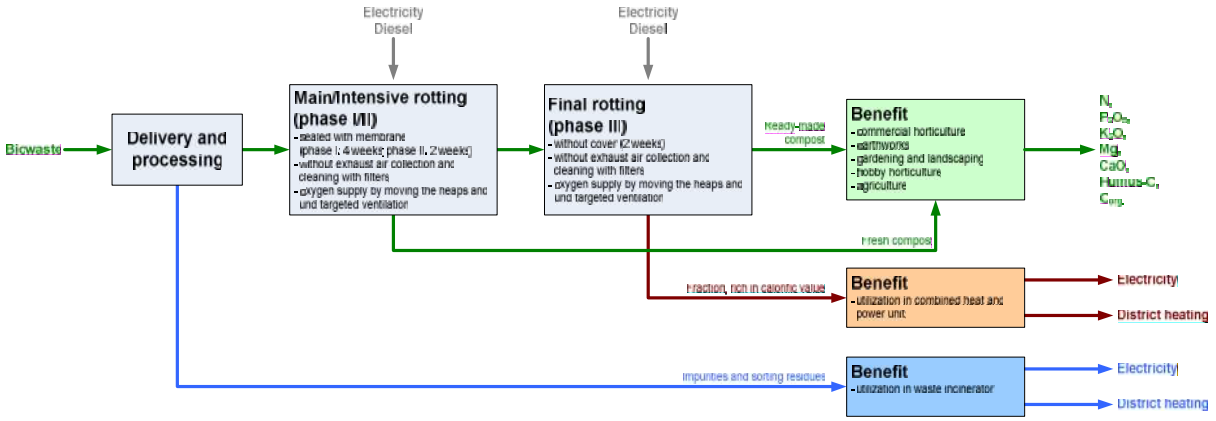
Fundamentals and results of the eco-efficiency assessment

The environmental impacts associated with biomaterial treatment are determined as part of a life cycle assessment analysis. Any treatment of biomaterial (biowaste) is associated with environmental burdens, among other things from the treatment process and the application of the material products, and with environmental benefits from the additional uses provided for energy, fertilizer and organic substance. The overall environmental effect of the treatment results from the offsetting of the environmental burdens and benefits.

The following main material flows are to be taken into account when modelling the biomaterial composting via encapsulation with semipermeable membrane cover:

- On the input side: biomaterial and the necessary quantities of diesel and electricity as mechanical and electrical process energy.
- On the output side: air-side carbon and nitrogen emissions from all sections along the whole disposal route, nutrients and organic substance from the recovery and utilization of the material products (e.g. compost), fresh and ready-made compost as well as electricity and district heating from the utilization of a separated output fraction, rich in calorific value, and the utilization of impurities and sorting residues in waste incinerators.



Schematic diagram of composting via encapsulation with semipermeable membrane cover

Values from studies performed by gewitra GmbH on the emissions situation in the composting and fermentation of biomaterial were used to compare the emissions from the biomaterial composting via encapsulation[1]. As part of this study, emission loads for carbon and nitrogen

[1] gewitra mbH: Ermittlung der Emissionslage bei der Verwertung von Bioabfällen. Funded by the German Umweltbundesamt. Grant reference (UFOPLAN) 206 33 326 and 3709 44 320. Draft final report, as of 8.12.2011.

compounds were determined by taking measurements in only one composting plant with semipermeable membrane. For further description of average operation of a plant with composting via encapsulation with semipermeable membrane cover it was assumed that, with regard to treated biomaterial, the compost quantities and qualities produced are not expected to be any different from those of closed and partially closed composting processes.

Based on the quantity of waste composted over the complete lifecycle, the environmental impact of membrane and laminate production is negligible compared to composting processes and is therefore not taken into account.

Overall, composting via encapsulation with semipermeable membrane cover resulted in environmental benefits for six of the seven impact categories examined: global warming potential, acidification, terrestrial eutrophication, resource conservation, eco and human toxicity. This is a result of additional material (nutrients and organic substance from the use of composts) and energy uses (electricity and heat from the thermal recovery of a separated out woody fraction with a high calorific value). As a result, emissions are avoided, which are produced by the conventional production of electricity, heat and mineral fertilizer as well as the supply of peat, bark humus and organic substance of crop grass. Due to the design and specific process management of encapsulation with semipermeable membrane cover and the interaction of the semipermeable PTFE membrane and a condensate film, which forms on the underside of the cover during the process, high emission retention of methane, nitrous oxide and ammonia occur during the composting process compared to other treatment processes. In the impact category photochemical oxidant formation, ozone-forming emissions harm the environment. This is mainly due to emissions of volatile, organic compounds (methane + NMVOC) from the composting process itself.

The treatment costs, which are incurred by composting via encapsulation with semipermeable membrane cover operated according to good practice, were estimated conservatively. Here the costs are the net expenditure incurred by the towns, cities and rural districts, if they contract out the treatment service externally. From a costs point of view, composting via encapsulation with semipermeable membrane cover lies between partially enclosed composting and open composting.

For the indicative comparison of composting via encapsulation with semipermeable membrane cover with alternative treatment processes, the eco-efficiency of the treatment process was compared with those of alternative processes in a portfolio. To this end, the environmental impacts were plotted against the corresponding costs.

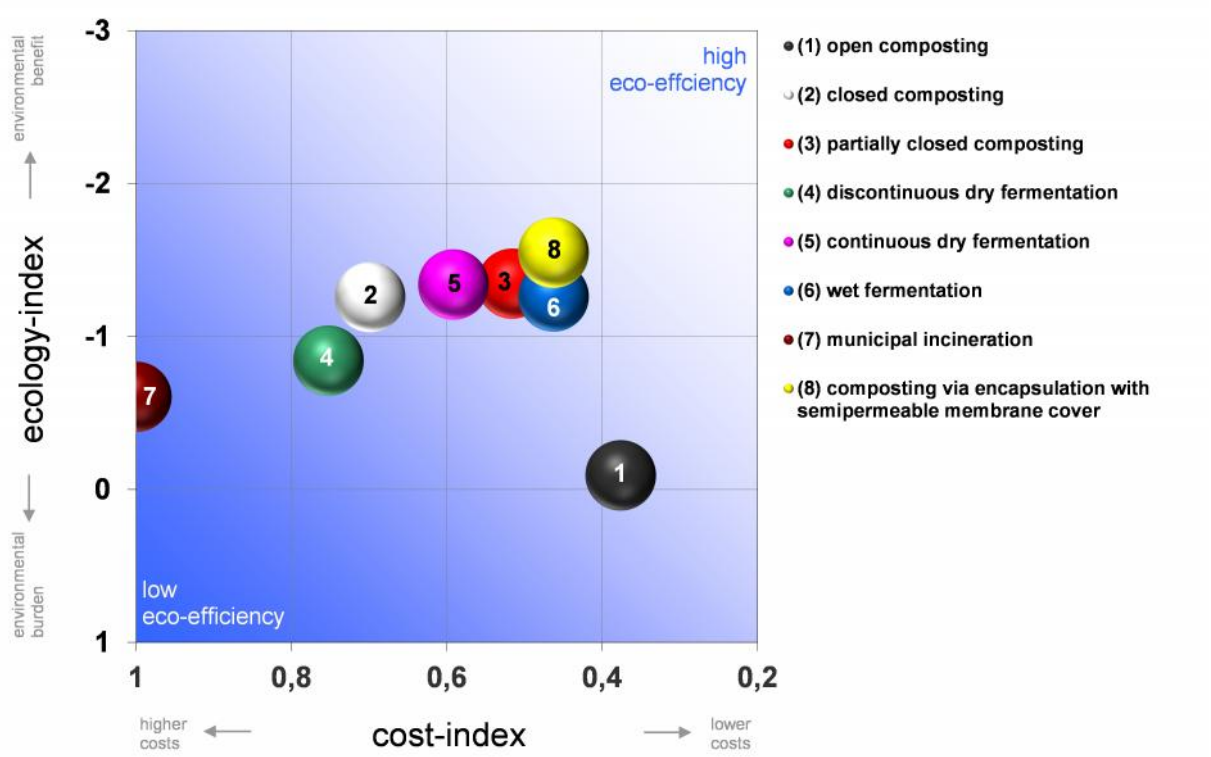
The environmental impacts and costs of the alternative treatment processes were taken from bifa-Text No. 61[2]. A comparison of all considered parameters and emissions shows that composting via encapsulation with semipermeable membrane cover differs in the following ways compared to closed/partially closed composting: lower electricity requirement and lower process-related carbon and nitrogen emissions due to the emission-reducing effect of the semipermeable membrane as the functional component of a fine tuned treatment system in combination with a well-managed process. There are no differences in the downstream pro-

[2] bifa Umweltinstitut GmbH: ¥koeffizienzpotenziale bei der Behandlung von Bioabf¤llen in Bayern. Bayerisches Institut f¿r Angewandte Umweltforschung und -technik GmbH (bifa) on behalf of the Bayerisches Staatsministerium f¿r Umwelt, Gesundheit und Verbraucherschutz, bifa-Text No. 61, Augsburg 2013

cesses of recovering the material products and utilization of the separated out fraction rich in calorific value and disposal of impurities.

In the portfolio the eco-efficiency of the average plant operation of composting via encapsulation with semipermeable membrane cover is compared with the eco-efficiency of average plants using following alternative processes to treat biomaterials:

- Open, partially closed and closed composting of biomaterial
- Continuous and discontinuous dry fermentation of biomaterial with subsequent composting of the solid fermentation residues (plug-flow process and batch process)
- Continuous wet fermentation of biomaterial with subsequent composting of the solid fermentation residues
- Thermal treatment of biomaterial as part of the residual waste in municipal incinerators



Eco-efficiency portfolio of different biomaterial treatment processes (ecology-index < 0 means environmental benefit; ecology-index > 0 means environmental burden; costs index: Scaling of the process-specific costs at the maximum value)

If fermentation and composting plants are managed well, there are only small environmental differences between the alternative treatments - with the exception of open composting. Composting via encapsulation with semipermeable membrane cover has the lowest ecology-index and therefore, if average plant operation is considered, it is the process with the highest environmental benefit, but is close to closed and partially closed composting as well as continuous dry fermentation and wet fermentation.

The objective of the comparison of the environmental impacts and costs with those of alternative treatment processes was not to identify a preferred process in general, but instead to classify composting via encapsulation with semipermeable membrane cover compared to alternative composting and fermentation processes. In order to answer the question, which treatment strategy is the most eco-efficient for a specific disposal case the actual situation on site must be examined. This must then be balanced, for example, with a view to the material provided, the existing plant infrastructure, the specific process technology, the sales situation for material products (e.g. compost) and the heat produced and the specific economic framework. Aside from determination of the environmental impacts as part of the eco-efficiency examination, composting via encapsulation with semipermeable membrane cover as a system in heaps or a side wall version is eligible for approval in Germany, if verification is provided of its equivalence with a closed system, which is the case for the various systems being built in Germany to date.