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INSTALLATION FOR AEROBIC SOLID PHASE COMPOSTING

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ABSTRACT: Composting is a process of complete utilization of various residues and wastes from the plant-growing, stock-breeding and food, beverages and tobacco industries, as well as from the households, timber industry and other industries. Composting as a process is gathering speed and is increasingly applied in the preparation of manure compost in order to increase the humus content in the soil and to improve its fertility. The current publication presents and reviews one new installation for aerobic solid phase composting and shows its advantages over the well-known installations, thus giving ground for its implementation in practice.
KEYWORDS: Composting, installation for composting, aerobic solid phase composting

INTRODUCTION

Composting is an exothermic process of transformation of organic residues and wastes under the influence of various micro-organisms until the formation of a solid humus-like product known as compost. Main resource environments for the carrying out of the process are the organic residues and wastes.

The aerobic solid phase composting is a biological maturing, under controlled conditions, of organic matter of plant and animal origin with a view of obtaining materials with a simpler molecular chain, which are also more stable, more hygienic, rich in humus ingredients and suitable for the recovery of the organic matter in soils, as a selective compost for growing of mushrooms and for the production of vermicompost (bio humus, bio fertilizer).

The aerobic solid phase composting of residues and wastes from the plant-growing, stock-breeding, timber-producing and processing industries, as well as those from household waste, aims at their utilization for the obtaining of compost of full maturity for fertilization of soils or of partial maturity as a raw material for lubricant and mushroom production. Simultaneously from an eco-energy point of view it is advisable to take away the released heat energy and the obtained carbon dioxide in a form that is suitable for their utilization, which is solved in a good way [4].

The various objectives, economic conditions, scale and sources of raw materials have imposed the great variety of technologies and techniques for aerobic solid phase composting. All of them aim at providing optimum conditions for the flow of the fermentation process, in which they succeed in varying degrees.

The installations for aerobic solid phase composting that are developed and used till present function through the following main groups of operations: shredding; fermentation; filtering. These operations are interrelated and interdependent, without a mandatory functional boundary between them. Each of these groups of operations includes one main and several auxiliary ones, providing for its flow. The installations for this purpose comprise a composter, filled with a biomass prepared for composting in advance, equipped with coil pipes with a circulating liquid for sluicing the heat energy exuded by the compost and for the simultaneous regulation of the temperature rate.

Among the considerable disadvantages of these installations is the fact that with the solid phase composting with the use of heat energy, the heat exchange between the coil pipes and the composted material happens in a contact way, which leads to the establishing of a different temperature rate in the different parts of the composter. The possibility for intensifying the spontaneous heating of the compost in the initial stage is limited, which leads to its protraction or the use of other means for that. Besides, the coil pipes and the coolant in it are quite inert in thermodynamic terms when being used for managing the process in changing conditions. The inevitable use of a non-corrodible heat-conducting material for the making of the coil pipes complicates, aggravates and raises the cost of the installation [1] [2] [3].

The afore-named disadvantages of the installations that are in usage now have necessitated the designing and making of a new installation for aerobic solid phase composting, which offers composting of a higher quality and greater intensity, and parallel to this, it is environmentally friendly, waste free and energy-saving, as well as intended to processing of residues and wastes from the plant-growing and stock-breeding industries, the processing industry and household for obtaining humus, for catching the carbon dioxide and for accumulation of the exuded thermal energy.

The aim of this study is to present the technical and technological peculiarities of the newly-made installation, as well as to point out its advantages, thus justifying the need for its fast implementation into practice.

❖ EXPOSITION

The newly-developed installation for aerobic solid phase composting (fig.1) consists of a composter. At a certain distance from its bottom a lattice with sackcloth is attached and the biomass is placed there. The space underneath the lattice with sackcloth is connected to an incoming heat exchanger and an air pump. At the opposite upper side of the composter an electronic thermometer is positioned and there is also an outgoing heat exchanger, connected to a bio-filter through an air pipe.

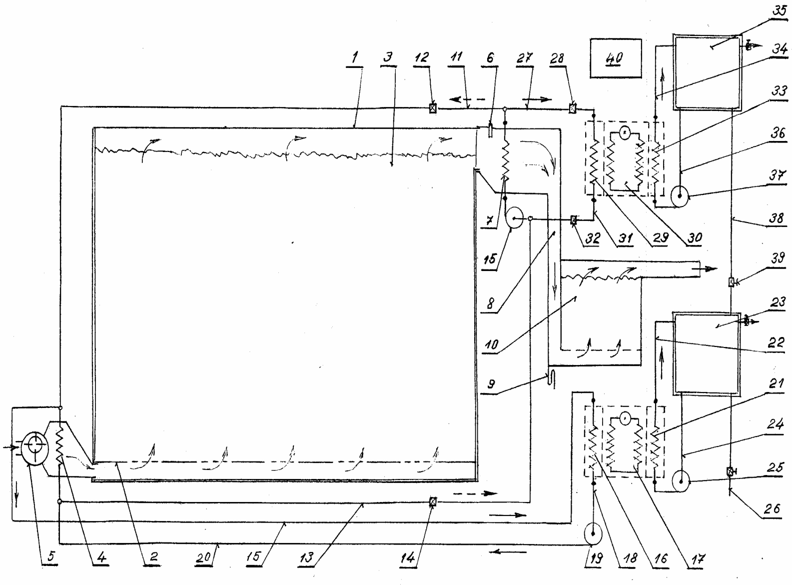

Figure 1. Installation for aerobic solid phase composting
1-composter; 2-lattice; 3-biomass; 4-incoming heat exchanger; 5-air pump; 6-electronic thermometer; 7-outgoing heat exchanger; 8-air pipe; 9-water seal; 10-bio-filter; 11-pipeline; 12-control valve; 13-pipeline; 14-controlled valve; 15-circulation pump; 16-first cycle; 17-first thermo pump; 18-pipeline; 19-circulation pump; 20-pipeline; 21-second cycle; 22-pipeline; 23-heat accumulator; 24-pipeline; 25-circulation pump; 26-feed pipe; 27-pipeline; 28-controlled valve; 29-first cycle; 30-second thermo pump; 31-pipeline; 32-valve; 33-second cycle; 34-pipeline; 35-second heat accumulator; 36-pipeline; 37-circulation pump; 38-pipeline; 39-valve; 40-controlling programmable circuit board.

To the upper end of the outgoing heat exchanger a pipeline is connected, whose other end is joined to the incoming heat exchanger via a control valve. The other end of this heat exchanger is connected to the inlet of a circulation pump through another pipeline and a controlled valve, and the outlet of this pump is connected to the bottom side of the outgoing heat exchanger. Besides, the upper side of the incoming heat exchanger, via a pipeline, is connected to the upper side of the first cycle of the first heat pump, and the other end, via a pipeline, circulation pump and a pipeline is connected to the bottom end of the incoming heat exchanger. The second cycle of the first heat pump through pipelines and a circulation pump is connected to the first heat accumulator. To the upper end of the outgoing heat exchanger through a pipeline and a controlled valve it is also connected to the upper side of the first cycle of the second heat pump. Its bottom end through a pipeline, a controlled valve and a circulation pump, is connected to the same controlled valve of the outgoing heat exchanger. The second cycle of the second heat pump, through pipelines and a circulation pump, is connected to a second heat accumulator. The first heat accumulator is connected at its bottom end to a power pipeline, and at its upper end, through a pipeline with a cock, is connected to the bottom end of the second heat accumulator. The air pump has an adjustable capacity, and the controlled valves are constantly closed. To an opening at the bottom side of the air pipe a water seal is fitted. Close to the composter there is a control programmable block, which is connected to the air pump, the electronic thermometer, the control valves, circulation pumps and the heat pumps.

❖ PERFORMANCE OF THE INSTALLATION

The composter above the lattice with the sackcloth is filled with the biomass which is prepared for composting in advance. Under the lattice with the sackcloth through the incoming heat exchanger from the air pump air whose debit meets the requirements of the aerobic microorganisms of the biomass is pumped. As a result of the comparatively high hydraulic resistance of the sackcloth lattice the air is distributed over the entire lower part of the biomass while the uneven resistance of the air in it turns out to be relatively low.

The air passing through the biomass stimulates the aerobic fermentation process which is accompanied by its saturation with carbon dioxide and water vapours. The process is characterised by release of heat, heat exchange and increasing of its temperature.

Going out of the composter, the air passes through an outgoing heat exchanger to which it gives most of its heat energy and enters the air pipe. There due to their decreased temperature part of the water vapours and probably ammonia are released. Their condense leaves through an opening in its lower part and a water seal. After that the air passes through a bio filter where it is purified from harmful volatile substances and enters the air consumers being saturated with carbon dioxide.

The composting process in the installation is carried out in accordance with the biomass temperature and the optimal temperature predetermined in the controlling programmable circuit board which has to be altered at the different stages of the process.

When the biomass temperature is lower than the predetermined optimal temperature, which is typical mainly for the initial stages of composting, it is necessary to increase it through self heating. It is intensified in the following manner: through signals from the controlling programmable circuit board the valves are open and the circulation pump is working. The remaining elements of the installation do not receive signals and do not function. Then the heat agent from the outgoing heat exchanger through the controlled valve passes through the incoming heat exchanger and releases its heat. After that it passes through another pipeline, through the controlled valve and through the circulation pump it goes back to the outgoing heat exchanger. In this way the energy obtained at the exit of the composter returns to it and is accumulated. The temperature of the biomass is increased intensively and reaches and even exceeds the optimal temperature. In this case the controlling programmable board stops its influencing the controlling valves and they are closed. When it sends signals to other controlling valves they are opened and put into action the thermo pumps and the circulation pumps.

As a result of the functioning of the thermo pump the temperature of the heat agent is reduced in its first cycle. Through the connections with the pipelines and the functioning of the circulation pumps and through the incoming heat exchanger is reduced the temperature of the oxygen entering the installation and respectively the biomass. After all, the temperature of the biomass is maintained within fixed limits around the predetermined optimal temperature. When the temperature of the oxygen entering the composter is lowered, the obtained heat energy is transmitted by the thermo pump to the water circulating in its second cycle. This increases the temperature of the heat agent and through the pipelines and the circulation pump is transmitted to the water in the first heat accumulator. As a result of the work of the thermo pump the heat of the heat agent is reduced. In the first cycle of this pump and by the connections with the pipelines, through the respective controlled valves and the circulation pump, the heat of the outgoing heat exchanger is also reduced. In this way the heat energy of the oxygen going out of the composter is taken away and its temperature is reduced more intensively compared to the previous mode of work. This also results in condensation of a considerably greater amount of water vapours and probably ammonia. The obtained heat energy is transmitted by the thermo pump to the water circulating in its second cycle. Its temperature is increased and through the pipelines and the circulation pump is transmitted to the water in the second heat accumulator.

For the normal functioning of this regime it is necessary to consume the heat energy accumulated in the heat accumulators and to feed unheated water through the feed pipe. Usually in the first heat accumulator the possible temperature of the water is lower than that in the second heat accumulator. In order to preserve as much heat energy as possible through a pipeline and valve the water from the first heat accumulator is fed to the second heat accumulator and there at the second step its heat is increased.

The main advantages of the proposed installation are based mainly on the fact that the heat exchange in the composter is carried out by an air stream evenly through the whole volume of the composted material. The feeding with air and the temperature regime are kept in optimal limits regardless of each other. They vary during the different stages of the composting process and lead to the realization of the following advantages:

The installation provides quality and intensive composting:

- The supplied air is distributed evenly over the whole surface of the lattice and the through the whole amount of the biomass.
- The composting conditions are optimal and adequate with regard to occurring changes. They are also safe and prevent drastic increases of temperatures leading to mineralization of the biomass.
- The installation provides predetermined working regime at the different stages of the composting process which is also important for the quality and intensity of the composting.
- Supporting the temperature regime does not influence supplying the biomass with the necessary oxygen (air).

- The installation provides the full and quick decomposing of the biomass at each step of the process. The biomass is also turned into humus and decontaminated as a result of which quality compost is produced.

The installation is environmentally friendly and waste free:

- The independent, continuous and optimal supply of the biomass with oxygen prevents the occurrence of anaerobic processes with harmful emissions and mainly the formation of methane whose green house effect is 20 times higher than that of carbon dioxide.
- The installation secures the full capturing of the obtained oxygen which is saturated with carbon dioxide and is purified through bio filters. This oxygen is free of harmful matters and can be used in photosynthesis processes.
- The obtained humus has high quality and is free of plant toxins.

The installation is energy-saving:

- The total amount of the streamlined and obtained heat energy resulting from the composting process is captured and accumulated in heat accumulators.
- The heat energy, obtained by lowering the temperature of the incoming air when it is necessary to cool the biomass, is captured and accumulated.
- The obtained heat energy is transformed into an energy which has higher temperature of the heat agent. This makes its use easier and its conservation more effective.
- Taking the energy from the air leaving the composter through the forced reduction of its temperature with the help of the thermo pump contributes to the production of additional quantities of energy.
- The lowering the temperature of the biomass without it being turned over or aerated does not lead to heat loss in the environment and to full consumption of the external heat.

❖ CONCLUSIONS

The following conclusions can be made on the basis of the performed analysis:

a. The newly-developed installation for aerobic hard phase composting provides high quality and intensive composting which is environmentally friendly, waste free and energy saving.
b. The air supply as well as the temperature regime is kept within optimal limits regardless of each other. The heat exchange in the composter is achieved through an air stream and is done evenly over the whole amount of the composted material.
c. The technical and technological advantages of the newly-developed installation provide sufficient grounds for suggestions concerning the implementation of the installation and its wider use in agricultural practice.

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