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Design and Application of an Innovative Composting Unit for the Effective Treatment of Sludge and other Biodegradable Organic Waste in Morocco

MOROCOMP (*LIFE TCY05/MA000141*)

Deliverable 5:

Technical Description of the in-Vessel Composting System

composting MOROCOMP

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TECHNICAL DESCRIPTION OF BIOREACTOR

The bioreactor will be fed with sludge originating from biological waste treatment units with yard and grass residues as well as other biodegradable organic waste (BOW). The bioreactor is a batch system and comprises of:

A. BIOREACTOR

1. The Bioreactor shell

The bioreactor shell is a horizontal cylinder of 1300 mm internal diameter and 3000 mm internal length. It is made of steel and both its perimeter and its generator are reinforced. The steel type is St 37.2. The steel thickness is 10 mm. The reinforcements are perimetrically welded to the outer perimeter of the cylinder. They form double angles and are stronger in the lower surface of the bio-cylinder and in particular close to the welding at outer surface points of the bio-cylinder's base and support carrier (supporting) elements. The supporting elements are hollow beams of steel St 37.2 of length 700 mm. The steel thickness of the supporting elements is 15 mm. It consists of four elements the upper ends of which are welded to the bottom bio-cylinder surface at 45^{o} double angles and in pairs at a distance of 750 mm from the closer end of the shell. Their bottom ends are made of lead and are welded to steel footings which are fixed-supported to the floor of the bio-cylinder installation building. For static efficiency reasons the above supporting elements are reinforced, in X-shape, through welded steel beams of steel St 37.2 of thickness 700 mm. The inside of the shell has longitudinal supporting profiles NP 65 which are welded at an axial distance so that the shell is reinforced against bending fatigue.

The outside bio-cylinder surface as all other peripheral equipment have anticorrosive protection which includes sand blasting and two paint coats of epoxy paint. The inside surface of the drum has a primer anticorrosive protection. The useful volume of the bioreactor is 3.979 m^3 and the degree of initial filling is 75%.

2. Supply portal

At the centre of the shell upper surface, the bioreactor has a supply portal which opens, of dimensions 500 x 500 mm, which is water-proofed through elastic leaves of adequate thickness. Supply of the biological sludge will be done by a lorry tanker which will approach and supply the bioreactor through its evacuation pipeline with the required quantity of sludge depending on the desirable composition in biological sludge plant residues of the bioreactor substrate. Through the same portal, the bioreactor will be supplied with precut plant residues.

3. Substrate stirring mechanism

The substrate stirring mechanism includes:

- **Stirring system**

  The stirring system comprises of a steel revolving axis which passes through the centre of the two cylinder bases and runs along the drum. It carries, welded on its body, steel blades ST 316, which are distributed along the length of its axis, at a distance from each other of 250 mm and at a distance of 80 mm of the upper end of the blades from the inside drum surface. The axis is a one-piece steel hollow beam ST 316, of cylindrical cross-section of 200 mm and 120 mm steel thickness. The blades are pieces of ½ IPN 400 profile and apart from stirring the substrate they further cut the plant residues, break-up the co-aggregation formed and support the uniform ventilation and uniform hydration of the substrate.

- **Movement system**

  The movement system consists of a redactor and a 25 kW electric motor which moves through an inverter. The revolution of the stirring axis will be between 1-20 rpm, that is, more revolutions during the first days and after the bioreactor supply, which will tend to be lowered as time progresses.

4. Substrate ventilation system

Substrate ventilation is a very basic parameter of the composting process since it concerns bio-oxidation processes of the organic substrate. For the substrate supply with air, a centrifugal fan is installed to supply the required amount of air. The fan sucks air from the environment and blows it into the bioreactor drum through the

opening located at the upper end of the left cylinder base and at a distance of 100 mm from the cylindrical perimeter of its base. Air supply, apart from securing the required O_2, contributes enormously to the lowering of substrate humidity since sludge humidity is high.

5. Air removal system from the bioreactor

Since composting processes are bio-oxidation processes, CO_2 is produced as well as other gases which must be removed so that the bioreactor air is rich in O_2, necessary for the bio-oxidation process. To satisfy the above, fans are installed to suck air from the bioreactor. The fan sucks air from inside the bioreactor and blows it, dispersing it through the air-pipe to its branches which are installed and run in the false-floor of the bio-filter which is used for the deodorization of the air sucked from the bioreactor. The suction opening (mouth) lies on the upper end of the right-hand base of the cylinder and at a distance of 100 mm from the circular perimeter of its base.

6. Substrate hydration system

The substrate humidity is a very basic composting process parameter since it influences the system biology. In order to ensure the required substrate humidity a simple time processor is installed through which water supply from the potable water network is controlled inside the bioreactor drum through ½ inch pipes which end inside the drum in the upper surface of the shell at an equal distance from both bases of the cylinder. Inside the drum it splits into two plastic branches, ½ inch each, which run the whole length of the drum, one in the direction of its left base and the other in the direction of its right one. Every branch has eight sprinklers at a distance of 200 mm from each other with the exception of the first sprinkler of each branch which is at a distance of 100 mm from the junction.

7. Leachate removal system

In the left bottom end of the drum and at a distance of 200 mm from its base, a ½ inch pipe starts from the inside of the drum, through which the bioreactor leachates

are removed. At the inside end of the pipe, a grid is installed and the intermediate volume is filled with geo-tissue in order to avoid pipe blockage.

8. Exit portal

The bioreactor, at the centre of the lower surface of its shell, has an opening exit portal of dimensions 500 x 500 mm. Collection of the compost will be done through the above portal, the water-proofing of which is insured by elastic leaves of appropriate thickness.

9. Control equipment

Bioreactor control is performed by a control system which controls:

- The movement of the revolving axis which is controlled through a time switch.
- The substrate ventilation fan which is controlled through a time switch.
- The air suction fan of the bioreactor which is controlled through a time switch.
- The temperature which is recorded by micro-chips installed in the bioreactor interior.
- The O_2 content in the bioreactor air which will result after sampling air inside the bioreactor and following its laboratory analysis.

B SHREDDER

The shredder will have a motor of maximum 1500 W. It will be able to receive wood waste and yard waste having a maximum diameter of 3 cm.

C. DEODORIZATION SYSTEM OF THE BIOREACTOR AIR EMMISSIONS

1. Bio-filter

Air emissions sucked by the bioreactor end up in the bio-filter; contain CO_2, NH_3, and chemical compounds which have a strong and unpleasant odour. The drastic reduction of odours will be achieved using the bioscrubbing method. To that effect, a bio-filter will be installed composed of:

- A low wall of armed concrete of thickness 200 mm. Its dimensions will be 2500x2500x1500 mm. Its base will be constructed from armed concrete of 200 mm thickness. The base and the interior surfaces of the low wall will be covered with three successive coats of asphalt-like material to insure proofing.
- From perforated pseudo-pavement of steel ST 37.2, of thickness 1500 mm. The pseudo-pavement will be boxed in the above construction and at height of 200 mm from the base, it will have Φ 100 mm holes at a distance of 100 mm between them.
- Geo-tissue which will cover all of the upper surface of the pseudo-pavement, as well as all interior walls of the low wall above the level of the pseudo-pavement.
- Mature compost bed. The space between the geo-tissue which protects the pseudo-pavement and up to a height of 1000 mm from it will be filled with mature compost, the humidity of which should be kept between 35% - 40%.

2. <u>Air pipe</u>

A suction fan blows air from the bioreactor, through a pipe which ends running through one side of the low wall and at a height of 100 mm from the base. The air blown passes successively through the pseudo-pavement, the geo-tissue, it is diffused in the body of the mature compost bed and exits from the upper surface of the bio-filter bed, having a deodorization estimated at 82%.