ABSTRACT

Three identical reactor vessels were designed, constructed and installed inside the biogas laboratory of the Agricultural Engineering Department, Faculty of Agriculture, Mansoura University, to study and test their performance in rapid composting of chopped maize stalks from March 2003 until May 2004. Each reactor vessel was cylindrical in shape and having a net volume of 0.147 m^3 (0.50 m diameter and 0.75 m high) under which an air chamber is in the bottom of vessel having a net volume of 0.0196 m^3 (0.5 m diameter and 0.10 m high).

A series of experiments were carried out to study and investigate some engineering parameters affecting performance of composting system and composting process such as; aeration rate, shredding sizes, and turning or agitation intervals. Laboratory tests were also executed to examine and evaluate some physical and chemical properties of the raw materials (cattle dung and chopped maize stalks) fresh compost, and final compost after curing process.

Three different levels of aeration rates (0.007, 0.0135, and 0.0203 m^3/min) were employed during this experimental work. Three different particle sizes of chopped maize stalks (2.0-5.5, 5.6-11.5, and 11.6-18.2 mm) were used. Three different levels of mechanical turning (without agitation, one agitation within seven days, and two agitations within five and ten days) were examined. Samples were randomly taken from all runs for biological analysis to determine the total counts of; *Viable, Coliforms, Salmonella*, and some pathogenic bacteria and fungi. The obtained results showed that, to maximize the microbial activity and speed up the composting process of shredded maize stalks with cattle dung,

the mixture would be turned (agitated) once every week, aerated by a rate of 0.007 m^3/min, and chopped to a smaller particles size of 2.0 – 5.5 mm. Moisture loss during composting process was found to be directly proportional to particles size of maize stalks, aeration rate, and mechanical agitation frequency. Bulk weight and bulk density were found to be directly proportional to particles size of chopped maize stalks, and inversely proportional to aeration rate and turning frequency. Porosity, air space, and dry matter were found to be directly proportional to particles size and aeration rate, and inversely proportion to turning frequency.

Organic matter was found to be directly proportional to particles size and inversely proportional to time at all treatments. Dry ash content was found to be directly proportional to aeration rate and turning frequency, and inversely proportional to particles size.

Total nitrogen content was found to be directly proportional to turning frequency and inversely proportional to aeration rate. Carbon to nitrogen ratio (C/N) was found to be directly proportional to particles size and aeration rate, and inversely proportional to turning frequency.

The energy generation was due to the microorganism's activity, and found to be 13.37 MJ over the entire experiment period (14 days), for the smaller particles size, lower air flow rate of aeration, and turning once every seven days. Energy output was due to heat removal from the reactor vessel through air reduced about 81.39 %, 20.88% and 26.13%, while it reached to -%, 53.11%, and 32.01 % during turning operations, and heat losses were about 3.86 %, 3.14% and 3.06% for unturned, turned once and twice, respectively. The total

power consumption in aeration operations were 0.343, 0.568, and 0.823 kW for aeration rates of 0.007, 0.0135, and 0.0203 m^3/min, respectively. Consequently, aeration rates of 0.0135 and 0.0203 m^3/min increased the power consumption by 65.6 % and 139.9 %, respectively, as compared with lower aeration rate of 0.007 m^3/min.

Finally, the obtained data showed that the rapid composting process can be accomplished within 14 days. They also indicated that there were no weed seeds in all treatment samples of fresh and cured composts. Rising up the temperature during composting process caused in destruction of pathogens and other organisms.

KEYWORDS: Composting, in-vessel bioreactor, internal mechanical mixing, engineering parameters, temperature profiles, physical, chemical, biological properties, energy and water balance, power required.

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