Universität für Bodenkultur Wien
Department für Wasser – Atmosphäre – Umwelt

Institut für Abfallwirtschaft

O.Univ.Prof.Dipl.Ing.Dr.techn. Peter Lechner
Muthgasse 107, A - 1190 Wien

Life Cycle Assessment (LCA)

Insulation System Thermowhite® compared to a conventional EPS insulation

Applicant

Thermowhite GmbH
Pyhrn 3
A-4582 Spital am Pyhrn
www.thermowhite.com

Contractor

Institut für Abfallwirtschaft Universität
für Bodenkultur, Wien Muthgasse
107
A-1190 Wien

Authors

Dipl.-Ing. Andreas Pertl
Dipl.-Ing. Gudrun Obersteiner

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Product Description Thermowhite®

Thermowhite® is an innovative insulation system which is based on recycled expanded polystyrene (EPS) mixed with a mineral binding agent consisting of portland cement and additives for a use as flexible floor insulation.

Life Cycle Assessment Framework

The LCA is done according to the methodology given in DIN ISO 14040ff in a simplified way as the end of life phase is outside the scope. All upstream chains of the production processes and transports are involved in the calculations. Data was collected directly at the producer and by using the ecoinvent® and GaBi-professional database. GaBi 4.2 was used as calculation software for the LCA. Datasets are from the year 2006 and younger.

The functional unit is 1 m² constructed floor.

Goal and Scope

Goal of the simplified LCA is the comparison of the insulation system Thermowhite® with a conventional system and to quantify the environmental benefits/disadvantages. As comparable system newly produced EPS insulation boards were selected. The scope of the study involves all necessary processes from raw material extraction to construction of the insulation systems including also the transports. The end of life phase was excluded due to the minor influence on the results of the comparison of the insulation systems as recycling or incineration can be applied and result in nearly equal results.

A specific characteristic of Thermowhite® is the possibility to produce a highly plane surface. Therefore floor screed thickness is reduced and the influence is also included in the comparison.

Due to the waste characteristic of the recycled EPS all emissions and material inputs from the production of EPS are allocated to the initial product (e.g. packaging, EPS insulation,…).

Material composition of the insulation systems for comparison

The following tables show the material composition for the construction of 1 m² floor and the material composition of Thermowhite®. For the comparison of the insulation systems the foil, tiling plaster and plaster fibre are not considered because of their equal quantity. Both insulation systems have an equal insulation quality (thermal conductivity = 0,818).

Table 1. Composition of 1 m² floor (considered materials in bold)

		Thermowhite®		EPS-Platten	
material	density (kg/m³)	thickness (mm)	mass (kg)	thickness (mm)	mass (kg)
floor screed	**1981**	**40,00**	**79,24**	**45,10**	**89,34**
PAE foil	1000	0,20	0,20		0,20
EPS insulation board	**20**			**58,00**	**1,16**
Thermowhite®	**118**	**53,50**	**6,31**		
tiling plaster	1007	5,00	5,04		5,04
plaster fibre board	1007	10,00	10,07		10,07

Data on the material composition of the different floor systems was given by the producer and is based on a report of a standardized test by a national certified laboratory.

Data on Thermowhite® was given by the producer. Due to corporate secrets the mineral binding agent was estimated as 100 % Portland cement. The content of additives is of minor relevance.

Table 2. Material composition of Thermowhite® in mass-%

materials	mass-%
recycled EPS	16%
mineral binding agent - Portland cement	48%
water	36%

Packaging materials are not considered within the LCA.

Production of materials and construction

The production process for Thermowhite® is based on producer information. Thus 22 kW are necessary for the production of 1500 kg Thermowhite® per hour. The production process includes shredding of the collected EPS waste and mixing it with the mineral binding agent. The mixing of Thermowhite® with water is applied directly at the construction site and done by a normal mortar mixer. The process for the mortar mixer as well as all other necessary production processes (e.g. production of EPS and Portland cement, material production and construction of floor screed,…) are taken from the ecoinvent®-database.

Waste resulting from EPS cutting, waste from the conventional insulation and EPS waste from shredding is estimated as being incinerated in a state of the art waste incineration plant. The produced energy is allocated to electricity and heat and is considered as emission credits compared to conventional energy production.

Electricity mix was taken from ecoinvent®-database and for Austrian conditions.

Transport

Transport distances for all necessary materials are estimated. The according emissions are calculated by using GaBi-professional datasets. All transports are assumed to be made by lorries. The following table shows the estimation of transport distances. All lorries are driven by diesel fuel. Diesel emission indicators are taken from the ecoinvent®-database. For the floor screed and Portland cement 28-34 ton-lorries are considered. All other materials are assumed to be transported by 7,5-12 ton-lorries.

Table 3. Transport distances for the materials

material	transport distance (km)
material for floor screed	50
portland cement	100
EPS for recycling	50
newly produced EPS boards	200
Thermowhite®	100
waste for incineration	100

Results

Table 4. Comparison of the insulation systems

		Insulation System		
		Absolute impact per m² floor		Relative impact Thermowhite® compared to EPS board
		Thermowhite®	EPS board	
Indicator	Unit	d = 53,5 mm	d = 58 mm	
Acidification Potential	kg SO_2 equ.	4,85E-03	1,82E-02	-73%
Photochemical Ozone Creation Potential	kg Ethen equ.	5,24E-04	1,15E-02	-95%
Ozone Depletion Potential	kg R11 equ.	1,03E-07	1,41E-07	-27%
Primary Energy Demand (non-renewable)	MJ	16,63	125,14	-87%
Primary Energy Demand (renewable)	MJ	1,73	0,51	70%
Primary Energy Demand (renewable and non-renewable)	MJ	18,36	125,65	-85%
Water	litre	20,06	30,49	-34%
Resource consumption	kg	25,01	32,45	-23%
Humantoxizitätspotential	kg DCB equ.	0,20	0,75	-73%
Global warming potential	kg CO_2 equ.	2,89	5,48	-47%
Eutrophication Potential	kg PO_4 equ.	7,14E-04	1,91E-03	-63%
Reuse of waste	kg	1,01	0	100%
Waste prevention	kg	-	-	-

Table 5. Comparison of the floor screed

		Floor screed for insulation type		
		Absolute impact per m² floor		Relative impact Thermowhite® compared to EPS board t
		Thermowhite®	EPS board	
Indicator	Unit	d = 40 mm	d = 45,1 mm	
Acidification Potential	kg SO_2 equ.	2,94E-02	3,31E-02	-11%
Photochemical Ozone Creation Potential	kg Ethen equ.	3,27E-03	3,69E-03	-11%
Ozone Depletion Potential	kg R11 equ.	5,39E-07	6,08E-07	-11%
Primary Energy Demand (non-renewable)	MJ	84,33	95,08	-11%
Primary Energy Demand (renewable)	MJ	3,84	4,33	-11%
Primary Energy Demand (renewable and non-renewable)	MJ	88,18	99,42	-11%
Water	litre	173,88	196,05	-11%
Resource consumption	kg	261,82	295,20	-11%
Humantoxizitätspotential	kg DCB equ.	1,30	1,46	-11%
Global warming potential	kg CO_2 equ.	14,05	15,84	-11%
Eutrophication Potential	kg PO_4 equ.	5,00E-03	5,64E-03	-11%
Reuse of waste	kg	-	-	
Waste prevention	kg	10,10	0	100%

Table 6. Comparison of the combination of floor screed and insulation system

		floor screed and insulation system		
		Absolute impact per m² floor		Relative impact Thermowhite® compared to EPS board
Indicator	Unit	Thermowhite®	EPS board	
Acidification Potential	kg SO2 equ.	3,42E-02	5,13E-02	-33%
Photochemical Ozone Creation Potential	kg Ethen equ.	3,79E-03	1,52E-02	-75%
Ozone Depletion Potential	kg R11 equ.	6,42E-07	7,49E-07	-14%
Primary Energy Demand (non-renewable)	MJ	100,96	220,22	-54%
Primary Energy Demand (renewable)	MJ	5,58	4,85	13%
Primary Energy Demand (renewable and non-renewable)	MJ	106,54	225,07	-53%
Water	litre	193,94	226,53	-14%
Resource consumption	kg	286,84	327,65	-12%
Humantoxizitätspotential	kg DCB equ.	1,50	2,22	-32%
Global warming potential	kg CO2 equ.	16,94	21,32	-21%
Eutrophication Potential	kg PO4 equ.	5,71E-03	7,55E-03	-24%
Reuse of waste	kg	1,01	0	
Waste prevention	kg	10,10	0	

Detailed Results

In the following Figure the influence of the life cycle phase production and construction are shown. The production of the materials including all upstream chains and transport processes has a significant higher influence than the construction process. For all other impact categories (e.g. acidification, eutrophication,..) the significance is nearly the same.

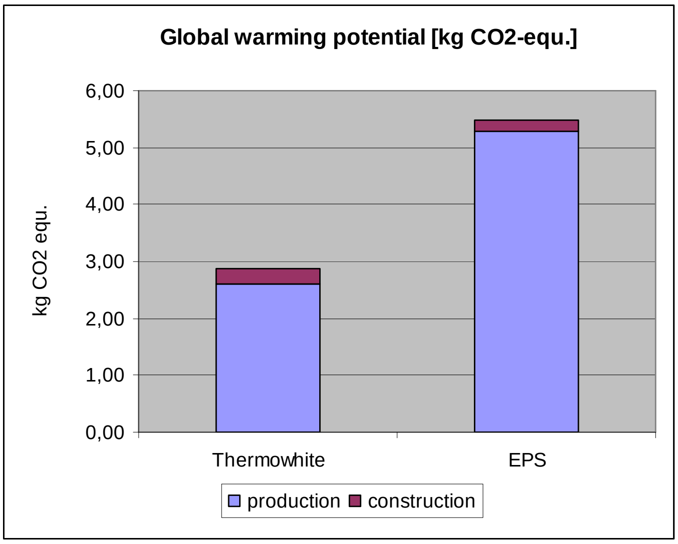

Figure 1. Global warming potential of EPS boards and Thermowhite® insulation systems

Including the advantage of the floor screed from Thermowhite®-floor system the overall results are higher but the effective lower environmental impact of Thermowhite® is also higher (e.g. Figure 2).

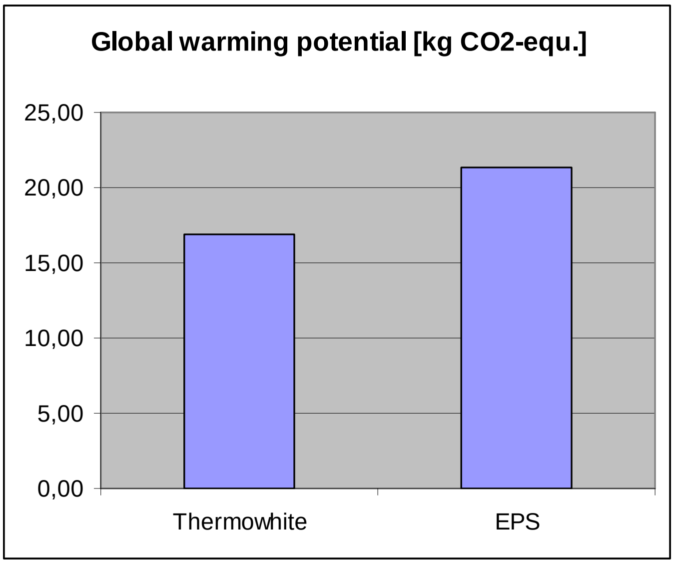

Figure 2. Global warming potential comparison of insulation systems and floor screed

Conclusion

Due to the waste characteristic of the Thermowhite® content of the recycled EPS, the environmental impact of Thermowhite® is significantly lower than the impact of newly produced EPS boards. The emissions related to the production of insulation materials are higher than the construction related emissions as well as the very low transport emissions.

Nowadays the conventional disposal of EPS is incineration but if developments in the future force the recycling and reuse of EPS except of Thermowhite® an additional study on the End of Life impact shall be done.