Environmental Impact of Membrane Materials and Structures

THE NEW TENSINET WORKING GROUP ON LIFE CYCLE ASSESSMENT FOR MEMBRANES

Increasing energy efficiency in the operation of buildings is a major challenge of our time. But we also have to focus on the energy consumption ("grey energy") and environmental impact of the materials and structures used for our buildings - with regard to their full life cycle, from the production to recycling or disposal. It is important to understand that the effects of our planning decisions extend deeply into the future. Most buildings are meant to last for decades. Our industry is proud to also offer this perspective to our clients when they embark on our materials and structures. In parallel, the planet’s resources are shrinking and get more and more contested and hard-fought. Compared to other industry branches, the building sector is still lacking efficiency in the use of materials and rationalisation, the overall recycling rate is very low. With regard to the membrane industry we see a Janus-faced discussion: On the one hand we apply polymers that use enormous amounts of energy for their production. They contain a high amount of primary energy in relation to their mass (Fig. 1), and emissions from some of the materials can represent dangers for the environment and users. On the other hand, they have an undoubted potential for generating resource and energy savings through forms of construction that utilise these materials very efficiently. Membrane material’s mass per area is very low.

Life Cycle Assessment (LCA)

Some months ago, a new working group has been founded by an initiative of the author which will focus on the subject of Life Cycle Assessment (LCA) in our industry. The aim of this group is to review the current status on membrane materials and typical membrane structures with regard to LCA issues which can be used as a key evaluation criterion in the objectification of the discussion on membrane materials that our industry is based on (Fig. 2). The LCA approach aims for a transparent evaluation of the complex environmental impacts of products and processes involved. It looks at the stages of material or structure’s life such as obtaining the raw materials, production, processing and transport, also use, reuse and disposal if applicable. LCA measures environmental impact across a range of issues such as impact: on air quality, on water usage and water quality, on toxicity to human life and to ecosystem functioning, on impact on global warming as well as resource use. There are "cradle-to-grave" assessments that investigate the entire life cycle of a product, but also "cradle-to-gate" assessments that consider only the life of a product up to the time it leaves the factory (Fig. 6). DIN EN ISO 14040 describes the LCA method which can be split into four phases: definition of goal and scope, inventory analysis, impact assessment and interpretation (Fig. 3). In a final step all results like reports and declarations have to be scrutinised by an independent group of experts which is essential if comparative statements, e.g. with respect to rival products, are to be made or the results are to be made public. Environmental Product Declarations (EPD)

Drafting a product LCA is a time-consuming and expensive process that is generally carried out for the product manufacturer or a group of manufacturers by a specialist company. The ecological characteristics of a product are communicated in the form of environmental declarations. According to the ISO 14020 family, these environmental product declarations (EPD) are classified as so called “type III” environmental labels which are highly regulated. Here, the most important environmental impacts of products are described systematically and in detail. The starting point is a product LCA, but further indicators specific to the product (e.g. contamination of the interior air) are also included. In this form of declaration it is not the individual results of measurements that are checked by independent institutes, but rather conformity with the product category rules (PCR) drawn up to ensure an equivalent description within that product category. An EPD describes a product throughout its entire life cycle – it contains all relevant environmental information. EPDs help in early planning stage, they show environmental performance of a product or a product group, they are often used in political discussion and can be a basis for a company’s internal benchmark and improvement.

Figure 1. Primary energy spans of individual building material groups, PEI in [MJ/kg]

Figure 2. Development of primary energy consumption for pneumatic structures with air pressure maintained by mechanical plant compared with a system without any air supply

Figure 3. The sequence and phases of a life cycle assessment (LCA)
Why we? And why now?
Why it is important for our industry to proactively address the LCA issue now? There are a number of drivers, for example:

- Building assessment systems with country-specific priorities for indicating the building’s performance and hence affects the operational energy use and the health and well-being of its occupants. Therefore, the industry needs to quantify these benefits in order to maximise its sustainability credentials.

Some more background
With the advent of the European single market for construction products, the European Commission became concerned that national EPD schemes and building level assessment schemes would represent a barrier to trade across Europe. The EU therefore sought a mandate from the EU Member States to develop European standards for the assessment of the sustainability performance of construction works and of construction products. This mandate is called CEN/TC 350. From 2010 European standards began to emerge from this process and Standard BS EN15804 was published in February 2012 providing core rules for construction product EPD.

Material and building component selection has a direct impact on the building design and performance and hence affects the operational energy use and the health and well-being of its occupants. Therefore, the industry needs to quantify these benefits in order to maximise its sustainability credentials.

Where we are and next steps
The status reached so far is rather heterogeneous and inconsistent for the typical materials we use. There are some forerunners, for example there is a first (but only company specific) EPD on ETFE (Fig. 5). On the level of structure types, there is hardly any information...
available so far. The LCA Working Group will identify and describe steps that could be taken within the Tensinet association to achieve a coherent data base to work with. It should also be as open and transparent as possible to gain a maximum of credibility.

Kick-off workshop
As a next step we will have a kick-off workshop in Stuttgart with LCA-consultancy PE International on October 11th/12th. Aiming to define goal and scope of a common project, our topics are:

• discussion and agreement on the goals of the LCA/EPD membrane project;
• specific, average or template EPDs, value of an EPD calculator?;
• clustering of comparable products for EPDs;
• definition scope of the work;
• proposal for products to be included (PTFE/glass, ETFE, PVC/PES, PTFE fabric, PTFE glass laminate, silicone glass fabrics, others?);
• agreement on producers and sites to be included;
• agreement on contractual and financial solution.

The idea of having a common successful LCA/EPD membrane project is based on some assumptions:

• joint project of several producers and other players of the membrane sector;
• for each product group there is at least one producer of final product involved and willing to contribute;
• for each product group the key producers of raw material are involved and willing to contribute;
• the project is managed by a neutral third party (PE International) to allow for confidentiality in data handling, producers will supply data in agreed time schedule.

Following the workshop we intend to structure the LCA project in the following tasks:

• Development / adaption of the PCR-Documents;
• Data collection for the production of Membranes;
• Data collection for the End-of-Life Scenarios;
• Provision and development of the upstream data (supply chain data);
• System modelling and calculation of the LCA results;
• Documentation of the LCA and development of the EPDs.

So far, there are amongst others the following manufacturers involved: Dyneon, Verseidag-Indutex, Serge Ferrari, Saint-Gobain PP, and Sefar. We hope that even more relevant and important players in the membrane world understand the chance of this project, also with regard to economical benefits compared to individual actions on the subject. Thanks to the Tensinet Board, the kick-off workshop will be free of charge to all the participants.

If you are interested to join us for the workshop or generally for the group, please contact the author via email (jan.cremers@hft-stuttgart.de).

about Hightex
Hightex Group is a specialist provider of large area architectural membranes for roofing and façade structures. Hightex has been involved in the construction of a number of high profile buildings including Cape Town Stadium and Soccer City Stadium in Johannesburg, the Wimbledon Centre Court retractable roof, the roof of the Suvarnabhumi International Airport in Bangkok. Recent projects include the new stadia of Warsaw, Kiev, Vancouver, and most recently Porto Alegre and Maracana in Brazil.

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REFERENCES

© PICTURES AS FOLLOWING:
4: DGNB/ PE International
5: Institut Bauen und Umwelt e.V.
6: taken from [2], p. 5

Figure 5. Company-specific Environmental Product Declaration for ETFE: EPD-VND-2011111-E, 10-2011

Figure 6. Life cycle of a construction product

‘Cradle to Grave’
Extraction
Recycling
Demolition
Refurbishment
‘Cradle to Cradle’
Manufacture
Transport
Construction
Maintenance