LCA comparison analysis of the thermal processing of waste streams in the clinker production vs. incineration of these waste streams in belgian waste incinerators4

Comments of the first rewiewer

0. Goal and scope of these comments

TNO, the Netherlands organisation for applied scientific research, and Neosys have been contacted in order to provide a study to both FEBELCEM and the Flemish regional authorities which should be the common objective and scientific basis allowing the comparison of incineration and co-processing of waste from an environmental perspective.

TNO and Neosys agreed on a common idea of how to elaborate such a study and of an internal distribution of the necessary work. In this collaboration TNO has done the LCA modelling, the data collecting and the calculations and written the necessary reports. Neosys has contributed to the LCA work by continuously discussing and questioning the different results achieved. Thus, Neosys acts as a first reviewer of the study and states a kind of quality assurance.

Neosys has been contacted because of its specific experiences in this kind of study and because of its geographical and political distance to the problem. Combining the high scientific reputation of TNO and the independency of Neosys seems to be an attractive formula to win a high acceptance of the results of the study.

The following comments refer to the study in its state of July 31st 2007 (Draft report D04).

1. General LCA approach

The chosen LCA approach is correct and according to standards. The phases:

- Goal and scope definition;
- Gathering and analysis of the inventory
- Impact assessment
- Weighing
- Interpretation and reporting

are worked out in a clear and transparent way. The definition of the boundary conditions and the compensation effects in order to obtain a correct comparison has been made very carefully and we agree to it.

The choice of CML2 as the method of impact assessment seems suitable to us. However, as we do not have much experience with CML2, we apreciated much the performed parallel calculation with EcoIndicator 99 which showed the same results. This gives a very high confidence in the correctness of the chosen method.

2. Weighing and the conformity of the study with ISO 14044

During the project sessions there was an intense debate on the conformity of the study to ISO 14044 if a method of weighing of the different impact indicators is applied. We repeat here our statements:

- A method of aggregation of the different indicators must be applied to make the study comprehensible. A decision about the application or not of a tax to waste coprocessing must be based on an aggregated judgement on the overall ecological performance of waste coprocessing. It could not be based on a comparison of 9 different indicator results which are hardly understandable for the decisionmaker.
- The chosen method of shadow cost is very suitable for the given problem because it takes as a base the situation of environmental action in a country. Since taxation of a certain handling of waste is actually a way of realizing an environmental policy the chosen aggregation reflects exactly the problem to decide on: If e.g. the study shows that coprocessing of a certain waste saves X Euro per ton shadow cost compared to incineration, this can be directly taken into account to decide on applying a tax of Y Euro per ton to one or the other method of waste elimination.
- Since any kind of aggregation / weighing is always subjective it must be made explicitly and transparently and the results of the analysis before weighing must be given in the study. This has been done correctly.
- ISO 14044 explains weighing and clearly allows it as a method to facilitate the interpretation of the results of an LCA study. As VITO argued in the discussions ISO 14044 prohibits weighing if a comparative LCA study is addressed to a general public. The idea behind is to prevent for the abuse of LCA studies which could occur when results are given to an uncritical public which doesn't have the means for independent interpretation. We think that this does not apply to our situation. This LCA comparison is not addressed to a general public but to decisionmakers for a tax, i.e. to people that have enough means to interprete the study independently.

As a result we think that the study is conform to ISO 14044 and that weighing has been applied correctly and in a very suitable way.

3. Choice of the waste. Representativity

There was a big debate on the representativity of the chosen waste streams. Finally, 5 waste streams have been chosen, which cover 91% of the mass input or 83% of the caloric input of wastes in Belgian cement kilns. We acknowledge that the question of representativity of the analysed wastes with respect to all wastes burned in the cement plants is important for the decisionmakers if you start from the idea that the tax would be applied equally to all wastes being burned there. However, the question of representativity does not affect the LCA study itself. The LCA study gives a comparative result to any waste given as an input if only it is clear to which incinerator the comparison has to be done.

Thus, we do not comment the representativity of the chosen waste steams. We would rather advise the decisionmakers to discuss the question of taxation for different wastes seperately and depending on their individual result out of the LCA comparison analysis.

4. Modeling of the inventory

The basic principle applied to obtain an inventory of relevant environmental impacts is the idea of marginal changes. Following this idea one additional ton of waste is used in the analysed process and replaces there an equivalent amount of fuels and/or raw materials. The impact is then calculated from a comparison of the emissions in both cases. We agree generally with this approach. However, it must be clear that the emissions regarded really depend on the input. This is not so for several substances. E.g. for NO2, the NO2 emission of the cement kiln does mainly not come from oxidation of the N-Input, but from oxidation of air-nitrogen in the high-temperature flame. Therefore the NO2 emission is much more dependent on the flame temperature than on the nitrogen input via fuels. So the replacement of a fuel by a waste can lead to lower NO2-emissions even if the N-content of the waste is higher, because of a lower flame temperature. For NO2 this effect has been taken into account in a good and conservative way. A similar effect applies for SO2: The SO2 emission of the cement plant is strongly dependent on the sulphur content of the raw material and not so much on the sulphur content of the fuels. This is because the fuel-sulphur is transferred into SO4 due to the high temperatures and oxigen content in the kiln. It remains afterwards in form of sulphates in the clinker. On the other hand sulphur in the raw material is slowly heated in the preheater cascade and will eventually oxidize and evaporate in form of SO2 before it enters the kiln. For SO2 we can not reproduce the reported transfer coefficient, however it seems plausible to us.

There are some other transfer coefficients we could not reproduce or not identify in the reported data. These are the coefficients for mercury, for VOC's and for the carbon content of the waste transferring into CO2.
For these transfer coefficients clarification requests are presently still pending.

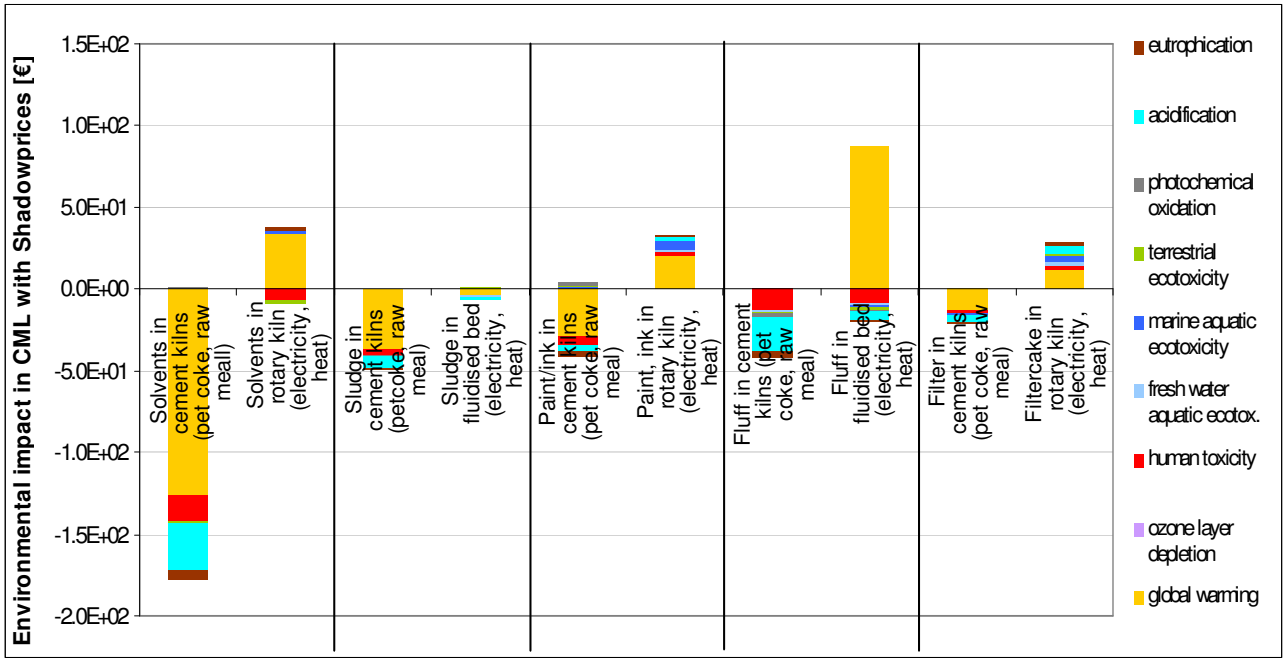
TNO: The transfer coefficients for the cement industry have been sent under the confidentiality agreement. These factors will not be published as febelcem whishes to keep these confidential.
The emission of VOC as a result of pre-treatment of waste is described in paragraph 3.2 in the report
The CO2 emissions per waste type are added to table 2 in Annex 1.

5. Plausibility Check of the results based on a Neosys model (2004)

For a rough estimation of the plausibility of the TNO results – especially for the chosen inventory model – we have made a test run of our 2004 transfer model / Eco-Indicator 99 impact calculation with the given data of the 5 waste categories. The result and its comparison to the TNO result is shown in the table on the following page. There is a generally very good confirmation of the TNO results.

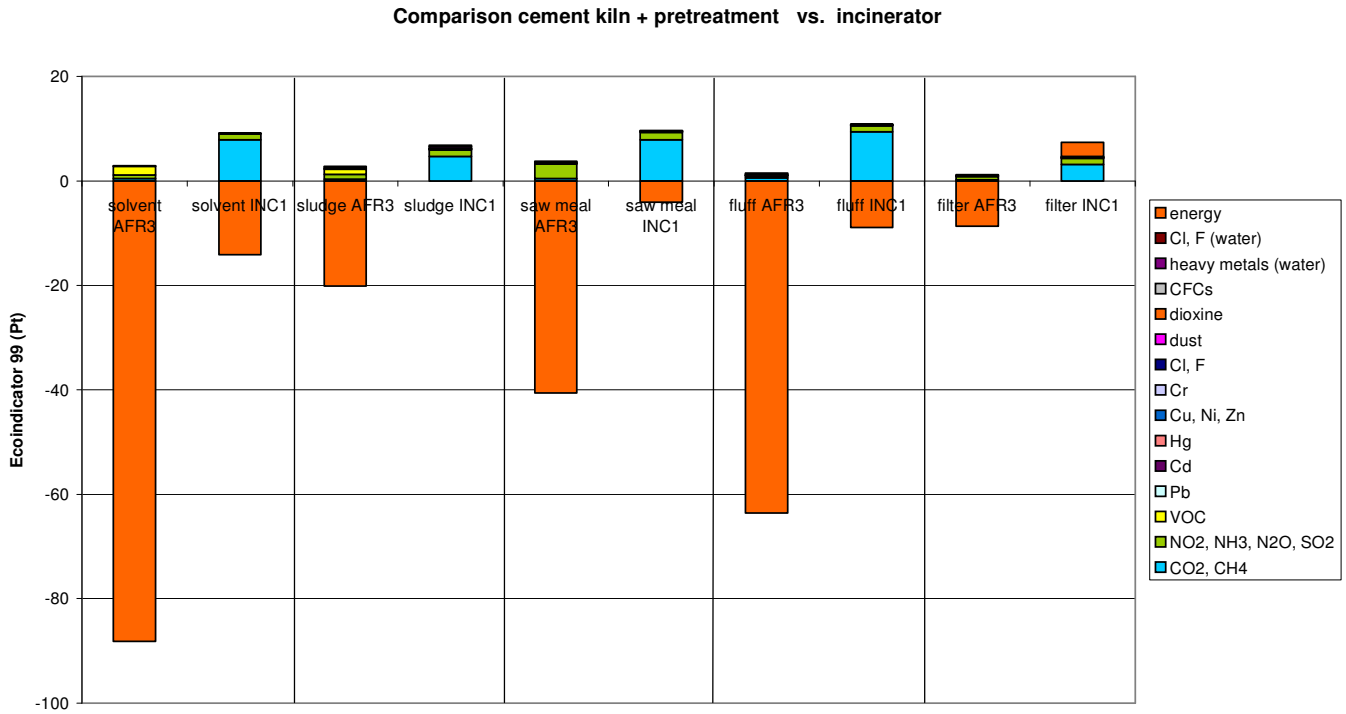
There are some methodological differences which lead to an other scaling and we do not show the contributions of the different impact parameters but the contributions of the different emissions and consumptions. We used a Lepol cement kiln and a pretreatment facility of which we adapted the VOC-emission to be what we expect approximately from the Geocycle plant. We used a rotary waste incinerator kiln type Indaver. As for the wastes we used the given input information of the 5 waste categories and we added estimated values for the VOC and C content of the wastes. On the other hand our model did not make use of the informations about the elements As, Sb, V and Tl.

Apart from our discussions with the TNO representatives and the feeling that we got a common understanding of the problem this check-up with its very well reproduced results gives us a strong confidence in the correctness of the assumptions and calculations in the TNO model and therefore in the accuracy of the results.



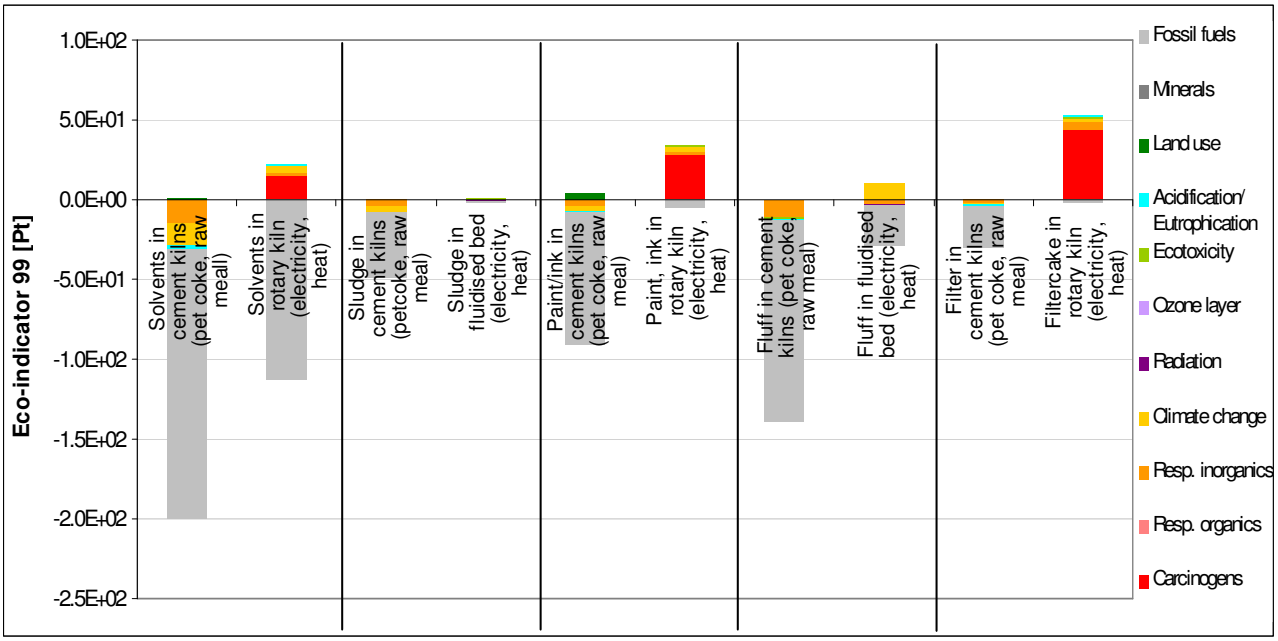
LCA result for 5 waste categories. Calculation witht **TNO inventory**, **CML2 impact assessment** and **weighing with 'shadow cost'**.

Left column is always co-processing in the cement system, right column is incineration in the corresponding Belgian incinerator.



LCA result for 5 waste categories. Calculation with **Neosys 2004 inventory**, **Ecoindicator 99 impact assessment** and **weighing according to Ecoindicator 99: 40:40:20**.

Left column is always coprocessing in the cement system, right column is incineration in an 'Indaver-type' rotary kiln.



LCA result for 5 waste categories. Calculation with **TNO inventory**, **Ecoindicator 99 impact assessment** and **weighing according to Ecoindicator 99: 40:40:20**.

Left column is always co-processing in the cement system, right column is incineration in the corresponding Belgian incinerator.

6. Sensitivity analysis

A sensitivity analysis has been applied to the results of the LCA. The variations of input data and system parameters have been chosen carefully and according to the uncertainties of the system. Especially we appreciate that the following parameters have been variated and the sensitivity of the system to these variations have been evaluated:

- the contents of heavy metals, halogenes and sulphur in the waste
- the carbon content and the caloric content of the waste (applied to fluff)
- the VOC content of the waste (applied to paint/ink/impregnated saw dust) resp. the transfer coefficient of VOC of the pretreatment

The LCA results of the variation cases show no significant difference. This means that the basic conclusions that are taken from the study are stable and that one can have confidence in them even if the uncertainties in the data and system parameters are taken into account.

7. Summary

We believe that the results of the LCA comparison analysis given in the draft report of july 31st are generally accurate and correct.

This belief is based on:

- Good discussions with the authors which led to a common understanding of the problems
- Agreement with the principles and methods chosen to perform the analysis
- Taking into account of our remarks by the authors during the establishment of the analysis

- Very good global reproduction of the results by a run of our own and independent LCA method

For economical reasons we did not checkup every single point or calculation from bottom to top. We checked points of crucial influence and points where mistakes seemed more likely than elsewhere.

Some of our clarification requests are still pending and we would like to comment on the transfer coefficients once more, after annex 2 is finalized.

July 31st 2007

Dr. Jürg Liechti