THE INCREASING IMPORTANCE OF ENVIRONMENTAL THINKING THROUGH LIFE CYCLE ASSESSMENT

Authors: Mr. T. Blomberg and Mr D. Lyall on behalf of the European Bitumen Association

Keywords

Bitumen, Bituminous membranes, Environment, Life Cycle Assessment, Eco-profile

ABSTRACTS

The general public and public authorities increasingly express concerns and demand information regarding the environmental impact of industrial activities.

Society has the right to ask for this information and industry must plan for a future where there will be an ever increasing spotlight on environmental issues.

Life Cycle Assessment[LCA] is considered by the European Union to provide a sound methodology for describing environmental impact.

This paper describes the LCA methodology and the relevant ISO standards.

Eurobitume has developed a Life Cycle Inventory or "eco-profile" for bitumen which is part of the process of developing an LCA for a bituminous application.

The paper provides examples of LCA studies for the road sector to illustrate the method and describes ongoing work with asphalt contractors to provide a tool to assess environmental impacts for road applications.

Eurobitume would like to carry out a similar project together with the IWA and representatives of polymer manufacturers to develop a tool for bituminous membrane manufacturers.

Auswirkung von industriellen Aktivitäten auf die Umwelt.

Die Gesellschaft hat das Recht auf Informationen und die Industrie muß sich darauf einstellen, daß die Umweltfragen immer mehr in den Vordergrund rücken.
Zur Beurteilung des Umwelteinflusses wird in der Europäischen Union die Ökobilanz als geeignete Methode in Betracht gezogen.

Das beiliegende Papier beschreibt die Grundlagen zur Erstellung einer Ökobilanz und die entsprechenden ISO Normen.

EUROBITUME hat eine Ökobilanz für Bitumen entwickelt, die als Grundlage für eine Bilanzierung von bitumenhaltigen Produkten dienen soll.

Das Papier enthält Beispiele für Ökobilanzen im Bereich des Straßenbaues. Damit wird eine von EUROBITUME und der Asphalt Industrie entwickelte Methode dargestellt, mit der man die Auswirkungen durch den Straßenbau auf die Umwelt beurteilen kann.

EUROBITUME würde gerne zusammen mit IWA und den Herstellern von Polymeren ein ähnliches Projekt durchführen, um für die Bitumen-Dach- und Dichtungsbahnen ein Beurteilungsverfahren zu entwickeln.

WRITERS

The authors present in this paper the work of the members of the European Bitumen Association "Eurobitume". Further information can be obtained from the Central Secretariat c/o Madame Viviane Dupont, Tour Madou 1/25, Bruxelles or from the website www.eurobitume.org

The increasing importance of environmental thinking through life cycle assessment

INTRODUCTION

Environmental awareness has grown considerably during recent years.

Une importance croissante de la réflexion sur l'environnement à travers l'évaluation du cycle de vie

Le public en général et les autorités expriment de plus en plus leurs préoccupations et leur besoin d'information concernant l'impact sur l'environnement des activitées industrielles.

La Société est tout à fait en droit d'exiger cette information et l'industrie doit se préparer à ce que les questions environnementales se retrouvent sous le feu de projecteurs encore plus puissants à l'avenir.

L'évaluation du cycle de vie (ou LCA, de l'anglais Life Cycle Assessment) est considéré par l'Union Européenne comme une méthodologie judicieuse pour décrire l'impact environnemental.

Cette communication décrit la méthodologie du LCA ainsi que les normes ISO correspondantes.

Eurobitume a élaboré un inventaire du cycle de vie ou éco-bilan pour le bitume, qui constitue une partie du processus du développement du LCA pour une application bitumine use.

Cette communication fournit des exemples d'étude LCA dans le domaine routier pour illustrer la méthode et décrit le travail poursuivi par Eurobitume en association avec l'industrie des enrobés bitumineux afin de mettre au point un outil d'évaluation de l'impact sur l'environnement des applications routières du bitume.

Eurobitume est prêt à s'engager dans un projet similaire avec l'AIE et les représentants des producteurs de polymères pour développer un outil à l'usage des producteurs de membranes bitumineuses.

Wachsendes Umweltbewußtsein durch Beurteilung der ökologischen Bilanzierung. (Life Cycle Assessment, LCA)

Die breite Öffentlichkeit und die Verwaltungen äußern zunehmend Besorgnis und fordern über die Informationen

Auswirkung von industriellen Aktivitäten auf die Umwelt.

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INTRODUCTION

Environmental awareness has grown considerably during recent years.

Industry has been confronted with an ever increasing demand for information about the management of its environment.

The general public has concerns about a wide number of environmental issues such as the safety of plant, transport and products, pollution, and global sustainability. These concerns grow as awareness of environmental matters increases.

Public authorities increasingly demand information regarding the environmental impact of industrial activities.

Society has the right to ask for this information and industry must plan for a future where there will be an ever increasing spotlight on environmental issues.

If the concerns and demands are not addressed then new plants and expansions will be blocked and new products will be rejected. There will be growing regulation and environmental taxation. Insurance and financing costs will rise. And a poor environmental image will make it difficult to attract new people into the industry. Thus it is in the self interest of industry to work for the environment.

For our industry to be successful in the future it must demonstrate that it understands the environmental impact that it makes. Life Cycle Assessment is considered to provide a sound methodology for describing environmental impact.

The purpose of this paper is to describe this methodology and to report on the actions which Eurobitume has taken with bitumen users in the road sector to provide a tool to assess environmental impacts.

What is Life Cycle Assessment?

Life cycle assessment [LCA]is a relatively new technique, which aims to account for the environmental burdens created by a product or a service throughout its whole life cycle – "from cradle to grave". The technique had its origin in the energy studies in the late 1960s and in the early 1970s. Today it is a developed, standardised tool for environmental assessments.

LCA evaluates from the environmental point of view all the resources and inputs needed for the system studied and all the outputs from the system, which are emissions to air, water and soil. LCA does not address the economic or social aspects of a product. LCA covers the whole product system from raw material acquisition, transportation, material and product manufacture, product use and maintenance and recycling to final disposal.

LCA provides a new point of view towards a product system and it can totally change the market profile of the product. A very bad eco-profile can even destroy a product. In the future environmental costs will be more and more transferred to the product price. So it will be beneficial to produce and buy products with lower environmental costs.

LCA may be utilised for several purposes:

- To identify opportunities to improve the environmental aspects of a product and to find out the weak points in the product chain, where the changes are needed.
- For selection of relevant indicators of environmental performance.
- For product development for environmentally better products.
- For decision making in governmental organisations.
- For product comparisons and product selections.
- For development of specifications, regulations or purchase routines.
- For marketing

The European Union has selected LCA method as one of the "official" methods for environmental evaluation. Also the European standardisation organisation, CEN, has highlighted the importance of the environmental aspects. CEN recognises that every product has impact on the environment during all phases of its life and it has started a system, where new product standards are attached with a temporary environmental annex to each product standard. For this annex LCA is a central tool.

LCA methodology and ISO 14 040 series

The standardisation of LCA methodology is under preparation. The first two standards in the ISO 14 040 series have already been published and the two others are under debate. The standards are:

ISO 14 040 Life cycle assessment – Principles and framework.
ISO 14 041 Life cycle assessment – Goal and scope definition and inventory analysis.
ISO 14 042 Life cycle assessment – Life cycle impact assessment.
ISO 14 043 Life cycle assessment – Life cycle interpretation.

The LCA method can be divided into three basic steps: goal and scope definition, inventory analysis and impact assessment as illustrated in figure 1.

The methodology for the two first steps is relatively well established while the third step of impact assessment is more difficult and controversial.

Goal and scope definition and inventory analysis are usually referred to as the Life Cycle Inventory or LCI.

This part of study can be done separately without impact assessment. If the inventory part of the study is not driven to the final disposal, but to a certain stage of the product life cycle, for example polymer pellets at the factory gate, the study is called as a partial life cycle inventory or eco-profile. This is what many of the producers prepare from their own product, because the product route is know and managed by the producer to this point. The user of the product may further build on the eco-profile and calculate his own eco-profile depending on his specific application.

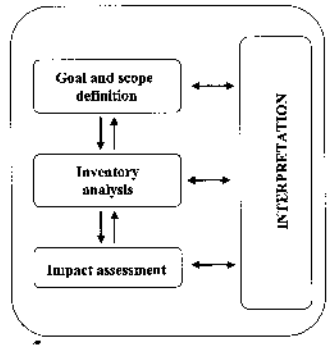

Figure 1. Life Cycle Assessment framework according to ISO 14 040

The first step in the LCA method is the goal and scope definition. The goal definition states clearly the intended application of the study, the reasons for carrying out the study and the intended audience.

For the scope the following items should be clearly described:

- The product system to be studied.
- The functional unit.
- The product system boundaries.
- Allocation procedures, assumptions made and limitations.
- Data requirements.

The second step in the LCA method is the inventory analysis which involves data collection and calculation procedures to quantify inputs and outputs of the system. These inputs and outputs are the use of natural resources e.g. raw materials, use of energy and emissions to air, water and soil.

The life cycle inventory must be clearly described and the system must be transparent. This includes especially the scope of the study, assumptions made, limitations, data sources and data quality and calculation principles.

The third step of the life cycle assessment, impact assessment, is qualitative by nature. It is difficult and the methodology is still under development. At this stage the process followed is to evaluate the significance of environmental impacts by associating inventory data with specific environmental impacts and attempting to understand those impacts. But there are no generally accepted methods for associating inventory data with specific environmental impacts. So this part of the process is generally not included in environmental impact assessments.

Life cycle assessment studies are always iterative processes, where interpretation of the results is done all the time. This may have an effect on the earlier parts of the study, which may be revised based on later findings. Findings in the interpretation phase may also lead to conclusions and recommendations to take improvement actions. Directly the LCA process does not give any final answers or improvement plans. Normally the

result of the LCA process is one of many factors affecting a final purchasing decision like technical performance, economic and social aspects.

Life cycle assessment studies – examples for bituminous products

There have been two examples of LCA studies made on bituminous products for asphalt pavements, namely a Swedish "IVL study" from 1995 financed by the Swedish Road Authorities and a Finnish "VTT study" from 1996 financed by the cement industry. The Finnish study was a direct comparison between asphalt and concrete pavements. The Swedish study included a comparison, but this was not the main point of the study.

The comparison below, taken from these two studies, gives an example of how to compile a goal and scope which are the first steps of an LCA.

	IVL-study	**VTT-study**
Functional unit	1 km road	1 km road
Pavement width	13 m	8,5 m
Construction	Stabilised soil Base course 1,5 m Asphalt 8 cm	Base course 1,9-2,5 m Asphalt 24 cm
Traffic	ADT 5 000 Not included	ADT 20 000 Included
Time period	40 years	50 years
Lighting	Included	Included
Construction work	From virgin land to final road	Base course and pavement
Operation	Sanding & salting Snow ploughing Grass cutting Ditch maintenance Traffic sign cleaning etc.	Salting
Maintenance	Six operations /40 year	Six operations /50 year

Table 1. Comparison of the scopes of the IVL- and VTT-studies on asphalt pavement.

The results from the comparison between asphalt road and concrete road shown in fig. 2 below are rather good for asphalt. Asphalt construction showed lower figures in almost all the major emissions and energy use. Street lighting has a large effect on the total energy consumption and this may effect on the conclusions made from the different studies.

When comparing the impact of the pavement or the whole road construction with the impact of the traffic moving on the road during the whole time period, we can say that the traffic makes 95...99 % or even more of all the emissions and energy use. So if we can diminish traffic emissions by a few percent by having a better pavement we have made an environmental impact.

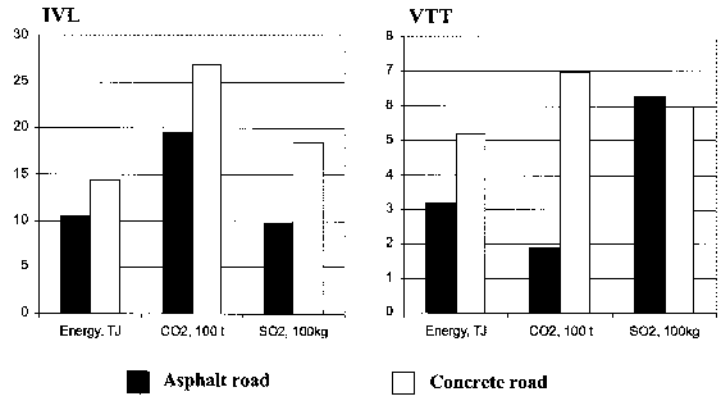

Figure 2. Results from the Swedish and Finnish LCI studies. Energy use and emmissions to ait per 1km road during the calculation period.

Inventory Analysis for Bitumen the eco-profile

Eurobitume started as one of the first producer organisations in the oil sector to do life cycle assessment studies. Bitumen producers saw clearly the increasing importance of environment for modern society. Our customers needed an environmental evaluation of bitumen for the calculations of their own products. Also authorities and official organisations started to ask for environmental data about the products. Therefore Eurobitume started a project with all the bitumen producers to make an eco-profile for a typical European paving grade bitumen. The reasons for making an average profile and not to have tens of different profiles were several:

- We wanted to have all the producers involved in the process and to teach the LCA methodology to all our members.
- We wanted all the producers to use the same methods and principles when making their own eco-profiles.
- We wanted to save resources, because the LCA process, especially the data collection, is very laborious.
- We wanted to prevent unsound competition with eco-profiles made with different principles.

Our project took several years and it was a long learning process. One of the major difficulties was to get relevant data and when data is available to determine how accurate and representative it was. Figure 3 illustrates the system boundaries for the project.

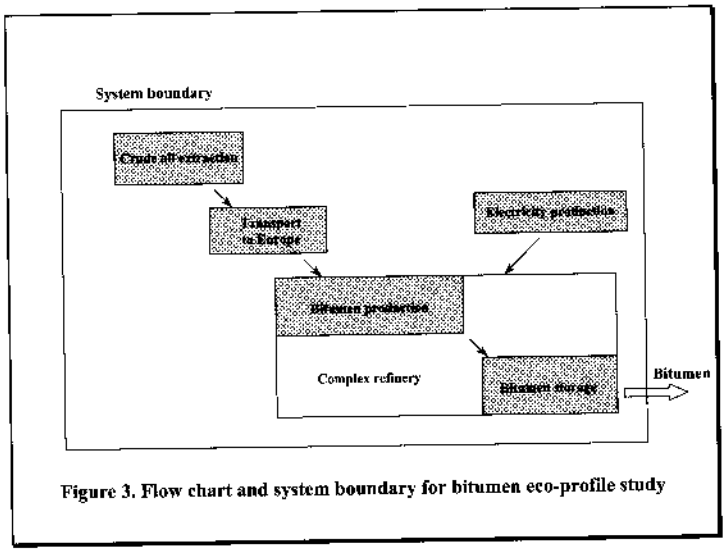

Figure 3. Flow chart and system boundary for bitumen eco-profile study

Inventory Analysis for bituminous products used in the road sector

The European Asphalt Pavement Association EAPA and Eurobitume started a joint LCI study for an asphalt pavement in 1998.

The project has been performed by The Swedish Environmental Research Institute.

The target of the study is:

- To develop a model for LCI calculations.
- To collect base data from the paving process for the companies for their own calculations.

During the project a Microsoft Excel based calculation tool was developed. This gives huge flexibility to the user to make his modifications to the system. The tool can be used easily by a LCA expert, because the system contains a huge amount of asphalt data. The tool can also be used easily by an asphalt expert, because the system contains also a huge amount of environmental data. The user may accept the typical data suggested or he may select more suitable data for his case from the database or he may use his own data if that is available. The tool will be ready and available for the EAPA and Eurobitume members at the end of this year.

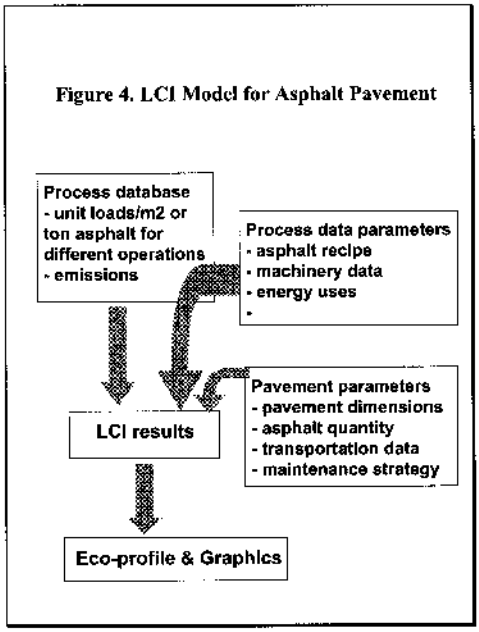

Figure 4. LCI Model for Asphalt Pavement

The model illustrated above in figure 4 contains three databases and calculation algorithms. Pavement parameters contain the specification of the studied pavement like pavement area, asphalt quantity, maintenance operations during the calculation period. Process parameters contain energy uses and emissions from different engines and recipes of asphalt,

with this data process database is calculated. In the process database there are energy uses and emissions from different operations per produced asphalt ton or laid asphalt m^2. Then LCI results are calculated and some graphics are automatically drawn to help to demonstrate the result.

The new tool will help asphalt producers to study closer their own specific paving projects and it makes possible to compare alternatives for a better environment.

Eurobitume strongly recommends the development of a similar tool for the manufacturers of bituminous membranes. This will need the active involvement of all users groups involved in the manufacture of the membrane and we are discussing with IWA if they will join us in this project.

Summary

The general public and public authorities increasingly express concerns and demand information regarding the environmental impact of industrial activities. Society has the right to ask for this information and industry must plan for a future where there will be an ever increasing spotlight on environmental issues.

The European Union has selected the Life Cycle Assessment methodology as one of the "official" methods for environmental evaluation

Eurobitume has developed a Life Cycle Inventory or "eco-profile" for bitumen. This eco-profile is available for the users of bitumen.

Eurobitume has developed jointly with EAPA[European Asphalt Pavement Association] a new tool which will help industry to study closer specific paving projects and make it possible to compare alternatives for a better environment.

Eurobitume would like to carry out a similar project with the IWA to develop a tool for bituminous membrane manufacturers.

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