Life cycle implications of biological treatment

Konrad Schleiss

Environment & Compost Consulting

Dr. Konrad Schleiss, Weinbergstr. 46, CH-2540 **Grenchen**

Telefon +41 32 653 29 20, Fax +41 32 653 29 22

e-mail: k.schleiss@bluewin.ch

www.kschleiss.ch

Abstract

What is a life-cycle assessment (LCA)?

An LCA is the ecological accounting of negative impacts and some positive effects of a process or product on the environment. The main drawback of LCAs is that they require to work with approximately 50 different currencies and with debatable conversion factors between these currencies. Accountants find working with a single currency difficult… this is one good reason why the results of an LCA should never be considered just for themselves. They should always be valued in the frame of the sustainability triangle, and correlated with economic and social impacts. This is the only way to ensure that the results will really be valid over the long-term.

A good LCA should always use more than one methodology, in order to ensure that the criteria are weighted in several different ways. This will make an LCA more reliable. In Switzerland the methodologies most used are the Eco-indicator method and the method of environmental scarcity.

The Eco-indicator 99 method (Goedkoop & Spriensma 2000a) develops and refines the concept of the "damage oriented" impact assessment method for LCAs. Compared to Eco-indicator 95, it takes more environmental impacts into account (in particular the depletion of resources and land consumption).

The method of environmental scarcity (EIP method) allows a comparative weighting and aggregation of various environmental interventions by use of so-called eco-factors. The eco-factors

are based on the actual pollution (current flows) and on the pollution considered as critical (critical flows). Current flows are taken from the newest available data. Critical flows are deduced from the scientifically recognised goals of the Swiss environmental policy. The global environmental impact is then measured as so-called environmental impact points (EIP).
Several recent LCAs have compared composting to anaerobic digestion or to incineration.
In general, composting always obtains the lowest scores, when all factors are taken into consideration. The "winner" is always either incineration or anaerobic digestion, depending on with type of energy recovery is chosen and how the characteristics for the input feedstocks are defined (% dry matter).
There are two main reasons for this. Firstly, energy plays a decisive role in LCAs: depending on the type of energy recovery considered, this results in high credits for fossil energy substitution. Second, composting and anaerobic digestion only exploit about 50% of the energy potential of the input material, the rest remains as organic matter in the products.
In the following studies efforts were made to find a better way of assessing certain factors:

- The UNEP/SETAC Life Cycle Initiative concerning heavy metals;
- Essent Milieu Haelen (the Netherlands) Grontmij Nederland bv ir. A.J.F. Brinkmann: Compost credits – the carbon balance of biowaste composting, arjen.brinkmann@grontmij.nl;

- Working Group on Composting And Integrated Waste Management, Scuola Agraria del Parco di Monza: Soil, biowaste and compost: potential contribution to tackle climate change.
- Entsorgung und Recycling Zürich: Verwertung der biogenen Abfälle in der Stadt Zürich, www.erz.ch
- Research project about positive aspects of composts and digestate at the research institute for organic farming FiBL, Frick, www.fibl.org

In the following paragraphs we will discuss the factors specifically affecting the assessment of composting and AD in LCAs.

Difference between biological and technical processes

Organisms are the main actors of biological processes, while technological processes are ruled by physical parameters. Organisms require a supply of nourishment to ensure their basic metabolism, and only what is "in excess" of this can be transmitted further. One consequence of this for composting is the emission of more unwanted substances, such as NH_3, N_2O or CH_4, than during direct incineration. If, in addition, the energy liberated by incineration is then recovered as completely as possible (electricity production and use of the heat), something which is generally not possible in the case of composting, these two aspects then result in incineration receiving comparatively fewer negative points.

Biological processes are disadvantaged in LCAs on the following points:

- ***Heavy metals***: the heavy metals content of fertilisers is weighted very negatively. No distinction is made between heavy metals that were already in circulation and heavy metals that are newly put into circulation.
- ***Degradation of organic matter (OM)***: in biological processes, this generally amounts to only a fraction of the total, conversely to incineration, where mineralization amounts to almost 100%. The remaining OM in compost is difficult to weigh, as humus is not awarded any value in LCAs.
- ***Documented positive aspects***, such as the improvement of the water retention capacity, the reduction of erosion or the suppressivity of plant diseases, cannot be simply integrated into an LCA (what use is the suppressivity potential against a disease of cucumber plants for a wheat crop?). How can one generalise such specific results? Before they can be taken into account, they must be converted into a normalised currency (just as in any bookkeeping system). This is why it seems a reasonable idea to first establish an organised market for the products of composting, which will automatically set a price for them. It is then easier to convert this into LCA currency. Bookkeeping that relies exclusively on theoretical budgets is always less reliable.
- ***Energy in LCAs***: since a lot of environmental impacts are due to the utilization of fossil energy sources and its consequences (global warming, …) and these have been researched in detail, energy is awarded a lot of importance in LCAs. In comparison, impacts related to soil erosion or

fertility must be assessed individually, as they vary highly from region to region. However this regional variation weakens their weight in our globalized world. Incineration has the added advantages of fully exploiting the energy potential of the input material.

- ***The value of the OM in compost or digestate*** can be partially accounted for by considering it as a replacement for peat. In Switzerland, the use of peat in agriculture is negligible. So instead, we considered compost a substitute for straw. Naturally, this means also taking into account the replacement of all the upstream processes necessary to obtain the peat (incl. the exploitation of non renewable resources) or the straw (incl. the use of pesticides, etc.). This results in very high credits for compost or digestate.
  What we have not yet been able to quantify satisfactorily is the quality of the OM. We postulated here a degradation of the straw and peat to 50% of the original OM. This means that the compost OM replaces a double amount of OM originating from straw or peat. We postulate that the positive aspects of disease suppressivity and reduced erosion are then also covered by this higher quality awarded to the organic matter of compost our digestate (which is the stabilized OM remaining after degradation / neoformation processes).

In the case of our own LCA (ERZ), despite these improvements in the evaluation of compost, the comparison with waste incineration with optimised energy recovery still remained unfavourable to composting. If, however, the energy (or even only the part

liberated as heat) is not recovered, then incineration loses its advantage.

One problem still remains to be solved: contrary to classical accounting, LCAs are primarily a way of evaluating negative impacts (debits) and not of assessing benefits (credits). Therefore all pollutants, such as heavy metals for example, are assessed negatively, even if, at certain dosages, they might also actually become positive trace elements (Zn, Cu, …). Moreover, positive aspects are often difficult to assess or demonstrate quantifiably.

Closing the triangle

The multi-attribute utility theory (MAUT) has shown its usefulness as a tool to integrate the three sides of the sustainability triangle, the environmental, economic and social aspects of a process or system. The results of LCAs can be integrated into such higher-order analyses. MAUT can integrate positive assessments that are not scientifically provable (such as the social effects of a composting project).

Thus it is a well-known fact that composting is in most cases very advantageous economically. This is why, even though most LCAs carried out in the last 10 years did not place composting first, people continue to compost successfully all over the world.