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THE POSSIBILITY OF COMPOSTING ANIMAL WASTE PRODUCTS***

This article presents the research project, the realization of which was started in 2006. Its gist refers to the possibilities of composting animal waste products. Animal waste products intended to compost within the confines of research project are the material of category III, especially food waste products from the households as well as waste products from the butcheries. The process of composting the above-mentioned waste products has been prepared on basis of closed technology with modified bioreactor. Biodegradable plant waste has been the input mass of such a rector. In order to modify the process in bioreactor, an intensive decomposition was completed with an intensive hygiene improvement as a result of placing in work space of bioreactor the monitoring system of temperature with time. The article has described the research method and the results expected.

1. INTRODUCTION

Animal waste products have been defined in a decree (of the European Community) No. 1774/2002 of the European Parliament and the Council dated on 3 October 2002 making health regulations connected with animal waste products which are not intended to be consumed by people [8]. The above mentioned decree establishes the division of animal waste products into three categories. The research subject is focused on waste products of category III. The waste products of this kind, are produced in slaughterhouses and butcheries and they can be itemized as follows: the parts of slaughtered animals deemed edible by people but not intended to be consumed for the sake of commercial reasons; the parts which have been rejected and deemed inedible by people but which are not infected with the diseases

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which can be transmitted to humans or other animals and they come from carcass which is regarded as edible by people as a result of pre- and postslaughter examinations (skin, hooves, horns, pig bristle, feathers, fat-free bones). Apart from the above-mentioned source of animal waste products (which is crucial in terms of quantity), there are food waste products from the households, restaurants, catering appliance and soup kitchens.

In Poland, organic waste from the households poses the most serious problem. On the one hand, we have to limit biodegradable waste storage to the appointed levels which forces a selective collection of this kind of waste and its preferable organic recycling. On the other hand, the places where organic waste its converted to compost are not adapted to carrying out this process in accordance with legal requirements of the European Union for this kind of waste. Besides this aspect, there is also a problem of animal waste products generated by butcheries. Presently, this waste is neutralized in recycling plants, which according to domestic plan of waste management are characterized by relatively low technological and sanitary standards. However, in our country this is not the only way of handling animal waste products from the butcheries. Sometimes this kind of waste is stored in an unprocessed form, which poses a threat to all components of the environment and consequently to the health of human beings. In Poland, there is a need to find a way of dealing with the above-mentioned waste whose production approaches 600,000 tons per year [2], [3], [11]. If waste composting is carried out properly, there will be no need to remove waste by using other methods. While carrying out the process in bioreactor, oudour nuisance is eliminated. Additionally, what is even more crucial in the case of animal waste products, microbiological contamination is eliminated by means of maintaining a suitably high temperature in a suitably long period of time which results in hygienization of input material. Last but not least, the compost process creates the possibility of obtaining a considerable quantity of valuable substitute for natural fertilizer.

2. EXPERIMENTAL

In order to examine the possibility of composting animal waste products, bioreactor, which works in a technology of Herhof, has been modified. A limited-liability company ‘Beskid’ in Żywiec rendered the bioreactor accessible to us for research time. The diagram of reactor has been presented in figure 1. A crucial element of the bioreactor is a reinforced concrete chamber with external heat insulation. The inside of the bioreactor is lined with a protective coat made of nickel-chromium sheet resistant to acids and alkalis, which are produced as a result of biochemical processes taking place during composting. In bioreactor, organic substances contained in waste

undergo intensive chemical decomposition. The process of intensive composting can be divided into four phases [1]: an initial phase (heating for about 2 days to a temperature up to 40 °C), decomposition phase (about 3 days, temperature of 40–45 °C), hygienization phase (about 4 days, temperature up to 60 °C) and cooling off phase (temperature below 40 °C). In bioreactor, the whole process of composting organic plant waste lasts from 7 to 11 days. As a result, a fresh compost is obtained which should be subjected to ripening in heaps.

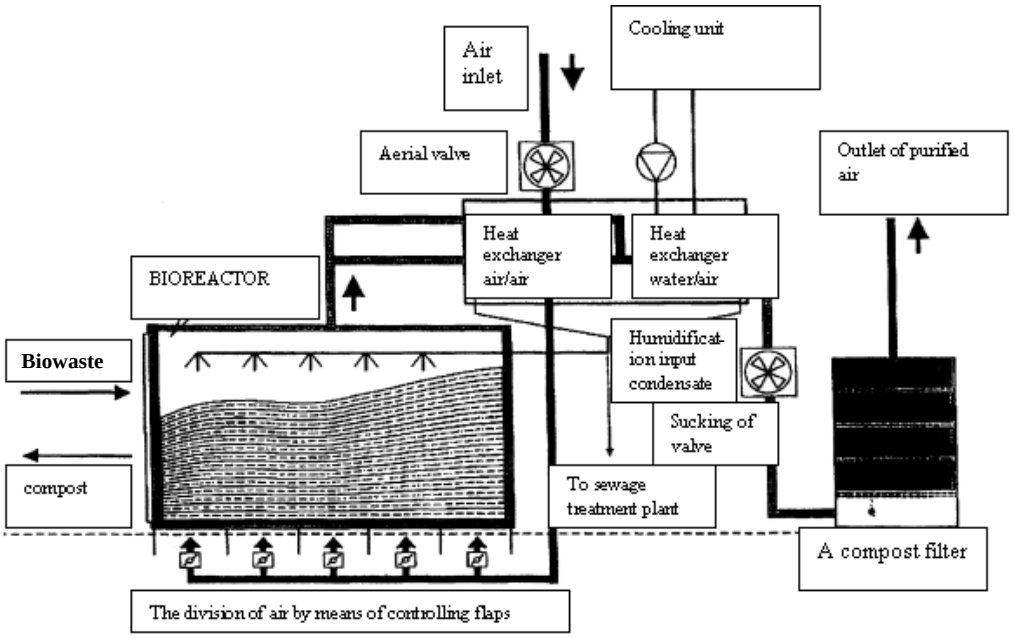

Fig. 1. Air circulation in bioreactor

Temperatures in a chamber of reactor testify to a correct composting process. One-point temperature measurement is carried out at the air outlet from the reactor. The diagram of the reactor control mechanism is given in figure 2. In order to maintain fixed temperatures in the reactor, its input mass should be continually provided with suitable amount of air and water. To that end the bioreactor is equipped at the bottom with multi-point system of aeration. Air streams are controlled by means of the system of valves operating in superordinated control mechanism. Such a system allows the values assigned for subordinated controllers to be obtained which in turn regulates separately every valve. What is more, a superordinated controller regulates the com-

post humidification, depending exclusively on the temperature inside the reactor, in an open system (without feedback).

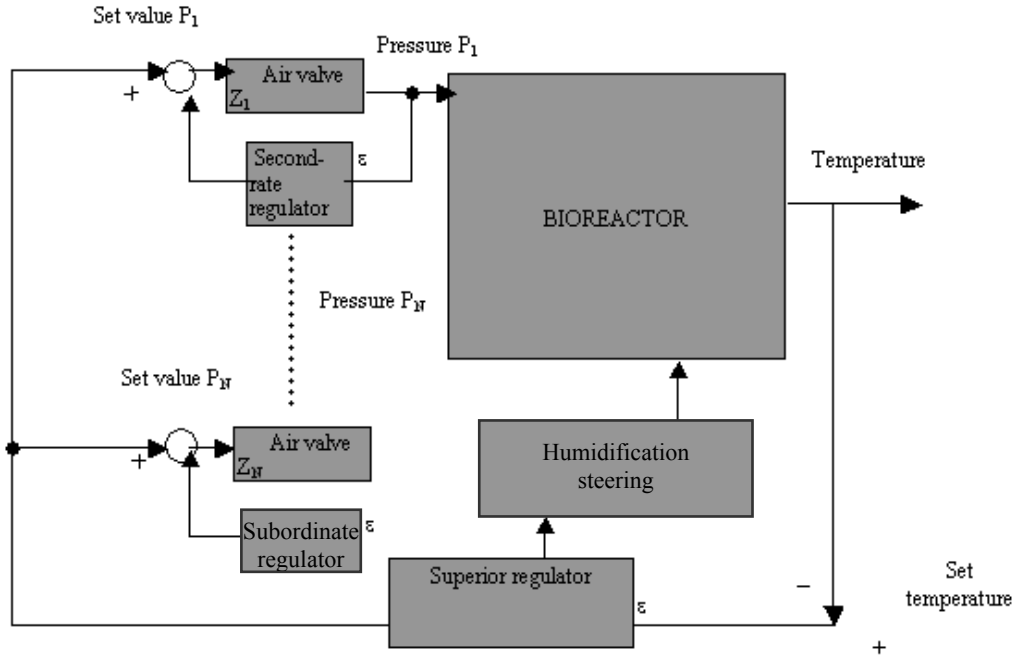

Fig. 2. The diagram of control mechanism of reactor

2.1. THE STRUCTURE OF MEASURING SYSTEM

To carry out experimental tests, which are aimed at specifying a proper temperature determined for superordinated controller, it is necessary to work out the monitoring system within the reactor. This system should make it possible to determine a minimal temperature in the whole space of reactor, depending on the parameters that control the process. The monitoring system is devised in such a way that inside the reactor the temperature-sensitive elements are assembled (figure 3). In the work space of the bioreactor *1*, 30 temperature-sensitive elements are assembled. The signals from detecting elements are multiplexed *3* and registered in the system PXI of a company National Instruments *4* with software Lab View *8*. The system PXI is connected to a local area intranet in order to monitor the system work and to analyse the measurements obtained by means of the protocol TCP/IP. This procedure is applied to slow-changing processes of temperature alterations [9].

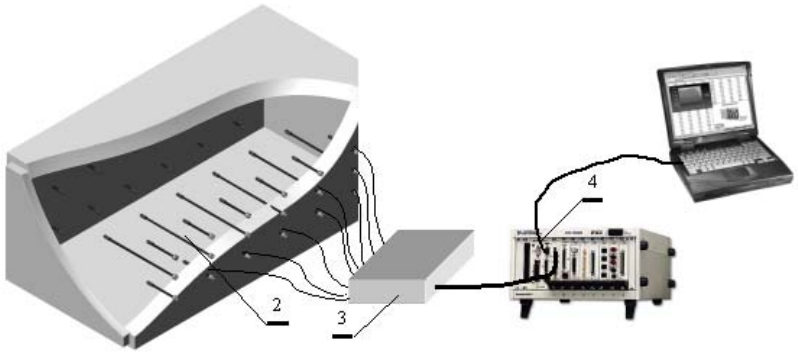

Fig. 3. The temperature monitoring system in bioreactor

Detecting elements have been built on the basis of temperature-sensitive electronic elements LM35 with a suitable electronic system in which a measuring signal can be adjusted [10]. The structure of this element is depicted in figure 4. Temperature-sensitive electronic element and an adjustable signal system are placed in a measuring head made of aluminum alloy. The other side of the element is ended with a steel measuring head which allowed the element to be pushed into an input mass, following the loading of bioreactor.

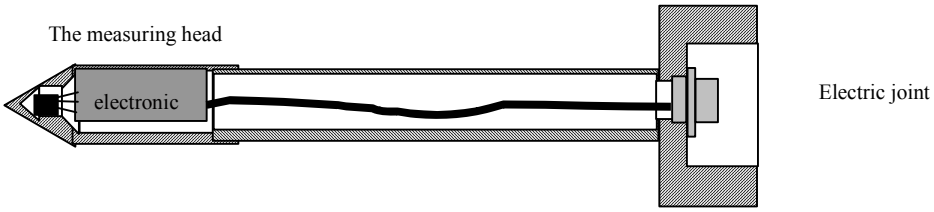

Fig. 4. The structure of detecting element

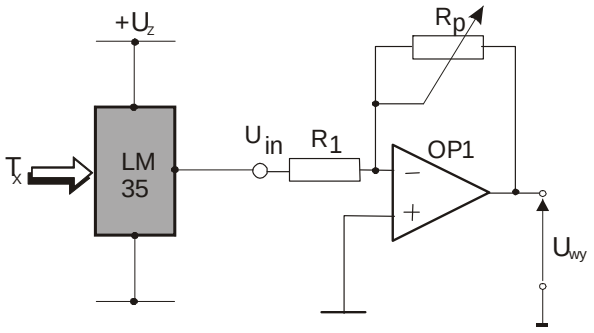

Fig. 5. The structure of adjustable signal system

The diagram of electronic adjustable signal system is given in figure 5. This system consists of intensifier which makes the phase irreversible with huge input impedance. This is particularly favourable because of a poor current efficiency of voltage output of temperature-sensitive electronic element LM35. The output signal of the system ranges from 0 to 10 V at the temperature changes varying from 0 to 100 °C. The system is calibrated by a variable resistor Rp which is fitted to the system of feedback.

2.2. RESULTS

Animal waste products of category III as the waste from the households will be used in the process of composting. In the next stage of experiments, waste from the butchery in Żywiec will also be used. This waste includes: fat-free bones (waste of this kind makes up 90% of waste products in this industrial plant), confiscated meat, skin elements, meat and precipitate from cleaning the food processing industrial appliances. The whole material will be comminuted to the particles of 12 mm size. The tests on composting were carried out using animal waste products and some structural materials (comminuted branches and sawdust) that are necessary for this process. Other tests are also conducted with animal waste material mixed with selectively collected organic substances of municipal waste in two proportions. This municipal waste comprises organic waste from the households, vegetable warehouses and green waste being selectively collected in the area of the Żywiec commune. The above-mentioned assumptions allow us to arrive at the conclusions referring to such technological guidelines that guarantee the outcome of the best quality.

The whole process of composting animal waste products consists of two stages. In the first stage, this process takes place in a modernized bioreactor with the process of monitoring described above. In the second stage, the compost ripens in heaps on the hardened, roof-covered surface (4–6 months). Each of the stages is preceded by the following chemical tests and sanitary qualification tests: the content of organic substance, organic carbon, total nitrogen, P, K, Mg, Ca, Pb, Cd, CR, Cu, Ni, Zn, Hg, the pH measurement, the presence of parasite eggs in alimentary canal (*Ascaris* sp., *Trichuris* sp., *Toxocara* sp.), *Salmonella*, *Escherichia coli* and *Enterococcaceae* bacteriological and parasite tests in 5 replications. The same tests are also provided for ripe compost which is in accordance with a decree of the Minister of Agriculture and Countryside Development dated on 1 June 2001 as regards putting in force some regulations of a decree about fertilizers and fertilization [6] and a decree of the European Community No. 1774/2002 of the European Parliament and the Council dated on 3 October 2002 which make health regulations connected with animal waste products that are not regarded as edible by people [8]. During a ripening process in heaps such factors as: temperature, humidity of heaps and sanitary conditions will be monitored.

In order to give credence to the results obtained, the process of composting will be repeated at exactly set composition of waste input and exactly set parameters of the

process. Apart from the above-mentioned tests, the influence of working bioreactor on the environment is assessed. Because the conent of bioreactor circulates in closed cycle, its impact on the environment will be based on the quality of the air leaving bioreactor assessed in terms of sanitation and odour. Should the influence of the process be negative within the above mentioned range, the modification of biological filter or additional filtering of the air leaving the bioreactor is considered.

3. SUMMARY

Technological requirements established by the European Union legislation [5], [8] and imposed on composting animal waste products are based on the following parameters: the size of particles before their entering the bioreactor (12 mm at the maximum), temperature of the whole raw material during its treatment in bioreactor (70 °C at the minimum) and the time of treatment at 70 °C (60 min at the minimum). The decree passed by the Committee of the European Community No. 208/2006 dated on 7 July 2006, which changes the schedules VI and VIII to the decree No. 1774/2002 of the European Parliament and the Council dealing with the standards for biogas generation and composting plant and the requirements imposed on manure [5], allows different parameters of the process to be used, provided that they minimize biological risk.

Following preliminary experiments (which have been carried out in order to test the system of temperature monitoring) it can be concluded that it is necessary to establish new parameters for treating organic waste from the households. The content of animal waste products in such wastes is minimal (from 1 to 5%), but they contain mainly plant debris. Because this waste is treated as animal waste (the lack of a detailed segregation, difficulties in separating biofractions from the households and waste registration in catalogues [7] under the code 200108 of biodegradable kitchen waste without the division into animal and plant), it seems that its comminuting to the size of 12 mm has no foundation. If in the waste from households the plant debris is mainly found and its comminution is poor, we deal with a compact mass which creates favourable conditions for anaerobic fermentation. Such a fermentation has adverse effect on composting process.

The next parameter of the process, which is difficult to realize despite electronic control of aeration and humidification, is a uniform temperature in the whole input mass. An input mass in bioreactor is not subjected to mixing, therefore the temperature differences may arise in the middle part of input and in the input adhering to the walls of bioreactor. The preliminary experiments show that these differences in temperature range from 10 to 15 °C.

In view of the above, new parameters which can guarantee the sanitized compost mass biodegradation are indispensable. The guarantee will be proved by inserting a well defined test strain or a virus into the input material.

Presently, in Poland, there is no installation which on a technical scale would allow animal waste products to be used in the process of composting. However, there are numerous installations whose operation is based on the use of plant debris in the process of composting. Conducting research will allow the following questions to be answered:

1. What parameters of installation will guarantee conducting the process of composting animal waste products?
2. Is there the possibility of composting organic plant waste together with animal waste?
3. Will the compost produced meet the criteria of organic fertilizer?

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MOŻLIWOŚCI KOMPOSTOWANIA UBOCZNYCH PRODUKTÓW POCHODZENIA ZWIERZĘCEGO

Przedstawiono badania, których realizację rozpoczęto w 2006 roku, a których problematyka dotyczy możliwości kompostowania ubocznych produktów pochodzenia zwierzęcego. Odpady pochodzenia zwierzęcego przeznaczone do kompostowania to materiał kategorii III, a w szczególności odpady żywno-

ściowe z gospodarstw domowych oraz odpady pochodzące z zakładów mięsnych. Proces kompostowania tych odpadów został oparty na technologii zamkniętej z wykorzystaniem zmodyfikowanego bioreaktora, którego dotychczas masą wsadową były roślinne odpady biodegradowalne. Modyfikacja pracy bioreaktora polegała na dodaniu do procesu intensywnego rozkładu kolejnej fazy – intensywnej higienizacji i umieszczenia w przestrzeni roboczej bioreaktora systemu monitoringu temperatury w czasie. Opisano budowę systemu pomiarowego oraz wstępnie przyjętą metodykę badań.