durability.

Effect of roller speed

Relating to the effect of roller speed on pellets durability .Data in Fig. 5 showed that, increasing the rollers speed from 175 to 225, 275 and 325 rpm increased the pellets durability by 3.73%, 4.81% and 6.21%, 3.71%, 4.77% and 6.17%, 3.82%, 4.92 and 6.35% and by 3.88, 4.99 and 6.45% using die A, by 3.60, 4.63 and 5.99%, 3.57%, 4.60% and. 3.95%, 3.67%, 4.73% and 6.12% and by 3.73%, 4.81% and 6.21% using die profile B, by 3.70, 4.77 and 6.15%, 3.68,4.73 and 6%.12, 3.78, 4.87 and 6.30% and by 3.85, 4.95 and 6.40% using die profile C, and by 3.58, 4.61and 5.96%, 3.56, 4.58 and 5.93%, 3.66, 4.72 and 6.09% and by 3.72, 4.79 and 6.19% using die profile D under compost moisture content of 15, 20, 25 and 30% respectively.

The increase in pellets durability by increasing the roller speed from 175 to 225,275 and 325 rpm could be due to the high correlation between the compost granules by high raw material compact time that make the pellets out put more compacted and decreasing the pellets cracks.

The Effect of Physical and Mechanical Factors on Disk Pelleter Energy Requirement

Effect of compost moisture content

Regarding to the effect of compost raw material moisture content on energy requirement data in Fig. 6 indicate that increasing the compost moisture content from 15% to 20, 25 and 30% increased the energy requirement by 2.04, 33.22 and 49.65% using die profile A, by 0.72, 23.59 and 39.03% using die profile B (20.3 mm land length with 13.5 mm entry diameter), by 2.95,38.77 and 55.30% using die profile C and from by 1.11,26.76 and 42.69% using die profile D under roller speed of 175 rpm, by 1.81, 31.06 and 47.13% using die profile A, by 0.76, 22.49 and 37.45% using die profile B, by 2.53, 35.84 and 52.16% using die profile C and by 1.01, 25.35 and 40.83% using die profile D, under roller speed of 225 rpm, by 1.31, 26.90 and 42.31%

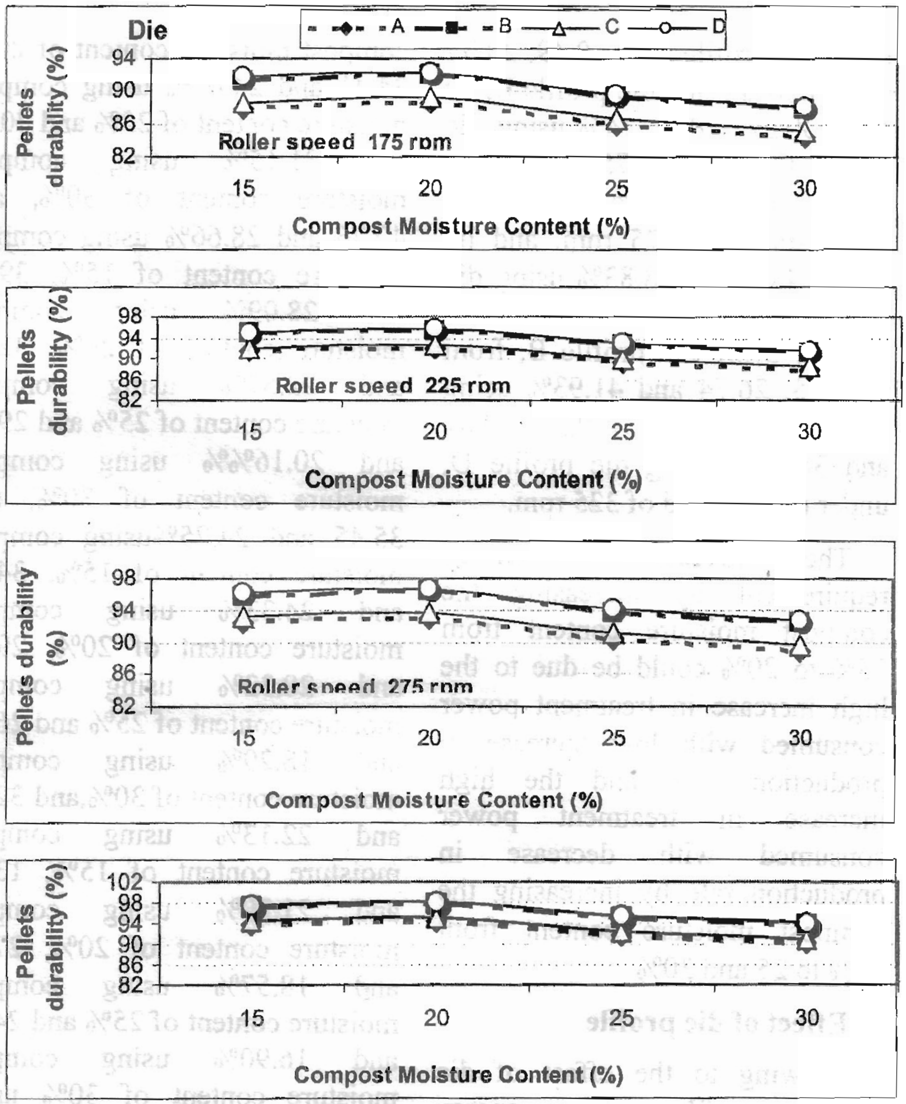

Fig. 5. The effect of compost moisture content on pellets durability using different die profile of (A, B, C and D) under rollers speed of175, 225, 275and 325 rpm

-Die- A (18.8 mm land length with 13.5 mm entry diameter)
-Die- B (20.3 mm land length with 13.5 mm entry diameter)
- Die- C (18.8 mm land length with 14.2 mm entry diameter)
- Die- D (20.3 mm land length with 14.2 mm entry diameter)

using die profile A, by 0.49, 20.33 and 34.60% using die profile B, by 1.76, 30.32 and 46.14% using die profile C and by 0.75, 22.59 and 37.36%, using die profile D, under roller speed of 275 rpm, and by 1.02, 24.08 and 38.83% using die profile A, by 0.39, 18.73 and 32.38% using die profile B, from by 1.35, 26.74 and 41.93% using die profile C and by 0.59, 20.61 and 34.72% using die profile D, under roller speed of 325 rpm.

The increase in energy requirement by increasing the compost moisture content from 15% to 20% could be due to the high increase in treatment power consumed with low increase in production rate, and the high increase in treatment power consumed with decrease in production rate by increasing the compost moisture content from 15% to 25 and 30%

Effect of die profile

Viewing to the effect of die holes profile on energy requirement results in Fig. 6 showed that changing the die holes profile from Die A to Die B and Die D increased the energy requirement by42.68 and 30.72% using compost moisture content of 15%, 41.90 and 30.06% using compost moisture content of 20%, 34.41 and 24.01% using compost moisture content of 25% and 30.59 and 31.15% using compost moisture content of 30%, and 40.26 and 28.66% using compost moisture content of 15%, 39.56 and 28.09% using compost moisture content of 20%, 32.83 and 22.57% using compost moisture content of 25% and 29.32 and 20.16%% using compost moisture content of 30%, and 35.45 and 24.75%using compost moisture content of 15%, 34.91 and 24.33% using compost moisture content of 20%, 29.64 and 20.32% using compost moisture content of 25% and 26.82 and 18.29% using compost moisture content of 30%,and 32.10 and 22.13% using compost moisture content of 15%, 13.66 and 21.79% using compost moisture content of 20%, 27.32 and 18.57% using compost moisture content of 25% and 24.93 and 16.90% using compost moisture content of 30% using roller speed of 175, 225, 275 and 325 rpm, respectively.

The increase in energy requirement by changed the die holes profile from A to B and D could be due to the increase in die hole land length, that increase the compost raw material retention time in the die hole, and increase the machine load that increase the power consumed and decrease the machine production rate.

Main while changing the die holes profile from Die A to die C decreased the energy requirement by 29.48, 28.28, 18.72 and 14.94% using roller speed of 175 rpm, 25.97 25.04, 17.25 and 13.99% using roller speed of 225 rpm, 20.08, 19.52, 14.46 and12.12% using roller speed of 275 rpm, and 16.77, 16.38, 12.68 and 4.15% using roller speed of 325 rpm, under compost moisture content of15, 20, 25 and 30% respectively.

The decrease in energy requirement by changing the die profile from die A to die C could be due to the increase in die hole entry diameter, that make the compost raw material flow through the die hole easily, with decrease in formula retention time in the die hole, that decrease the machine load and power consumed with slow increase in production rate.

Effect of roller speed

Relating to the effect of roller speed on energy requirement. Data in Fig. 6 showed that, increasing the rollers speed from 175 to 225 rpm increased the energy requirement by 4.33, 4.10 and 1.24% and decreased the energy requirement by 0.45% using die profile A, by 0.29 and 0.24% and decreased the energy requirement by1.14 and 2.28% using die profile of B, 6.92, 6.52, 2.46 and 0.37% using die profile of C and by 1.49 and 1.40% and decreased the energy requirement by 0.39 and 1.68% using die profile of D under compost moisture content of15, 20, 25 and 30% respectively.

The increase in energy requirement by increasing the rollers speed from 175 to 225 rpm under the moisture content of 15 and 20% could be due to the increase in machine power consumed, while the decrease in energy requirement under compost moisture content of 25and 30% could be due to the increase in production rate under this level of moisture.

Mean while increasing the roller speed from 175 to 275 and 325 RPM increased the energy requirement by 19.19 and 27.21%, 18.58 and 26.45%, 11.53 and 17.25% and 7.41 and 11.58 using die profile A, 9.00 and 13.78%, 8.79 and 13.50%, 5.11 and 8 .30% and 2.38 and 4.37% using die profile of B, 25.05 and 34.36%, 24.14 and 33.28%. 14.70 and

21.46% and 9.68 and 14.73% using die profile of C and by 12.23 and 18.19%, 11.91 and 17.76%, 7.24 and 11.33% and 4.06 and 6.81% using die profile of D under compost moisture content of15, 20, 25 and 30% respectively.

The increase in energy requirement by increasing the rollers speed from 175 to275 and 325 rpm could be due to the high increase in power consumed by motor load with low increase in machine production rate.

The Effect of Physical and Mechanical Factors on Disk Pelleter Compost Pellets Cost Per Mass Unit

Effect of compost moisture content

The effect of compost raw material moisture content on cost per mass unit, data in Fig. 7 showed that increasing the compost moisture content from 15% to 20, decreased the cost per mass unit by 0.07, 0.17, 0.04 and 0.13% using roller speed of 175 rpm, by 0.06, 0.14, 0.03 and 0.11% using roller speed of 225 rpm, by 0.06,0.15,0.04 and 0.11% using roller speed of 275 rpm, and by 0.07, 0.14, 0.04 and 0.11% using roller speed of 325 rpm under dies profile of A, B, C and D respectively

The very slow decrease in cost per mass unit by increasing the compost moisture content from 15% to 20% could be due to the slow increase in pellets mass production rate. While increasing the compost moisture content from 15% to 25 and 30% increased the cost per mass unit by 5.88 and 12.22, 5.83 and 12.50, 5.94 and 12.22, and 5.90 and 12.51 using roller speed of 175 rpm, by 5.60 and 11.58, 5.55 and 11.83, 5.65 and 11.58, and 5.61 and 11.84 using roller speed of 225 rpm, by 5.34 and 11.07, 5.29 and 11.31, 5.38 and 11.08, and 5.35 and 11.31 using roller speed of 275 rpm and by 5.07 and 10.53, 5.03 and 10.74, 5.12 and 10.54, and 5.08 and 10.75 using roller speed of 325 rpm under dies profile of A , B, C and D respectively.

The high increase in cost per mass unit by increasing the compost moisture content from 15% to 30% could be due to the high decrease in machine production rate and the increase in power consumption, that increasing the cost per time unit.

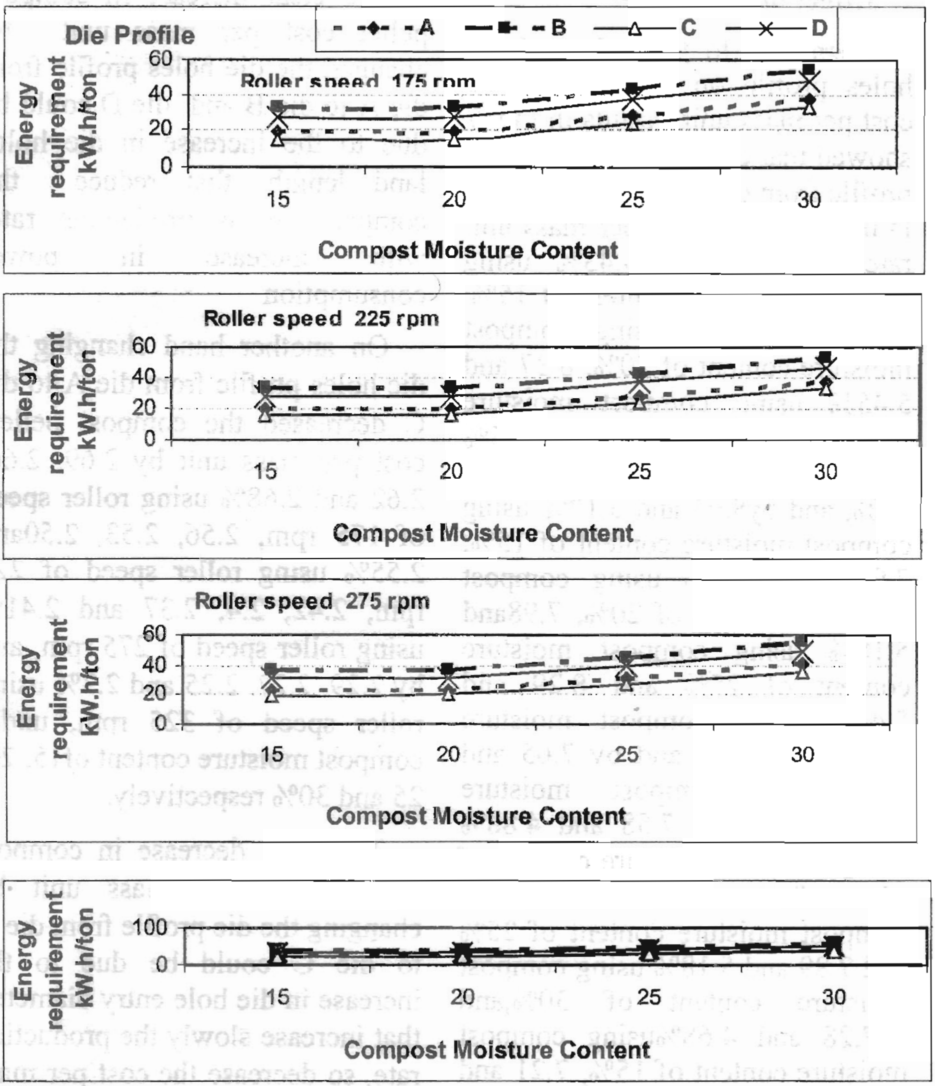

Fig. 6. The effect of compost moisture content on disk pelleter energy requirement using different die profile of (A, B, C and D) under rollers speed of175, 225, 275and 325 rpm

- Die- A (18.8 mm land length with 13.5 mm entry diameter)
- Die- B (20.3 mm land length with 13.5 mm entry diameter)
- Die- C (18.8 mm land length with 14.2 mm entry diameter)
- Die –D (20.3 mm land length with 14.2 mm entry diameter)

Effect of die profile

Regarding to the effect of die holes profile on compost pellets cost per mass unit, results in Fig. 7 showed that changing the die holes profile from die A to die B and die D increased the cost per mass unit rate by 8.42 and 5.43% using compost moisture content of 15%, 8.33 and 5.37% using compost moisture content of 20%, 8.37 and 5.45% using compost moisture content of 25% and 8.72and 5.75% using compost moisture content of 30%, and by8.03 and 5.17% using compost moisture content of 15%, 7.94 and 5.11% using compost moisture content of 20%, 7.98and 5.18% using compost moisture content of 25% and 8.29 and 5.45% using compost moisture content of 30%, and by 7.65 and 4.93%using compost moisture content of 15%, 7.58 and 4.88% using compost moisture content of 20%, 7.61 and 4.94% using compost moisture content of 25% and 7.89 and 5.18% using compost moisture content of 30%,and by7.28 and 4.68%using compost moisture content of 15%, 7.21 and 4.64% using compost moisture content of 20%, 7.24 and 4.70% using compost moisture content of 25% and 7.50 and 4.91% using compost moisture content of 30% using roller speed of 175, 225, 275 and 325 rpm, respectively

The clear increase in compost pellet cost per mass unit by changed the die holes profile from die A to die B and die D could be due to the increase in die holes land length, that reduce the compost pellets production rate, with increase in power consumption

On another hand changing the die holes profile from die A to die C decreased the compost pellets cost per mass unit by 2.69, 2.66, 2.62 and 2.68% using roller speed of 175 rpm, 2.56, 2.53, 2.50and 2.55% using roller speed of 225 rpm, 2.42, 2.4, 2.37 and 2.41% using roller speed of 275 rpm, and by 2.29, 2.27, 2.25 and 2.3% using roller speed of 325 rpm, under compost moisture content of15, 20, 25 and 30% respectively.

The slow decrease in compost pellets cost per mass unit by changing the die profile from die A to die C could be due to the increase in die hole entry diameter, that increase slowly the production rate, so decrease the cost per mass unit.

Effect of roller speed

Relating to the effect of roller speed on compost pellets cost per mass unit. Data in Fig. 7 showed the increasing of the rollers speed

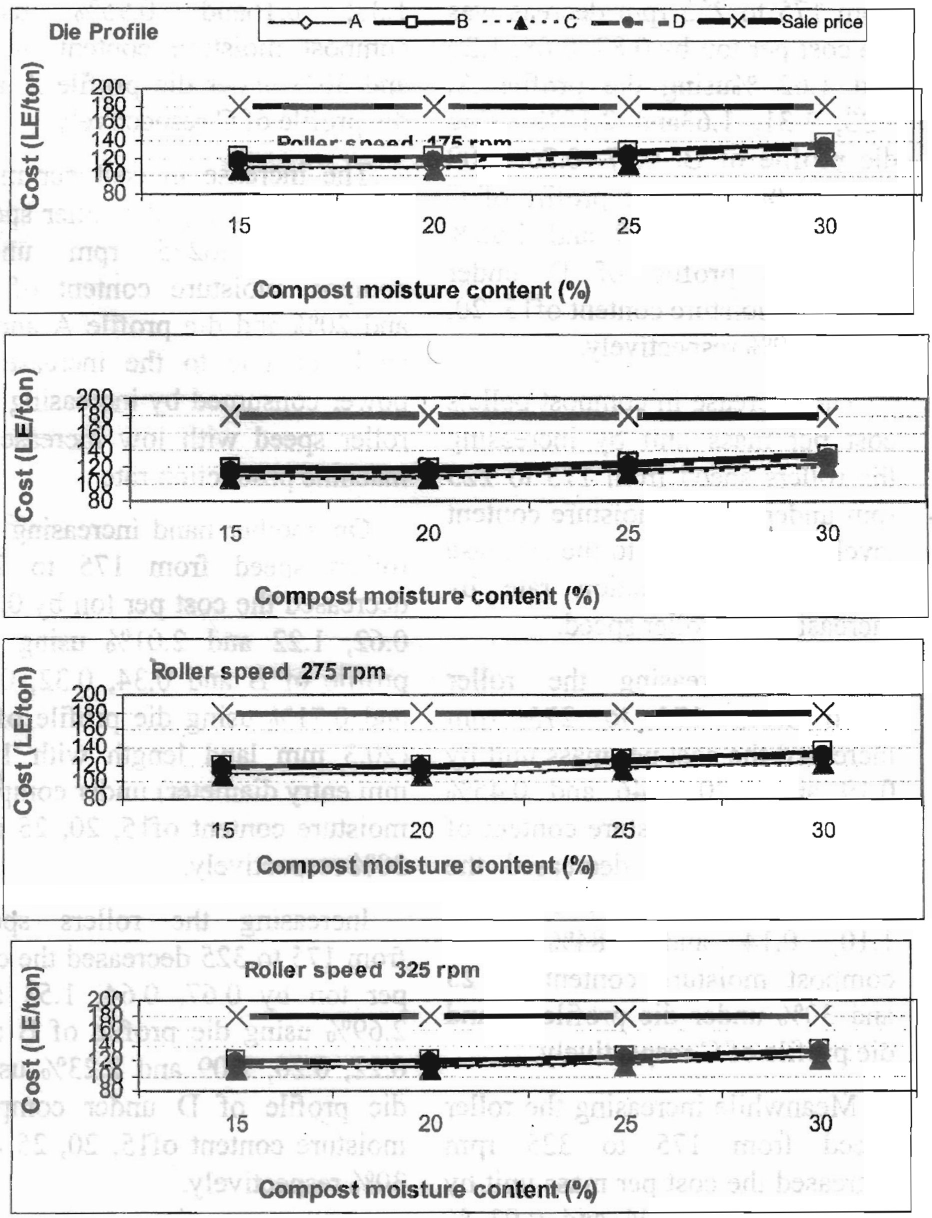

Fig. 7. The effect of compost moisture content on cost per mass unit using different die profile of (A, B, C and D) under rollers speed of175, 225, 275and 325 rpm

from 175 to 225 rpm decreas was the cost per ton by 0.89, 0.88, 1.20 and 1.62 %using die profile A, 1.33, 1.31, 1.63and 2.10% using die profile of B, 0.77, 0.76, 1.08 and 1.49% using die profile of C and 1.18, 1.16, 1.49 and 1.95% using die profile of D under compost moisture content of15, 20, 25 and 30% respectively.

The decrease in compost pellets cost per mass unit by increasing the rollers speed from 175 to 225 rpm under all the moisture content levels could be due to the increase in machine production rate by increasing the roller speed.

While increasing the roller speed from 175 to 275 rpm increased the cost per mass unit by 0.19 and 0.20, 0.46 and 0.45% using compost moisture content of 15 and 20%, and decreased the cost per mass unit by 0.38 and 1.10, 0.14 and 0.84% using compost moisture content of 25 and 30% under die profile A and die profile of C respectively.

Meanwhile increasing the roller speed from 175 to 325 rpm increased the cost per mass unit by 0.56 and 0.57, 0.94 and 0.93 % using compost moisture content of 15 and 20%, and decreased the cost per mass unit by 0.29 and 1.33, 0.16and 0.95% using compost moisture content of 25 and 30% under die profile A and die profile of C respectively.

The increase in cost per mass unit by increasing the roller speed from 175 to275 rpm under compost moisture content of 15 and 20% and die profile A and B could be due to the increase in power consumed by increasing the roller speed with low increase in machine production rate

On another hand increasing the rollers speed from 175 to 225 decreased the cost per ton by 0.64, 0.62, 1.22 and 2.01% using die profile of B and 0.34, 0.32, 0.92 and 0.71% using die profile of D (20.3 mm land length with 14.2 mm entry diameter) under compost moisture content of15, 20, 25 and 30% respectively.

Increasing the rollers speed from 175 to 325 decreased the cost per ton by 0.67, 0.64, 1.53 and 2.69% using die profile of B and 0.22, 0.20, 1.09 and 2.23% using die profile of D under compost moisture content of15, 20, 25 and 30% respectively.

The decrease in compost pellets cost per mass unit by increasing the rollers speed from 175 to 325 rpm under all the moisture content levels could be due to the increase in machine production rate by increasing the roller speed.

Conclusion

The important results as mentioned in the obtained data were summarized in the following Points:

1- It can be reported the optimum rollers speed of disk pelleter were 275 rpm, for high machine efficiency (machine productivity, energy requirement and total losses) and pellets quality.

2- To prepare the best machine performance were with compost raw material moisture content of 20%.

3- The best die profile (die holes dimension) were B (20.3 mm land length with 13.5 mm entry diameter), and die D (20.3 mm land length with 14.2 mm entry diameter).

4- The highest machine production rate were 302.4 kg/h using roller speed of 325 rpm, compost moisture content of 20% and die profile of C (18.8 mm land length with 14.2 mm entry diameter).

5- The lowest energy requirement were 14.58 kW .h/ton using roller speed of 175 rpm , 15% moisture content and die profile of C (18.8 mm land length with 14.2 mm entry diameter).

6- The highest pellets durability were 98.12% using roller speed of 325 rpm, 20% moisture content and die profile of D (20.3 mm land length with 14.2 mm entry diameter).

7- The low cost per mass unit of compost pellets were 107.01 LE/ ton using rollers speed of 225 rpm, 20% moisture content and die profile of C (18.8 mm land length with 14.2 mm entry diameter).

REFERENCES

Abou-Akkada, R.A. and A.M. Niur. 1985. By product utilization in Egypt. A proposed strategy for the development of animal feed resource ARNAP working shop 14-18 Oct 1985, Alex. Egypt.

Adap, P.K, LG. Tabil, G.J. Schoenau, B. Crerar and S. Sokhansanj. 2002. Compression characteristics of Fractionated.

Bhienki, K. 2000. Factors influencing pellet quality. Department of grain science and industry. Manhattan Kansas state Univ. USA 66506-*2201*.

David, A.F. 2003I. Pelleting for profit-part. National Grain and feed association. Feed and feeding digest. Vol 54, Num 6, November 13.

David, A.F. 2003 II. Pelleting for profit-part2. National Grain and feed association. Feed and feeding digest, Vol 54 Num 7 December 22.

Greer, D. and J. Fairchild. 1999. Cold mash moisture control boosts pellet quality. Feed management, Vol 50 Num 6 Watt publishing company, 14t. Marris, 111.

Hara, M. 2005. Fertilizer pellets made from composted livestock manure. Mie prefectural science and technology promotion center, Kawasakita 530. Uresinochou, Itisigun 515-2316 Japan.

Hasting W.H. 2003. Feed milling process. Mt. Vernon, Washington D. Higgs Enviroment Canda, Van couver, Britich Columbia.

Ismael, N. 2001. Engineering studies on the processing of some agricultural wastes. Ph. D Thesis Fac. of Agric. Eng. Dept. Mansoura Univ.

Jennifer, M. 2004. Physical characteristics of pellets from poultry litter. ASAE/ CSAE annual international meeting sponsored by ASAE/ CSAE. Fairmont. Chateau laurier. The Westin, Givernment center. Ottawa, Otario, Canada 1-4 Agust 2004.

Kaddour, U.A., T.A. Ewies and M.K. Afify. 2006. Influence of Geometrical dimension of extrusion die holes on machine efficiency and pellets quality. 4th annual conference of J. Agric. Sci. Mansoura Univ., 2006, 31 (7): 337-358.

Nour, A.M. 1988. By-product utilization in Egypt. A proposed strategy for the development of animal feed resource ARNAP workshop, 14-18 October 1985 Alx. Egypt, 131-150.

Shahab, S., S. Mani, X. Bi, P. Zaini and L. Tabil. 2005. Binderless pelletization of Biomass Sponsored by ASAE. Tampa convention center tam paflorida 17-20 July 2005.

تصنيع وتجميع وحدة مبسطة لإنتاج الأسمدة العضوية المحببة

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تهدف هذه الدراسة إلى كبس السماد العضوى (الكومبست) فى صورة مكعبات بهدف زيادة السعه التشبعية بالماء وذلك لاستخدامه فى الأراضى الحديثة أو شديدة النفاذية لرفع كفاءة استخدام المياه ومدة بقاء السماد فى التربة مما يؤدى لامتداد مفعوله لأكبر فترة ممكنة كما إن عملية التجانس بعد الكبس تؤدى إلى سهولة إضافته للتربة آليا علاوة على اقتصاديات التخزين والنقل والتداول.

وكانت عوامل الدراسة هي:

١- سرعات البكر: (١٧٥ -٢٢٥- ٢٧٥ و٣٧٥ لفة/د).

٢- نسبة الرطوبة في الكمبوست: (١٥-٢٠-٢٥ و٣٠%).

٣- أبعاد ثقوب المشكل:

أ- (١٨.٨ مم طول مؤثر + ١٣.٥ مم قطر مدخل الثقوب).

ب- (٢٠.٣٠ مم طول مؤثر + ١٣.٥ مم قطر مدخل الثقوب).

ج- (١٨.٨ مم طول مؤثر +١٤.٢٠ مم قطر مدخل الثقوب).

د- (٢٠.٣٠ مم طول مؤثر+١٤.٢٠ مم قطر مدخل الثقوب).

وكانت افضل النتائج كالاتي: ٢٨٧.٧٩ كجم/ساعة للإنتاجية و ١٩.٨١ كيلووات ساعة/طن و ٩٨.٦٨ % مقاومة المكعبات للصدمات و ١٠٨.٣١ جنية/طن للتكاليف وذلك باستخدام رطوبة ٢٠% للكمبوست و ٢٧٥ لفة/د لسرعة البكر و أبعاد ثقوب المشكل (١٨.٨ مم طول مؤثر +١٤.٢٠ مم قطر مدخل الثقوب).