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Comparative LCA of Air Duct systems ISO 14040 and 14044

Abstract summary: *Environmental characteristics and environmental performance of products are becoming an essential aspect of communication and marketing in particular for the building sector. The concept of Life Cycle Assessment (LCA), defined by ISO 14040 and ISO 14044 standards, has grown to be the reference methodology in this kind of communication, in particular through the use of ISO 14025 standard (providing aggregated Environmental Product Declarations - EPD), and national derivative standards.*

Moreover, both in public and private sector, EPD are more and more used to assign tender. Hence, it becomes major for any company to be able to perform a Life Cycle Assessment of their products and services.In that context, Saint-Gobain has carried out many LCA studies of its products. Moreover, Saint-Gobain has set its own LCA team and written its EPD Methodological Guide) in accordance with ISO 14025, which is used as the reference document within the Group for all products EDP.

In order to enhance its knowledge about its products and the systems they are part of, Saint-Gobain has decided to go further and to carry out a comparative LCA of the following air duct system solutions, that include Saint-Gobain products :

- *Metal air-duct with outside-insulation (metal duct with CLIMCOVER)*
- *Metal air-duct with inside-insulation (metal duct with CLIMLINER),*
- *Self-supporting air-duct made with glass-wool (CLIMAVER neto)*

First considerations on the self-supporting solution of Saint-Gobain, CLIMAVER; lead to think that this solution may be less harmful for the environment. However, only a complete life cycle assessment can ensure an accurate and robust comparison of the CLIMAVER solution with other solutions involving metal ducts and insulation products from Saint-Gobain.

This study is made in accordance with the ISO 14040 and 14044 standards (LCA methodology standards: Principles & framework, Requirement & guidelines).

Its verifiable and quantitative results will be used in both internal and external communication. They will be used in particular for supporting the marketing communication on CLIMAVER and confirming the continuous environmental improvement of Saint-Gobain solutions. The intended audience will be all building project managers and specifiers (architects, mechanical and HVAC engineers, etc.).

LCA, air duct, ISO 14040, ISO 14044, ISOVER, life cycle assessment.

Life cycle inventory analysis

This part presents the data collection approaches used of this project. Since Saint-Gobain Group is thoroughly involved in the evaluation of environmental product declarations of their products, main data as well as LCI concerning Saint-Gobain products and their packaging elements were provided by the corporate environmental team of Saint-Gobain Group.

Indeed, process data were collected in 2011 by Saint-Gobain Group from Saint-Gobain Cristaleria Azuqueca production site through an Excel questionnaire. Process data for

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insulating products are 2010 production data and were modelled by Saint-Gobain to prepare the EPD of Climaver, CLIMCOVER and CLIMLINER products.

After a phase of review of the coherence of the assumptions of this project with parameters considered in the modelling of the studied products made by Saint-Gobain with the LCA tool TEAM™, new LCI were calculated by Saint-Gobain. Detail of this part of the modelling as well as data sources are presented in the following part of the report.

Description of process phases:

1) Production: Saint-Gobain products: Glasswool and facings are manufactured on Azuqueca site. The detailed process is described in the figure below.

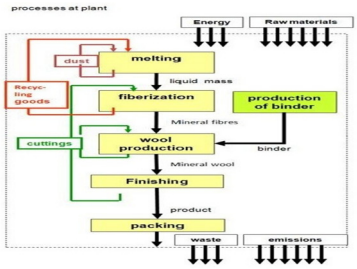

Figure 1: Insulated products production at Saint-Gobain plant

This step takes into account: the extraction and production of the raw materials, the transport of raw materials, the extraction, production and transport of all energy sources (fuels, natural gas, electricity…) used on site, the production of mineral wool, and the production of packaging.

Galvanized Steel ducts .The steel duct production step includes: the production of intermediary steel product (hot-dip galvanized steel) on a cradle-to-gate approach and the transport from the steel production site to the duct manufacture site.The manufacture duct phase is excluded, no data being available.Density of galvanised steel considered is 7 775 kg/ m^3 (density being between 7700 and 7850 kg/m^3).

2) Transport on construction site

CLIMAVER is transported as board and cut on the construction site. CLIMAVER is transported by pack of 7 boards with 12 packs per pallet (299, 98 m^2/pallet). 8 pallets (2399 m^2 of board) can be transported by one truck.There are three packaging options used to transport the CLIMAVER product. This study considers the solution named “en caja” which is the most conservative one since it required more packaging elements for the same quantity of boards. This solution consists in having 7 boards packed in one carton box. 12 boxes are grouped on one wood pallet and wrapped with PE ribbon. A specific wood pallet with dimensions adapted to CLIMAVER board is used.

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The retained packaging solution consists in: Carton box (5 kg each); PE Ribbon to wrap the boxes together (200 g to wrap 12 boxes); specific pallet, designed for CLIMAVER products (45 kg each)

CLIMCOVER is transported by rolls (19, 44 m2/roll). The roll is wrapped with a PE ribbon (0, 193 kg/roll) and transported on classical wood pallets (14 kg each). 20 rolls can be transported on one pallet. A truck can contain 18 pallets (i.e. 6998 m2 of Isoair product/truck).

CLIMLINER is provided by roll (24 m2 /roll) wrapped with a PE ribbon (0,193 kg/roll) and transported on classical wood pallets (14 kg each). 12 rolls can be transported on one pallet. A truck can contain 18 pallets (i.e. 5184 m2 of Intraver product/truck).

Galvanised steel duct: The duct manufacture site produces 1, 2 metre-long ducts that are transported vertically in a truck to the construction site.

3) Assembly.This step considers the specific consumptions and ancillary products for assembly.

CLIMAVER neto:
There are two different methods to manufacture duct assemblies:
• Straight Duct Method (recommended by Isover)
• Separate Module/ flat pieces method (traditional method).

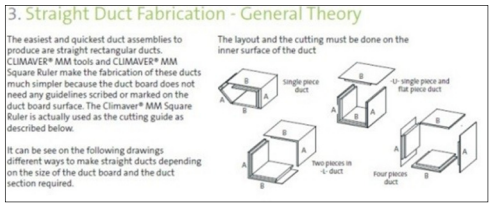

Figure 2: Extract of CLIMAVER installation manual

The assumption of the project considers the straight duct method. The length of contour required to make a 1, 19 long metre duct is: $C = P + e + l$ with

P = inner perimeter of the required duct, in this case: 2*(0, 2 m + 0,4 m)

e = 0,2 m, considering the thickness of the product (8*25 mm)

l = 4 cm, which is the overlap to fasten the duct.

In this case, to make a duct with a section of 0,2 m x 0,4 m, the width required should be :

C = (2*0, 2) + (2*0,4) + 0,2 + 0,04 = 1,44 m

With this approach and considering the format of CLIMAVER neto board (3 m x 1, 19 m i.e. 3,57 m²), it is possible to make two 1,19 metre-long duct per board of CLIMAVER. In order

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to make the reference flux which is a 20 metre-long duct, the quantity needed is 16,8 sheets of 1,19 m x 1,44 m dimensions

Based on information provided by Saint-Gobain, the maximum loss rate at the implementation phase of CLIMAVER product is 5 %. On a conservative approach, the study considers 5%.

So, the quantity of products will be: 16, 8 (1 + 5%) = 17, 64 boards of 1, 19 m x 1, 44 m or 30,23 m². In order to obtain this surface, the required quantity of CLIMAVER board is

30, 23 m² / 3, 57 m² = 8, 47 CLIMAVER boards of 3mx1, 19m

The product is delivered in box of 7 CLIMAVER board equivalent to 24, 99 m² per box so, the necessary quantity is 1, 2 box.

For its assembly, CLIMAVER requires the following tools and auxiliary materials:

- Tools: CLIMAVER tools such as square rulers, (with steel blades easy to be replaced), knife. The impacts for the tools will be neglected.
- Auxiliary products :
  - Perfiver H profiling (used to protect the edge of glass wool ducts in grid, machinery connections and inspections doors.) - not considered in the studied solution.
  - CLIMAVER neto tape: self-adhesive aluminium tape for sealing joints externally (pure aluminium tape 50 µm thick with resin-based acrylic adhesive). The adhesive has a nominal width of 65 mm. Presented in 50 metre long rolls in boxes of 12 rolls.
  - Staples (14 mm staples transported in 5000 staple box.)
  - CLIMAVER glue for non straight duct.

The quantities of auxiliary materials for the reference flow (20 metre-long straight HVAC CLIMAVER neto system) are: Tape: 44m, glue: 101g, staples: 538units

CLIMCOVER**,** in the case of CLIMCOVER, the formulae to calculate the length of contour to cut is: $C = P + 8\,x\,e + l$ with
P = inner perimeter of the required duct, in this case: 2 x (0, 2 m + 0,4 m)
e = 30, 6 mm, considering the thickness of the 30mm of ISOAIR and the 0,6mm of metal.
l = 5 cm, which is the overlap to fix the duct.

In this study case : C=2x(0,2+0,4)+8x0,0306+0,05 = 1,4948 m .Consequently, to insulate the reference flux of 20 metre-long, 16,67 CLIMCOVER sheets of dimensions 1,20 mx1,4948 m are needed
On a conservative approach, the loss rate considered in the study at the implementation phase is 5%. The quantity of CLIMCOVER becomes 16,67x (1+ 5%) = 17,5 sheets of 1,2 m x

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1,4948 m = 31,39 m². The product is delivered in roll of 19, 44 m² so, the necessary quantity is : 1,6 roll

As for galvanised steel, the solution requires 16,7 ducts of 1,2 meter long with inner dimensions of 0,2 m x 0,4 m (total volume will be 0,0144 m3 and mass will be 111,6kg).

The only auxiliary products required for the implementation of CLIMCOVER product are the same tape as for Climaver neto. The quantity necessary for a 20 metre-long duct is 44 m.

CLIMCLINER: There is no specific formula to calculate CLIMLINER length of contour to cut since there is no need of overlap.

$C = P$ with P = inner perimeter = 2x(0,2+0,4)=1,2 m. So the length of contour is C = 1,2 m
To insulate the reference flux of 20 metre-long.16, 67 CLIMLINER neto sheets of dimensions 1,20 m x 1,20 m are needed. A loss rate of 5% will be also considered to ensure an equivalent and conservative approach.

The quantity of CLIMLINER becomes 16,67 x (1 + 5%)= 17,5 sheets of 1,20 m * 1,20 m = 24 m².The product is delivered in roll of 24 m² so, the necessary quantity is : 1 roll

As for galvanised steel, the solution requires 16,7 ducts of 1,2 meter long with inner dimensions of 25 cmx 45 cm (total volume will be 0,0168 m3 and mass will be 130 kg).

The only auxiliary product required for the implementation of CLIMLINER product are adhesive pins (composition : 19 to 203 long and 2,7 mm of diameter nails in galvanised steel with adhesive 50 mmx50mm base made with polyethylene foam and resin-based adhesive closed by a 30 mm diameter clip in galvanised steel and a nylon protective cap). Based on the insulation product characteristics, 4 pins per m^2 of CLIMLINER to product are required.So, (4*24)= 96 pins are needed.

	Boards / rolls	Insulating Weight (kg)	Steel volume (m3)	Steel weight (kg)	Total weight (kg)
Solution 1	8,47	64,25	0,00	0,00	64,25
Solution 2	1,60	23,64	0,014	111,96	135,60
Solution 3	1,00	18,29	0,017	130,62	148,91

Table 1: Weight of the three solutions studied

4) Life in use and Maintenance

This step can be neglected. Indeed, there is no specific repair or maintenance required and the cleaning process can be manual (the methods are air sweep method, mechanical brush method, contact vacuum method).In this step, additional energy consumption due to energy loss for solutions with lower performance will be considered (basis will be CLIMAVER solution).

5) End-of-life

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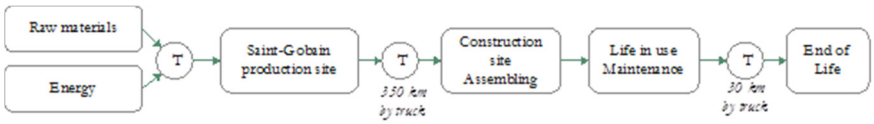
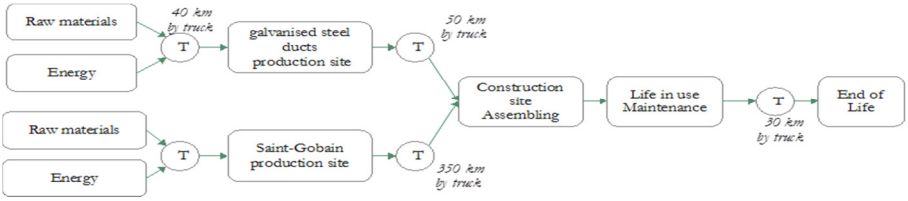
The insulating products (CLIMAVER, CLIMCOVER and CLIMLINER) will be dismantled and put into landfills. The distance from the demolition site to the landfill considered is 30 km. As for metal ducts, they will be recycled. The impact of steel recycling is already included in the steel production step since the Worldsteel Association took into account in the LCI of steel a recovery rate estimated at 85% based on average recycling rate from building sites. Distance to storage site before recycling has been considered to be 30 km as well.

Life cycle for CLIMAVER



Life cycle For CLIMCOVER and CLIMLINER



Calculation procedures

LCA tools: For the modelling as well as calculation of the LCI, Saint-Gobain environmental team used the LCA tool TEAMTM for the calculation of the LCI of the SG products.

Indicators and Environmental impact assessment methods

To assess the environmental performance of the studied solutions, the project will use the following environmental indicators, including impacts mid-point indicators recommended by ILCD. Midpoint indicators represent environmental issues, for example acidification, whereas the fate of the substances causing the environmental problems is not taken into account.

Indicators are the following:

- **Climate change**

Climate change is the impact of emissions from human activities on the radiation forcing of the atmosphere.The characterization factors applied here are based on the Global Warming Potential for a 100-year time horizon [IPCC, 2007].

- **Depletion of the stratospheric ozone layer**

The polar ozone hole formation consists in catalytic destruction of ozone by atomic halogens. Characterisation factors for ozone-depleting substances (ODS) which contribute to both climate change and ozone depletion impact categories, were implemented from the World Meteorological Organisation [WMO,1999].

- **Photochemical Ozone formation**

Photo-oxidant formation is the photochemical creation of reactive substances (mainly ozone) which affect human health and ecosystems. The characterisation factors applied here is the

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"photochemical Ozone Creation Potential" (POPC) [Van Zelm et al 2008 as applied in ReCiPe2008].

- **Air Acidification**

Acidification is mainly caused by air emissions of NH3, NO2 and SOX.The characterisation factors applied here are based on the Accumulated Exceedance (AE) indicator [Seppala et al 2006, Posh et al 2008].

- **Eutrophication**

Eutrophication includes all impacts due to excessive levels of macro-nutrient in ecosystems. Characterisation factors applied here are based on the Accumulated Exceedance (AE) indicator [Seppala et al 2006, Posh et al 2008] for terrestrial Eutrophication and concentration in P eq. and N eq. [Recipe 2008] for Aquatic Eutrophication.

- **Depletion of abiotic resources (ADP)**

For mineral and fossil resources depletion at midpoint, van Oers et al 2002 in the source of characterisation factors based on methods of Guinée et al 2002. Indicator is Abiotic Depletion potential, quantified in kg of antimony-equivalent per kg extraction, or kg of antimony-equivalent per MJ for energy carriers.

Validation of data

The general requirements regarding data quality are the following:

- Geographic scope: In term of geographic scope, the project focuses first on the production, implementation and dismantling of solutions in Spain. Indeed, data on Saint-Gobain production come exclusively from the site manufacturing the products in Spain.
- Time scope: The most recent available data have been used for all main products.
- Technical scope: The process technology underlying the datasets in the study reflects process as well as technical and environmental levels which are typical for process operation in the reference period.

Conclusion:

With this complete life cycle assessment we can assure that CLIMAVER solution is the solution less harmful for the environment in comparation with other solutions involving metal ducts and insulation products from Saint-Gobain.

References:

- ISO 14040:2006-Environmental anagement-Life cycle assessment-Principles and frame work
- ISO 14044:2006- Environmental anagement-Life cycle assessment-Requiremens and guideleines
- "Methodoly report: life cycle inventory study for steel products" from de wordsteel association.