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Treatment of Waste Water Sludge by Bunker Composting Plant

Contents

1 COMPOSTING PROCESS

The sludge (3 900 m^3/year; proposition of dry material on average 17,7 %) will first be hygienized and pre-composted in a closed bunker composting unit and then further processed into final soil-improvement compost in stacks.

In the hygienization and pre-composting stage the sludge begins to compost fast. The soil-improvement compost which is transferred to further processing is hygienic and safe to handle. The hygienization of the sludge will take approximately 2 weeks. During the process the sludge temperature is being increased beyond 55 °C by metabolism of microorganisms. No external source of energy is required for heating. To ensure efficient pre-composting, the matter under hygienization is being oxidized mechanically.

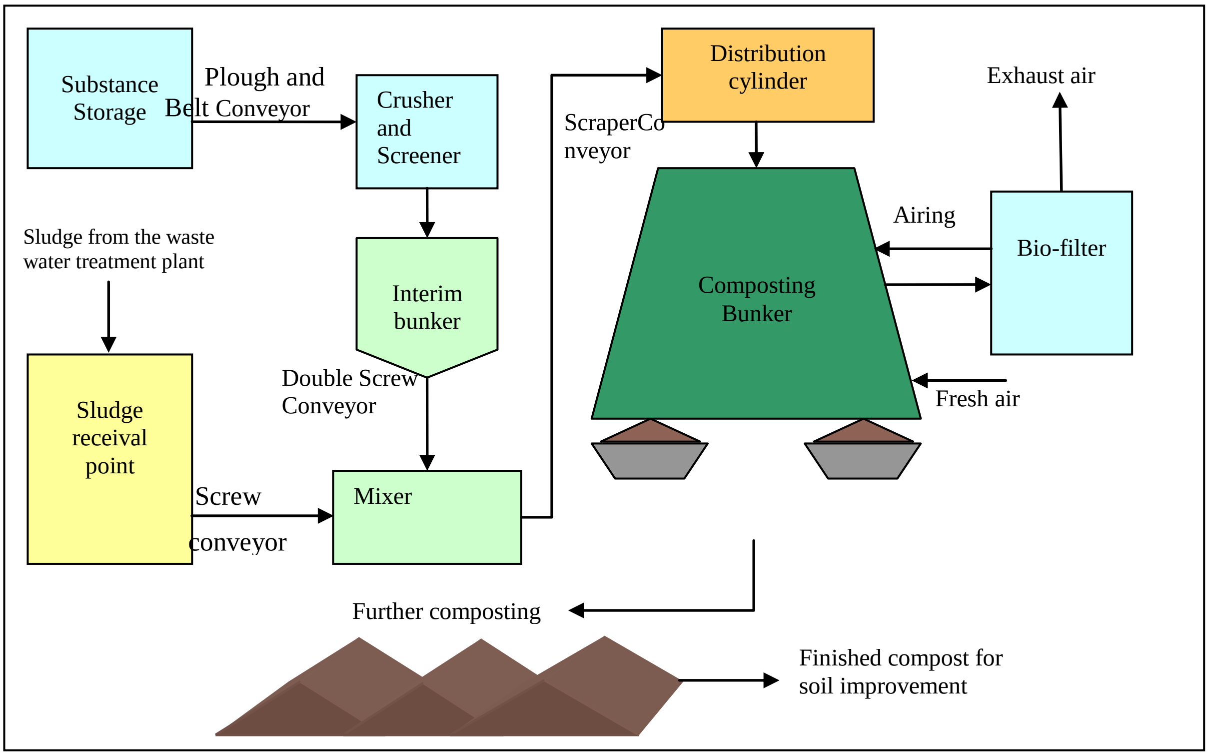
After hygienization the raw sludge compost is transferred to stacks for post-composting for another 12 months. The sludge compost slowly transforms to soil-improvement compost. After this the compost is ready to be used for soil improvement. There's no need to turn the stacks during the composting process.

The process is continuous i.e. the hygienization reactor is being fed daily with new sludge matter and respectively the raw sludge compost is being removed from below for further composting process. The daily input can touch around 25 m^3.

The sludge matter remains in the hygienization reactor (270m^3) for approximately 14 days. Within the first few days the temperature of the matter increases up to 55…70 °C due to metabolism of microorganisms. The steep increase in the temperature is due to the fact that new sludge is piled on the top of the already hearted matter.

The continuous and closed hygienization process ensures the optimal circumstances for microorganisms which in turn guarantees the fast increase in the temperature. Oxygen level, humidity and temperature of the exhaust air is being monitored along with the temperature of the matter at various levels. The oxygen intake is being improved by blowing air into the matter through pipelines. The optimal temperature for hygienization is around 55…65 °C. This condition is reached by regulating the aeration and humidity level of the matter. The air can be recycled: fresh air is only required when the oxygen level drops below the set limits.

2 EQUIPMENT LIST AND THE PHASES OF COMPOSTING PROCESS



Equipment list (Annexure 1)

Pos 1	RECEIVING STATION FOR SUPPORT SUBSTANCES 100 m^3
Pos 2	PLOUGH CONVEYOR
Pos 3	BELT CONVEYOR
Pos 4	CRUSHER
Pos 5	INTERIM BUNKER
Pos 6	DOUBLE-SCREW CONVEYOR DN 300
Pos 7	TWO-AXEL BLADE MIXER
Pos 8	SCRAPER CONVEYOR
Pos 9	DISTRIBUTION CYLINDER
Pos 10	COMPOSTING REACTOR 270 m^3
Pos 11	UNLOADING UNIT FOR COMPOSTING REACTOR
Pos 12	TARPAULIN HALL
Pos 13	PLATFORMS 2 PCS
Pos 14	SLUDGE RECEIVING POINT 10 m^3
Pos 15	SLUDGE SCREW
Pos 16	AIR PIPES
Pos 17	AUTO SCALE

The line consists of following elements: the receiving station for both support substances and sludge; mixer for support substances and sludge; hygienization in bunker; unloading of the hygienized matter from the bunker on two platforms; transmission of the matter; and stack composting.

The excavators pile the sludge in the receiving station (pos. 14) from where the sludge screw (pos. 15) leads it to mixer on the top of the support substance (pos. 7). The sludge is also being weighted on auto scale (pos. 17).

The sludge screw feeding in the sludge (pos. 15) and double screw conveyor (pos. 6) adding the support substance (pos. 7) operate in synchronized way. If the users desire to change the capacity, the sludge screw (pos. 16) automatically changes the rotating speed according to new volumes. The manual adjustment of both the screws is possible as well.

The support substance added to the sludge is received at the receiving station having a volume of about 100 m^3. This is enough for one week's requirement. The substance is delivered by trucks and unloaded from the back.

The support substance is transferred by unloaders into plough conveyor (pos. 2) and magnetic belt conveyor (pos. 3) and further into crusher (pos. 4). The plough conveyor's hole used for unloading is triangle-shaped to ensure the equal distribution of the substance on the belt conveyor (pos. 3) and further into crusher (pos. 4). The belt conveyor is cased to minimize the possible harms caused by dust and turf. .

The crusher (pos. 4) is equipped with screening plates. By adjusting the hole size one can change the piece sizes of the support substance. The crusher (pos. 4) includes two blades, one on the each side of the rotator to facilitate the movement both the ways which in turn increases the life-time of the cutting blades.

The matter falls into an interim bunker (pos. 5) located below the crusher (pos. 4). The fine-tuning of the feeding capacity of the support substance is managed with the help of double-screw conveyor (pos. 6) with adjustable rotating speed located below the interim-bunker (pos. 5).

The double-screw conveyor (pos. 6) located below the interim-bunker (pos. 5) feeds the mixer (pos. 7) with support substance to be added into sludge. The mixer (pos. 7) mixes the matters and further transfers it to double-belt scraper conveyor (pos. 8). This, in turn, lifts the matter on the cylinder (pos. 9) located on the top of the composting reactor (pos. 10). Cylinders transform the matter into the bunker. The daily capacity is around 25 m^3.

The composting reactor (pos. 10) has a closed top. One side is equipped with six shutters located at various heights to enable measuring and sampling. The volume of the reactor is 270 m^3.

Unloaders (pos. 11) unload the hygienized matter into two platforms (pos. 13). These platforms are of standard sizes and can be attached to trucks with wire ropes.

The composting plant (pos. 12) can be erected on any stable and even surface, like asphalt. Sewage lines should be digged into the ground below the building to ensure proper transmission of the washing and other water to the waste water treatment plant.

3 AIRING THE HYGIENIZATION REACTOR

The microorganisms taking care of the hygienization require right amount of oxygen. This is ensured by blowing air into the matter being processed. In addition to this, the crushed turf used as support substance includes air which airs the matter from inside.

The temperature of the matter is being controlled in various points at various levels. The data is stored in computer. The airing is guided by several parameters including the temperature and oxygen level of the exhaust air.

4 TREATMENT OF ODOUR EMISSIONS

The whole composting process starting from mixing to unloading of the hygienized matter takes place in closed in closed environment with slight under-pressure. This way the odour emissions can be collected and treated in controlled manner.

The air used in hygienization reactor is directed into bio-filter of 40 m^3 to eliminate the possible odours. This is done by a blower installed in exhaust pipings which creates slight under-pressure and thus no odour emissions leak outside. Turf and spruce peels are used for materials for the bio filter. Gas washer is not required since the sour turf used as support substance binds the ammoniac and ammonium-nitrogen that are possibly generated in the composting process

We have monitored the emissions regularly and have not come across any ammonium-nitrogen, ammoniac or sulphur-hydrogen emissions. We have installed a cooler/moisturizer in the exhaust pipes that – when required – cools and moisturizes the air that is being led into the bio-filter. If needed, after the bio-filter the process air can still be perfected by ozonazing and ionizing before leading it out through 13 m long exhaust stack.

Process equipment is further equipped with targeted removal systems that absorb gases to the odour treatment system from those points where odour gases are created.

5 SCOPE OF DELIVERY

- The composting plant specified in the annexure 1 along with the building
- Equipment and its installation and commissioning
- Training

6 COMPOSTING PLANT – GUARANTEED LIMITS

- Treated process gases before leading them into outside 3 000 p/m^3
- Temperature and duration requirement for hygienization process for required end-result. The limit for hygienization can be set by for instance defining the salmonella content of the end compost. The minimum durations of the hygienization shall be 14 days.
- The finished soil-improvement compost shall fulfill the criteria considering maturity as set in Fertilizer Act (539/2006, Fertilizer Act Annex 1 s. 25 ID2 Organic soil improvement matters, no 1, Soil improvement compost and fresh compost). The criteria for maturity can for instance be set as follows: seed development beyond 60 %, N_{O3}-N/N_{H4}-N ratio > 1 and C_{O2}-reduction < 3 mg C_{O2}-C/g VS/day.
- The waste water generated in the process shall not affect the waste water treatment plant's operations.
- NH_4-N content < 10 ppm

7 OPERATING COSTS

7.1 Electricity and oil consumption

The requirement for electrical power per each processed sludge ton is estimated to be 30 kWh resulting in annual requirement of approximately 120 MWh. Around 6000 liters of oil is required for heating up the premises.

7.2 Labor

The plant can be run by the staff of the waste water treatment plant. The daily working hours required for operating the composting plant (including transfer of the pre-composted matter into further composting and preparation of stacks) are around 4. The processing the finished soil-improvement compost and filling in the support substance storage are not included in above mentioned working hour calculations.

7.3 Other

The turf requirement (used as support substance) is 1,3 m^3 per sludge-m^3 resulting in annual requirement of approximately 5 000 m^3 of turf. This cost can be cut down by using turf grain found in the soil-improvement compost.

The amount of waste water created is 200 m^3per year. This is transferred to the wastewater treatment plant.

Maintenance, repair and quality inspections will constitute some additional costs. The annexures 2 and 3 present the estimates both per sludge m^3 and per year.

8 THE AMOUNT OF FINAL SOIL IMPROVEMENT COMPOST

Out of the 3 900 sludge-m^3 about 4 000 m^3 of soil improvement compost is generated each year. The volume of final soil is 6 000 m^3.

9 SPACE REQUIREMENTS

The area requirement can be found in annexure 1. The building surface area is14 m * 18 m resulting in appx. **250 m^2**. The area required for the whole plant (incl the scale and receival station for the support substance) 18 m * 29 m, i.e. appx. **520 m^2**.

For the final composting an area of 0,3 m^2 per m^3 of hygienized matter is required. Apart from that there is need for free surface area of additional 10…20 % resulting in final composting area requirement of **1 400 m^2**.

Thus the total area requirement will be **1 900 m^2**.

The height of the building is slightly over 11 m. All the maintenance points are equipped with maintenance platforms.

10 REFERENCES

The development work for the bunker composting plant started in 1997 with small scale trials at the Raahe waste water treatment plant. Since the results were encouraging, we started the work with an aim to develop a total composting solutions for composting the sludge generated by Raahe waste water treatment plant.

The plant was ready at the beginning of 2006 and was used successfully for composting the sludge for 1,5 years. During that time the plant technology was further developed. All the sludge of the Raahe waste water plant was processed in the plant. As per analysis carried out the end compost fulfilled the criteria set by the fertilizer act. More detailed results can be found in a separate research report.

Annexures:

Annex 1: Layout
Annex 2. Operational costs per sludge -m^3
Annex 3: Operational costs per year -m^3