21st International Research/Expert Conference
"Trends in the Development of Machinery and Associated Technology"
TMT 2018, Karlovy Vary, Czech Republic, 18th – 22nd September, 2018

COMPARISON OF EFFICIENCY OF REACTOR AND NON-REACTOR COMPOSTING SYSTEMS OF SLUDGE AND BIOWASTE

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ABSTRACT

The process of composting the bio-waste along with the required conditions and depending on the composition of the composted material can take place in controlled or natural conditions. If we want to influence the speed and stability of the organic matter degradation process, it is necessary to control one or more influencing factors of the process in such a way as to provide optimum conditions using a bioreactor that provides constant outdoor temperature, mixing and humidification of the compost mixture without external influences. Controlling some parameters using bioreactors leads to significant acceleration of the process, more stable development of composting heat and stimulus and other specificities compared to non-reactor composting systems.
Keywords: composting, process, bioreactor.

1. INTRODUCTION

Composting is the biodegradation and stabilization of organic substances, under conditions that ensure the development of thermophilic temperatures as a result of the composting heat produced, to obtain a final product that is stable, without pathogen, weed seeds and which can be useful for soil deposition [1]. The process of composting flows in the presence of oxygen or air, and as the main products appear: carbon dioxide, water, heat and compost. The stability of the composting process as a whole depends on many factors such as temperature, moisture of mixture sludge and additional component, pH value, particle size of each component, oxygen content, C/N ratio and other factors. With the assurance of the optimum mixture of materials, granulation and initial humidity [2], the stability and speed of the composting process can be influenced by maintaining optimal ambient temperature and ventilating or adding oxygen. Composting is a very complex process, especially considering that the organic part of the waste is degraded by biochemical reactions. Thus, it is a great number of menu-related physico-chemical, microbiological and thermodynamic phenomena that are true in natural conditions, but the described process is described in a closed, isolated bioreactor that has the ability to mix the mixture and inject the air without external influences.

2. RESOLUTION SETTINGS

For the purposes of research different sludge mixtures have been used with municipal from wastewater treatment plants and various types of biowaste according to the following recipes:

Sample 1 -Sludge 70%, Mixed biowaste 30%
Sample 2- Sludge 50%, Mixed biowaste 50%
Sample 3- Sludge 30%, Mixed biowaste 70%
Sample 4- Sludge 70%, Mixed biowaste 30%
Sample 5- Sludge 50%, Mixed biowaste 50%
Sample 6- Sample 48.5%, Mixed biowaste 48.5%, Wood ash 3%
Sample 7- Sludge 47%, Mixed biowaste 47%, Wood ash 6%.
Sample 8- Sludge 45.5%. Mixed biowaste 45.5%, Wood ash 9%

For the study of composting mechanisms and composting kinetics research, the various embodiments of laboratory reactors are used, in which the temperature, pH, moisture content and free air space are kept constant or within certain limits because any of the above parameters can limit the system and also the impact of initial factors on the process itself can be monitored [2]. The concept of the controlled composting process used in the present study is presented in the diagram in Figure 1.

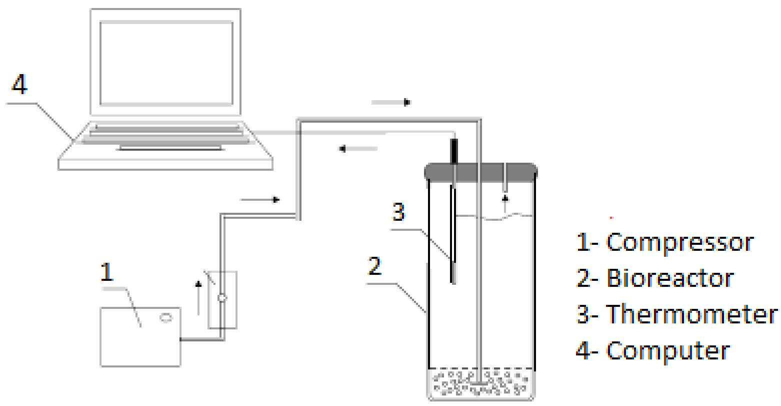

Figure 1: Controlled composting procedure System [3]

In non-reactor systems, called the "windrow" method and the substrate (static) that occasionally drains to allow air access. Identical mixtures or composting samples are placed under the conditions of the reactor and the non-reactor windrow system. As comparing the efficiency of the two composting systems observed, the length of the composting process and the quality of the compost were analyzed.

3. COMPARISON OF THE LENGTH OF THE COMPOSTING PROCESS IN THE REACTOR AND NON-REACTOR SYSTEM

The obtained results of measuring the length of the composting process in the reactor and non-reactor system are shown in Table 1. Since there is no precise definition when the composting process is completed, the study concludes that the end of the composting process is the day after which three days successively in the oscillation cooling phase the sample temperature is not greater than ± 0,5 ° C in relation to the ambient temperature in the reactor system, ie ten days successively in the cooling phase the sampling temperature oscillation is not greater than ± 1 ° C in relation to the ambient temperature for the process in the non-reactor composting system.

Table 1. Comparison of the duration of the composting process in reactor and non-reactor system

Composting sample	Composting Process Duration (day)	
	Reactor system	Non-reactor system
1	34	82
2	33	89
3	29	102
4	38	107
5	35	116
6	34	98
7	31	122
8	30	86

Samples placed in natural conditions, or non-reactor systems, were expected to have significantly longer duration of the composting process. The largest difference was measured in samples 7 (91 days) and the lowest in samples 1 (48 days). The average difference in the duration of the composting process in the reactor and non-reactor system is 67 days.

4. QUALITY ANALYSIS OF PRODUCED COMPOST

A comparison of the obtained values and the limit values was used to evaluate the quality of the compost obtained according to the "Ordinance on Determination of Permissible Quantities of Hazardous and Noxious Substances in the Land and their Testing Methods". This comparison is shown in Table 2.

Table 2. Evaluation of quality parameters of compost obtained in reactor and nonreactor composting system

Chemical properties	Arithmetic mean of the measured values in the reactor composting system	Arithmetic mean of measured values in the non-reactor composting system	Limit values
Overall C (%)	32.56	41,89	-
Overall N (%)	1.68	1,81	1,6-1,9
Ratio C/N	20,68	24,30	-
Organic matter (%)	52.95	51,38	> 46
Ash content (%)	47.05	48,62	< 54
Accessible P_2O_5 (%)	1.78	1,71	1,3-1,6
Accessible K_2O (%)	2.38	1,47	1,3-1,6
Overall Mg (%)	1.10	1,07	0,9-1,1
OverallCa (%)	1.79	1,77	1,3-1,6
Moisture (%)	53.41	67,08	40-60
pH Value	8.18	6,96	6,5-6,2

The average values of compost quality parameters in the reactor system show certain deviations of the P_2O_5, K_2O, Ca and pH values relative to the precautionary rule. The P_2O_5 value is 0.18 or 11.2% higher than the prescribed upper limit. The share of phosphorus (P) P_2O_5 in soil impacts on the binding of other nutrients, supplies the energy plant with the compounds necessary for proper metabolism. The excess of this nutrient can lead to a lack of microelements and a weaker plant growth [3,4]. The K_2O value is 0.78 or 48.7% higher than the prescribed upper limit. The role of potassium (K) in soil mostly in the form of K_2O is the synthesis of carbohydrates. Potassium-powered plants are resistant to droughts and diseases. In excess, potassium (K) can lead to lack of magnesium (Mg), calcium (Ca) and nitrogen (N). The Ca value is 0.19 or 11.8% higher than the prescribed upper limit. The Ca value is 0.19 or 11.8% higher than the prescribed upper limit. The role of Ca is maintenance of a pH value that affects the availability of other nutrients. In excess Ca can lead to the lack of macro elements. The pH value is 1.68 or 25.8% higher than the prescribed upper limit. The value of pH has an effect on most processes in the soil. Increased pH value can cause lack of microelements in the soil [4].

The average values of the parameters of the compost quality produced in the non-reactor system show certain deviations of the P_2O_5, Ca, moisture content and pH values in relation to the prescriptive rule. The P_2O_5 value is 0.11 or 6.8% higher than the prescribed upper limit. The Ca value is 0.17 or 10.6% higher than the prescribed upper limit. Moisture content is 7.08% higher than the prescribed upper limit. The pH value is 0.46 or 7% higher than the prescribed upper limit. The dotted parameters are the compacts obtained in the non-reactor system, similar to the reactor, in excess.

5. CONCLUSION

Comparison of the length of the process in the reactor and the non-reactor composting system shows the advantage of using the reactor system which significantly reduces the time of the composting process. For a detailed assessment of the justification of using one or other system it is necessary to carry out an analysis of other factors such as economic and ecological factors. As far as the quality of compost is concerned, there are only minimal differences in the parameters of the quality of compost produced in the reactor and non-reactor composting system. In both cases, the parameters are mostly in surplus. In the field of soil nutrients so far [4], the excess parameters are mentioned in the context of significantly higher values than those found in this analysis. In the other hand, according to a positive interpretation of the precautionary rulebook, the possibility of compost being obtained by composting the sludge from municipal waste water purifiers at a certain concentration may be confused with the soil that will reduce the content of the parameters. Thereafter, the compost was produced by reactor and non-reactor composting system, which could be applied to agricultural land.

6. REFERENCES

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